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The International Magazine for the Wire & Cable Industries

ISSN 1463-2438

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The star of
SICME ITALIA IMPIANTI
KEEPS ON SHINING IN VIETNAM

One more big contract for SICME Italia Impianti in Vietnam
After the realization in 2008 of the factory in Hanoi for HANAKA Following the completion in 2008 of Hanaka Group's Hanoi factory, in March 2011 Dr Do Van Trac, General Director of SACOM Development and Investment Corp, and Ing. Franco Bensi, President of SICME Italia Impianti, signed an important contract in Ho Chi Minh City, to the value of approximately €2,000,000.

The contract foresees the supply of a complete factory of enamelling machines, lab testing Instruments etc. in Ho Chi Minh City, enabling the production of round and flat wire covering all the ranges.

This contract represents a further success for Italian technology in the world of enamelled wire, and awards SICME Italia Impianti, the first and oldest company producing this technology for 40 years.

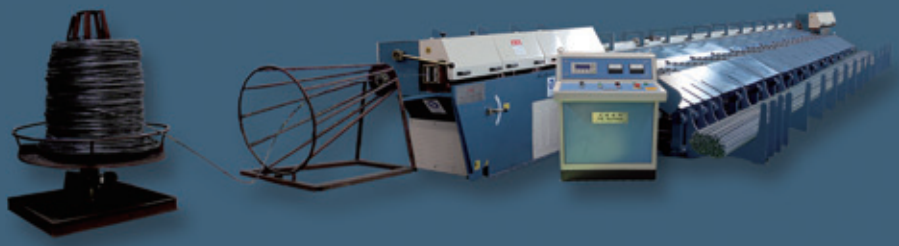
The success in this area is completed by NGO HAN Joint Stock Company, which bought a new vertical plant for its factory in Ho Chi Minh City, in November 2010.

SICME ITALIA IMPIANTI Via Torino 75 Druento (TO) ITALY
Phone: +39 011 98 44 567-Fax +39 011 99 45
sales@italiaimpianti.com aftersales@italiaimpianti.com www.italiaimpianti.com

STIRRUP BENDER WG-12D

STIRRUP BENDER WG-12B-2

WIRE STRAIGHTENING AND CUTTING MACHINE GT5-12



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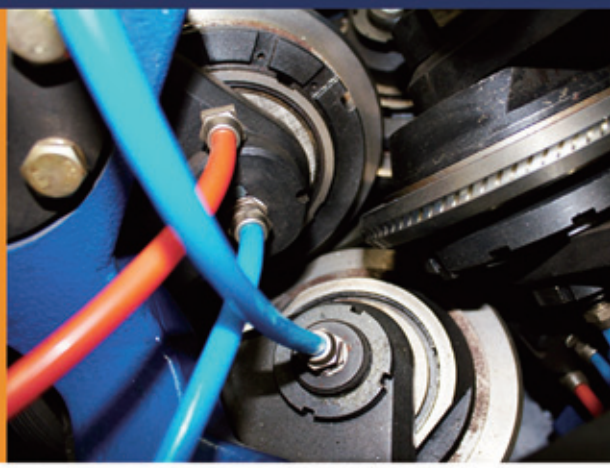
WIRE COLD ROLLING MACHINE LZ-9



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ALTANA

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Front cover: Sikora AG
See page 103 for further details

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Confidence running high as Interwire arrives

One thing which has struck me over the last couple of issues of EuroWire is the overwhelming confidence coming from within the industry.

Not only in terms of good news stories, the amount of record-breaking contracts being awarded, record profits being announced by some companies, and technological advances being made by investing in research and development.

There has also been a high number of company purchases and buy-outs – a sure sign of an industry gearing itself up for a return to a more financially stable period.

Whilst I think it is fair to say we're not out of the economic wilderness entirely, the green shoots of recovery bandied around somewhat prematurely by politicians a couple of years ago do seem to be taking hold and, in some cases, flowering.

There is an air of confidence – an ideal platform as we head to Atlanta, Georgia, for Interwire.

The biggest wire and cable show in the USA has undergone a transformation. Interwire is going back to its roots and has been given a whole new format. A brave move on the back of challenging times, but one that – from exhibitor numbers alone – seems to have paid off.

The exhibition – first held in the city some 30 years ago – has grown into one of the most influential in the Americas.

And if the confidence from organisers and exhibitors is passed down to the floor then the industry's emergence from an extremely trying and difficult period can only arrive sooner.

On a more personal note, I would like to thank everyone who has wished me well on my return to EuroWire, and I am hoping to meet up with many of you at Interwire.

David Bell
Editor

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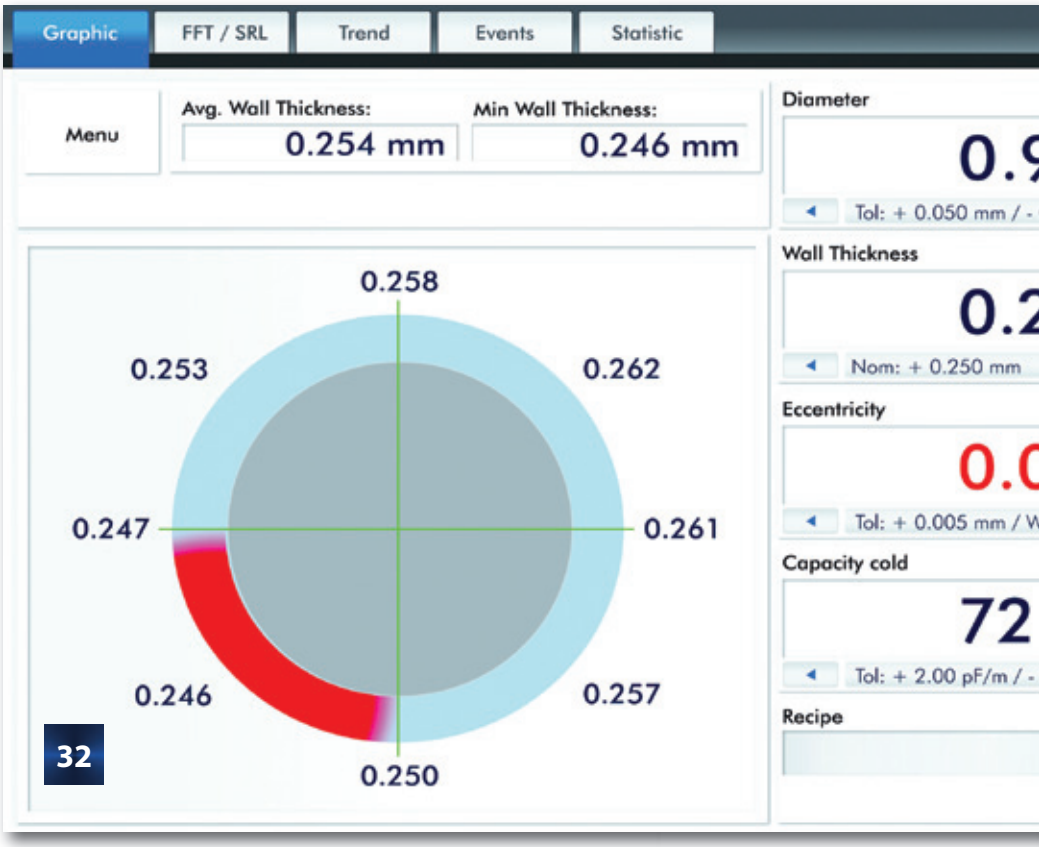
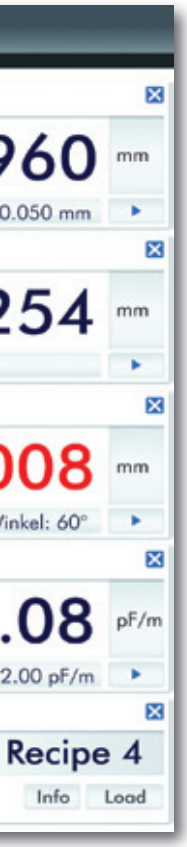
Only GOOD dies draw GOOD wire!

contents

Technical Articles





In The Next Issue

Features On

- Testing, measuring, monitoring & control
- Wire cleaning, treatments & finishes

Getting Technical

Reaction of fire performance of cables

dates for your diary . . .

'Versailles' Photo credit: www.bigstockphoto.com Photographer: 'Fyletto' (Filip Fuxa)

JICABLE 2011

June 2011

19–23: **JICABLE** – conference and trade exhibition – Versailles, France
Organisers: SEE
Email: jicable@see.assoc.fr
Website: www.jicable.org

2011

May 2011

3–5: **Interwire 2011** – trade exhibition – Atlanta, Georgia, USA
Organisers: Wire Association International
Fax: +1 203 453 8384
Email: info@wirenet.org
Website: www.wirenet.org

23–26: **wire Russia 2011** – trade exhibition – Moscow, Russia
Organisers: Messe Düsseldorf GmbH
Fax: +49 211 4560 7740
Email: info@wire-russia.com
Website: www.wire-russia.com

September 2011

13–15: **wire Southeast Asia** – trade exhibition – BITEC, Bangkok, Thailand
Organisers: Messe Düsseldorf Asia Pte Ltd
Email: wire@mda.com.sg
Website: www.wire-southeastasia.com

October 2011

4–6: **WiCAB 2011** – trade exhibition – Centro de Exposições Imigrantes, São Paulo, Brazil
Organisers: Grupo CIPA, Brazil
Fax: +55 11 5585 4359
Email: feira@cipanet.com.br
Website: www.cipanet.com.br

November 2011

6–9: **IWCS 2011** – conference and symposium - Charlotte Convention Center, North Caroline, USA
Organisers: IWCS
Fax: +1 732 389 0991
Email: info@iwcs.org
Website: www.iwcs.org

2012

March 2012

26–30: **wire/Tube Düsseldorf** – trade exhibition – Düsseldorf, Germany
Organisers: Messe Düsseldorf
Fax: +49 211 45 60668
Email: wire@messe-duesseldorf.de
Website: www.wire.de

▲ *An optical fibre plant, similar to the one being built in Russia by Nextrom. Inset. The project signing ceremony at the government hall in the presence of Mr Nikolay Ivanovich Merkushkin, President of the Republic of Mordovia; Mr Timo Id, managing director of Nextrom Oy and Mr Evgenij Fedorovich Bukaev, managing director of OVS signing the contract, from left to right*

Largest ever order for Nextrom

NEXTROM is establishing the first Russian optical fibre plant, located in Saransk, capital city of the Republic of Mordovia (about 650km east of Moscow).

This investment will fulfil the increasing demand of fibre driven by high speed telecommunication in Russia.

In the presence of the president of the Republic of Mordovia, Nikolay Merkushkin, the contract was signed with Optical Volokno Systems (OVS) by the project partners.

The strategic importance and significance of this project for the Russian Federation has been emphasised by Prime Minister Vladimir Putin.

Nextrom is the turnkey vendor for the technology, production equipment, infrastructure and supporting services. Nextrom's sister company Silitec, a specialist for single-mode and speciality fibres, will support Nextrom in providing engineering and plant operation services.

The factory will produce preforms and optical fibres based on Nextrom's leading VAD and FCVD technologies.

The plant will ramp up to full capacity within the next three years.

This project marks the next milestone in the fibre optic business for Nextrom and the Knill Group.

Nextrom OY – Finland
Fax: +358 950 253 003
Email: info@nextrom.com
Website: www.nextrom.com

DeRaps' 20 years' experience

Cerro Wire has hired Todd DeRaps, national contractor relations manager, to build relationships that will enhance better understanding of Cerro's value proposition in lowering their costs, in developing new products and services to enhance their business success and to partner in project businesses.

Mr DeRaps, who is based in Gilbert, Arizona, brings more than 20 years of success in the outside sales of electrical, telecommunication and networking products.

New range

Switzerland-based Kistler has developed a new range of indirect mould sensors which come with a single-wire, replaceable cable.

Kistler says the single wire simplifies mould manufacturing, as only a single bore hole is needed for the cable. In addition, several cables can be threaded down a single bore meaning the sensor is ideal for multi-cavity mould applications.

Record sales of nearly €3bn

LEONI, the leading provider of cables and cable systems to the automotive sector and other industries, generated record sales of some €2.96 billion (previous year: €2.16 billion) in the financial year 2010, according to preliminary calculations.

Apart from a further increase in the copper price, the forecast figure of about €2.8 billion was substantially exceeded thanks to a dynamic uptrend in demand from both the automotive industry and all other pertinent markets up to the end of the year.

The very strong increase in sales of cable harnesses and wiring systems for vehicles in the BRIC countries, as well as the USA, merits particular mention.

Likewise in terms of earnings before interest and taxes (EBIT) Leoni succeeded, with a figure of about €131 million (previous year: loss of €116 million), in clearly beating its most recent target of €120 million. Further restructuring charges incurred in the fourth quarter are already absorbed in this result.

Leoni managed to significantly exceed its target of at least neutral free cash flow. Consequently, net debt could be reduced by around €50 million according to preliminary figures, being again below equity at yearend for the first time since the onset of the economic crisis.

Leoni reaffirms its sales forecast of more than €3.1 billion for the 2011 financial year. The company is confident of generating further, significant increases in earnings. The recent impairment of production and logistics at the facilities in Tunisia and Egypt will, as it stands today, not result in any material financial burden.

Leoni AG – Germany
Fax: +49 911 2023 455
Email: info@leoni.com
Website: www.leoni.com

Bigger directory for wire and cable

Industrial Leaders, the original vertical American Industrial Directory and innovator of the B2B network Industrial Leaders Group (ILG), has launched its newly designed and larger cable and wire directory at www.dir.industrialcoop.com

ILG said the wiring and cabling products offered on the site include bulk, flexible, custom and standard (OEM) wire, low and high voltage, shielded, copper, high temperature, bare, Teflon®, electroluminescent, extra thin, automotive wire harnesses, heavy duty, rubber coated, precision, lock and galvanised wire, as well as custom cable, coaxial, delay, pulse, high temperature cable, twin axial, fibre optic, fibre channel, fieldbus, mechanical control, extra large cables and other types.

According to Industrial Leaders spokeswoman Iris Kurt, the cable and wire manufacturers on the site serve a wide range of industries and applications such as general manufacturing, material handling, construction, computer, electrical and electronic, winches, telecommunications, automotive and other wire and cable markets at www.foreigntradeexchange.com/suppliers/cable_wire.html

Kurt said ILG and its network recently added over 40 domestic and international designers, manufacturers and other suppliers of wire rope, power cable and ties, electrical building wire (US and foreign standards), stainless and copper wiring, complete automotive wire harnesses as well as a variety of industrial, networking, high temperature, telecom, flat, multiconductor, triaxial and coaxial cables and assemblies.

▲ *The Industrial Leaders' website with additional wire and cable companies added*

Industrial Leaders – USA
Email: info@industrialleaders.com
Website: www.industrialleaders.com

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www.supermacindia.com

Reaching the rural areas

FIBRE optics and all its benefits are now within reach of rural areas previously starved of advanced communications.

That was the key message from Alessandro Pirri, the head of connectivity and FTTx for Prysmian Cables and Systems, when he spoke at the FTTH Council Europe conference and exhibition in Milan.

In his address to an audience of international industry professionals as part of a "Voice of the Industry" session, Mr Pirri outlined the benefits of bringing fibre to rural areas, including its ability to maintain countryside culture, reduce migration to cities, encourage agricultural growth and enable home-working.

He also explained how Prysmian – a leading worldwide player in the energy and telecommunications cable market – has modified its QUICKDR@W® solution to aid FTTx deployment for projects in Europe and internationally.

QUICKDR@W® was originally designed to boost rapid FTTH rollout and is being demonstrated at the event.

"Using our expertise and technology, we have adapted our QUICKDR@W® pre-connectorised cabling system for successful use in low density areas right across Europe, where a "do-it-yourself" attitude must be supported by an easy to install product that requires minimal technical support," said Mr Pirri.

"So, focussing on customers' needs and responding to specific requirements, we have been able to deliver a reliable infrastructure based on low-cost cable installation using rural paths or cultivatable area borders, a high degree of mutualisation and do-it-yourself optical kits."

One scheme that Mr Pirri is set to highlight is that of the Yvelines Project in France through which 1,600 households and 25 SMEs across three villages were supplied with fibre using 12km of existing local authority ducts and 8km of rural distribution.

Working with FibTic – responsible for developing a sustainable optical fibre broadband implementation model across France – Prysmian used its QUICKDR@W® products and now intends to deploy over 200 DIY optical kits.

In addition to the Yvelines Project, Prysmian is also working with key telecom operators France Telecom, SFR and Free with the national rollout of fibre across the country and has demonstrated its cabling capabilities in several other countries in Europe.

Prysmian Cables and Systems – Italy
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New chief for new division

HOWARD Ungerleider, vice president for investor relations, has been named senior vice president for Dow, and president of the newly formed Performance Plastics Division.

The Performance Plastics Division will be comprised of all Dow plastics including solution polyethylene, wire and cable, elastomers, films and packaging resins and will include the packaging and converting unit that is currently part of the advanced materials division.

Its focus will be on high value market driven solutions in applications such as packaging, hygiene, food and telecommunications.

The division's formation reflects Dow's active portfolio management over the last two years that has resulted in the de-emphasis of its commodity plastics products, especially following the divestment of Styron.

Mr Ungerleider will join the Executive Leadership Committee (ELC) and report to Andrew Liveris, chairman and CEO.

His replacement as vice president of investor relations will be announced in the near future.

In a related move, Jim Fitterling, executive vice president, adds corporate development to his current Hydrocarbons Divisional leadership role.

He will assume corporate strategy development responsibility at the ELC level and will have responsibility for ELC, strategy and portfolio team (SPT), senior leadership team (SLT) and global leadership team (GLT) agendas, and oversight of the transformation project management office (PMO).

In addition, the chlorinated solvents business will move to the performance products and systems division and report to Juan Luciano, executive vice president and president of this division.

Dow will now have six business divisions: Dow Agrosciences, Advanced Materials, Performance Products and Systems, Performance Plastics, Chemicals and Energy, and Hydrocarbons, the first four driven by markets and technology, and the latter two driven by assets and feedstocks.

"These leadership and business moves are designed to further our transformation and our strategic shift to a diversified industry-leading portfolio of advanced materials, agrosciences, speciality chemicals, and now performance plastics businesses that deliver a broad range of technology-based products and solutions to our customers around the world," said Mr Liveris.

"Our Performance Plastics Division will have a technology, market-driven approach to intensely focus on downstream markets such as packaging, health and hygiene and food applications while we continue to optimise the commodity side of our plastics businesses.

"This division is positioned for further growth and market leadership in Dow's revitalised portfolio. I am excited to have Howard's focused leadership of this vital new division."

Dow Wire and Cable – USA

Email: info@dow.com

Website: www.dow.com

Follow us on:

facebook

You can now keep right up to date with all the latest in the wire and cable industry, simply by signing up to be our friend on Facebook. We update the site weekly, giving you the latest news of all the happenings in the industry, from the serious company buy-outs and mergers to the more light-hearted features.

Tweet us on:

twitter

Want news and quick? Then sign up for your Twitter account and follow us. Get short, bullet-pointed news throughout the week from the leading source of information in the wire and cable industry.

New Electrolock website launched

ELECTROLOCK Incorporated has launched a new website specifically targeting manufacturing professionals in the wire and cable industry.

Electrolock is an industry leader in designing, manufacturing, and converting high temperature electrical insulation materials for a wide range of wire and cable applications.

Since 1957 it has been developing material design solutions for applications requiring high performance electrical and thermal insulation products.

Available materials include but are not limited to: Cablosam® mica tape, Apical polyimide film, silicone glass, Craneglas, Mylar® film, and Nomex® paper.

Electrolock has the expertise and products to meet the needs of numerous applications including those with high temperature requirements.

These applications include appliance wire, flame barrier, circuit integrity, magnetic wire, traction motors and down hole pumps.

Rich Reed, sales manager, said: "We have a long history of quality, innovation, and technical leadership in many industries including electrical and thermal insulation.

"Our state-of-the-art electrical and chemistry laboratories keep us a step ahead in new product and process development.

"On top of that, our responsive and collaborative engineering ensure fast turnaround and short lead times."

Electrolock Incorporated – USA
Fax: +1 440 834 7525
Email: rich@electrolock.com
Website: www.wirecableinsulation.com

CIGRE appointment

DOW Wire and Cable's Simon Sutton, European End-Use Marketing Manager, has been appointed to the CIGRE Strategic Advisory Group (SAG) for solid insulating materials.

The SAG provides guidance to the Study Committee chairman and proposes topics for Working Groups within CIGRE's Materials and Emerging Test Techniques Study Committee (SC D1) whose scope includes, amongst others, cable insulation, silicone rubber and epoxies.

"CIGRE is one of the most respected international professional associations involved in all aspects of technology for electric power," said Tim Laughlin, general manager, Dow Wire & Cable.

"We are delighted that Simon was asked to join this Advisory Group to share his knowledge and expertise for the benefit of the industry."

Simon holds a Bachelors degree in physics with subsidiary mathematics and

▲ *Simon Sutton*

a Doctoral degree in physical properties of polymers, both from the University of Reading (UK). He is a Chartered Physicist and Member of the Institute of Physics.

Dow Wire and Cable – USA
Email: info@dow.com
Website: www.dow.com

Chemetall acquires Artech Technologies

Chemetall (Australasia) Pty Ltd has acquired the assets of Artech Technologies Pty Ltd, a speciality chemical company based in Geelong, Victoria, Australia.

Artech Technologies is a specialised supplier of high quality metal working fluids and surface treatment technologies. Established in 2002 as a privately owned company, Artech Technologies' customers are mainly located in Australia and New Zealand.

With the acquisition, Chemetall further strengthens its presence in the Australasia and South East Asia region and enlarges its product range for the metal working and surface treatment industry.

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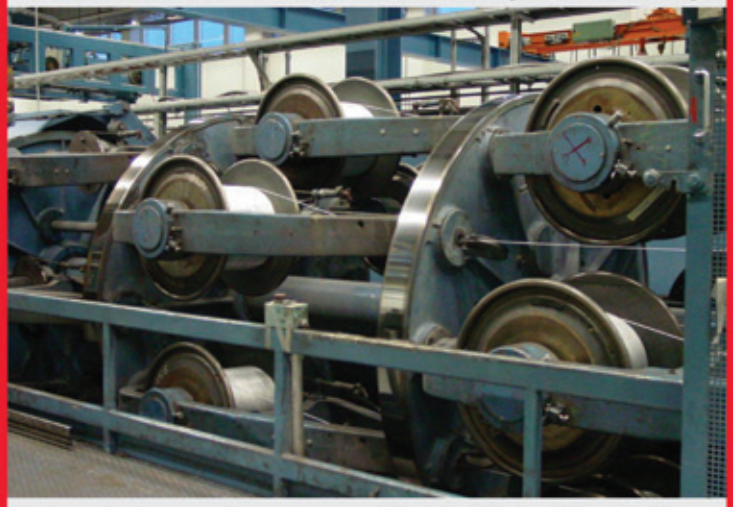

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SIMUFACT Engineering GmbH, a leading provider of software and services in the area of bulk metal forming, has released version 10.0 of Simufact.forming, its powerful integrated massive forming solution.

Registered customers will receive the new version by mail or can download the software at www.simufact.de/de/download

A major focus of the new version is the further improvement of existing software components and the addition of new functionalities.

Simufact.forming 10.0 offers more than 40 new functionalities alone in the area of pre- and post-processing, including new functionalities for the detailed modelling of larger and more complex models as well as an overall significantly improved handling.

In addition, the interaction between hexahedron meshing, parallel processing, and the use of cluster machines has been further optimised. In the area of massive sheet metal forming the software family offers new functionalities ie the design of progressive dies.

Version 10.0 introduces a wide variety of new functions, enhancements and updates, including:

- improved preprocessing capabilities
- new process menus and types
- flexible process definition
- improved postprocessing capabilities
- improved meshing techniques

New and enhanced modules:

- improved parallel processing capabi -lities
- improvements for die load calculation
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- flexible kinematics module
- improved rolling simulation
- improved ring rolling simulation
- improved control for incremental form -ing processes

Simufact Engineering GmbH – Germany
Fax: +49 040 790 162 22
Email: info@simufact.com
Website: www.simufact.com

Integrated production line for PV-ribbon

BÜHLER Würz Kaltwalztechnik and Maschinenfabrik Niehoff have presented a production line for manufacturing PV-Ribbon made of copper.

Ribbon is rolled by the mill from round copper wire and is tuned by in-line process by induction annealer to the desired mechanical properties.

Dimensions that can be handled are 1 to 7mm width and 0.03 to 0.7mm thickness.

The yield strength (Rp 0.2) of the final ribbon is ≤ 80Mpa, and the ultimate strain is > 25%.

The maximum speed of the production line is 1,000m/min, and this applies to the rolling process as well as to the integrated annealing process. For example, an output capacity of 1,500t/pa can be achieved for a solar strip with the dimensions 5.0 x 0.1mm.

Bühler Würz Kaltwalztechnik is a manufacturer of cold rolling mills for steel and non-ferrous alloys with long-time tradition and extensive experience in rolling technology for different applications.

Together with its partners, Niehoff develops production systems that address all of the needs and preferences of wire and cable manufacturers.

Constant improvements are incorporated into the production systems, reflecting the latest advances in technology.

Maschinenfabrik Niehoff GmbH & Co KG – Germany
Fax: +49 9122 977 155
Email: info@niehoff.de
Website: www.niehoff.de

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4-belt caterpillar capstans for offshore cables/umbilicals

Queins & Co, Germany, has supplied two heavy-duty caterpillar capstans to a Chinese customer, both laid out for a pulling force of 120 kN (12 tons) each.

The equipment can work with either two belts or four belts at a time.

Queins & Co GmbH – Germany
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Embracing 2D technology

IT was over 25 years ago that Whitelegg Machines of Crawley, UK, pioneered the development of fully automatic CNC wire forming and welding machines.

The latest Whitelegg CFM 12mm Wire Forming Machine is able to bend and weld wire from 3.mm-12mm, using the latest 2D technology and embodies accuracy, reliability and precision.

Machine models range from the CFM 400, 600, 800 and 1000, depending on the products being made; there is a 2D machine for anyone making flat components – from rings for lampshades to display stands, shopping trolleys, wire baskets and shelves for cookers and freezers.

Three roller wire feed wheels give extra grip and greater wire control making bend generation easier and flatter more consistent parts throughout the production run.

The touch screen icon-based software and simple functionality allows for ease of use by the operator.

A USB port on the command console allows for any software updates and programs to be uploaded.

The machine has the latest automatic butt welding feature, making the production process faster and more cost effective.

A parallel burr -free cut reduces the need for secondary operations and improves butt weld strength and clean finish.

The welding electrodes are adjustable, giving a big advantage when welding a large variety of products. Set up times and tooling changes are quick and easy to implement.

To complement the CFM range, Whitelegg offers the dedicated CFR ring former and welder. Incorporating all the advanced attributes of the CFM, the three machines in the range cover wire diameters of 2-8mm, with finished ring diameters between 50 and 1,000mm.

Whitelegg Machines Ltd – UK
Fax: +44 1293 538910
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▲ *This latest wire forming machine makes wire work for garden planters*

Las Vegas is home

Allied Wire & Cable's Las Vegas, Nevada, facility is the new home of sales manager Skip Bjorkman, a wire and cable industry veteran with more than 30 years' experience.

Skip will be the sales manager for the Las Vegas facility, which opened in November in last year. Mr Bjorkman has been in the wire and cable industry for more than 30 years and has an impressive resume to show for it.

DSM's new chairman

Royal DSM NV, the global Life Sciences and Materials Sciences company, has appointed Rob Routes as chairman of its Supervisory Board.

The 64-year-old Dutchman has held various positions at the Royal Dutch Shell group until 2008.

Superior design from DEM

DEM Wire Rolling Technology is a comprehensive provider of technology for cold forming of metals.

This includes the design and supply of cold rolling lines for processing steel wire rod into reinforcing wire for the construction industry.

DEM, with a large portfolio of rolling equipment for metals transformation, has now developed and supplied High-Speed Lines for Ribbed Bars which, starting from wire rod in coils, can finish 4 to 16mm diameter ribbed wire in straight bars in lengths ranging from 0.9 to 14m, running at speeds of up to 8m/sec and collected in bundles.

The superior design stands in the unbeatable straightness results and cutting precision that are achieved notwithstanding the high speed.

Bar straightness is ensured thanks to the special double straightening station. The smart design allows quick and simple set up of straightening rolls to match any production campaign. The precise cut-to-length at high speed is granted by the DEM patented bar braking and unloading device. This system consists of a continuously rotating shear, bar deviator, braking device and double channel discharging system, all controlled by an in-house developed automation package.

DEM straightening and cutting-to-length sections can also be installed on existing or newly delivered cold drawing/ rolling lines for the production of coils, as additional extensions to grant the production of straight bars.

DEM Wire Rolling Technology – Italy
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Website: www.demgroup.com

All set for Interwire

Zumbach's broad range of measurement and control systems for wire insulating and jacketing, wire drawing and rod mill applications will all be on show at this year's Interwire.

An extensive range of proven measurement solutions and the latest technological advancements will be demonstrated at the show at the Georgia World Congress Center, Atlanta, from 3rd to 5th May.

Zumbach Electronic AG – Switzerland
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LMH up and running

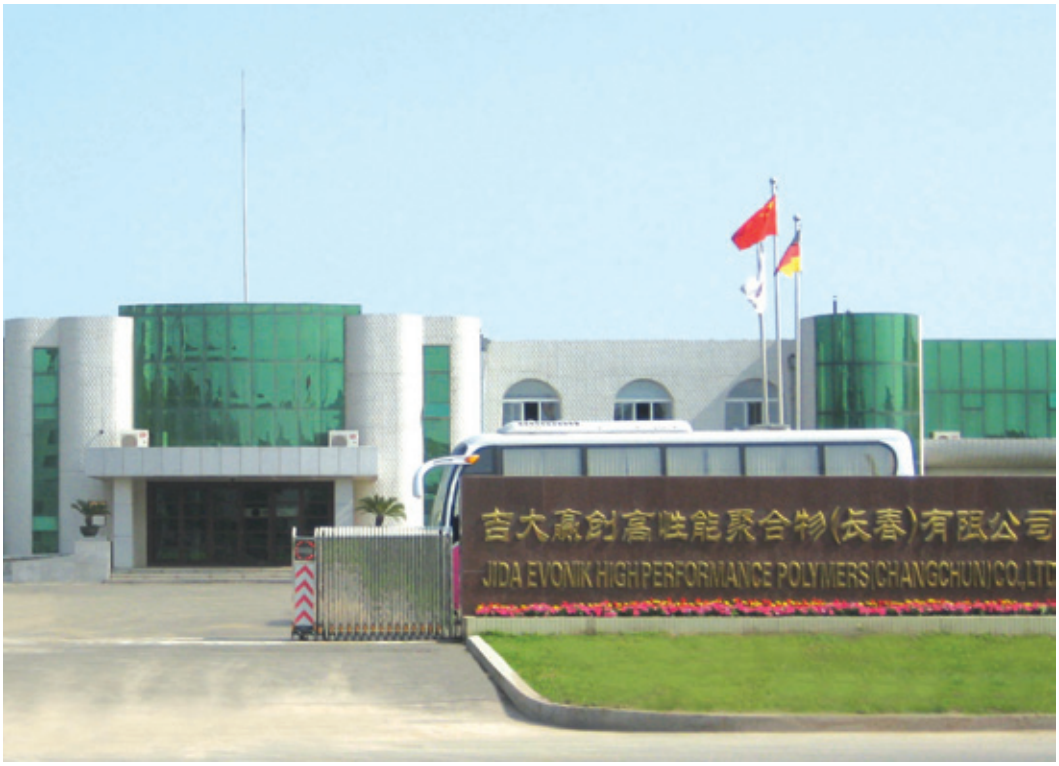
A new manufacturing business is up and running in Redmond, Oregon, USA, after LMH Industries leased a 17,000ft² building for new cable assembly manufacturing facility. Once they are up to full speed they hope to have 40 people working there.

Change of chairman

After three years as IWMA chairman Stephen Wood's tenure of office ended in February when he was succeeded by vice-chairman Colin Dawson, of Whitelegg Machinery Ltd.

Executive board member Steve Rika was elected as the new vice-chairman and Terry Robinson re-elected honorary treasurer.

▲ *Colin Dawson, new IWMA chairman*



▲ *The Changchun site in China*

Plant expansion for polyether boom

GERMANY-BASED Evonik Industries is expanding its polyether ether ketone (Peek) capacity in response to growing global demand.

Along with a number of optimisation measures, the company is modernising an existing plant at the Changchun site in China, which is scheduled to be completed by the third quarter of this year.

Evonik has been selling its highly temperature-proof and chemical-resistant Peek polymers under the brand name Vestakeep® for a number of years.

They are used for manufacturing components that must withstand long-term use under the most severe end-use environments.

"The capacity expansion not only reflects the continuous growth in all relevant industries, but is also the result of the successful commercialisation of numerous new projects. This expansion testifies to the on-going commitment we are making to support our customer's continued growth," said Sanjeev Taneja, Evonik's global business Vestakeep® manager.

Evonik has more than 40 years' expertise in high-performance polymers and enjoys an excellent reputation as a reliable partner in all relevant Peek segments.

Vestakeep® Peek polymers are used in demanding applications in medical as well as in the automotive, aerospace, semiconductor, and entertainment electronics industry and in the oil and natural gas sectors. Furthermore, thanks to the unique combination of mechanical, thermal and tribological properties Vestakeep® Peek allows the replacement of metal in these and several other applications.

Vestakeep® 5000G is the latest Peek polymer addition to Evonik's product range. The material offers significantly higher impact resistance and a better fatigue profile under dynamic stress as compared to commercial available grades. It addresses the unmet needs of the customers.

The company also introduced its Vestakeep® M and Vestakeep® i series for applications in the medical and implant industry two years ago. The comprehensive product portfolio covers virtually all industrial applications and supports Evonik's strategy of serving as a long-term, reliable partner in the Peek market.

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Antenna's green light

ROCKWELL Collins has received type approval on its SWE-DISH CommuniCase® Technology CCT120 antenna from two leading providers of satellite communications – Intelsat and Eutelsat.

A type approval confirms that the equipment meets the providers' operating performance requirements, ensuring that all units of the model perform in a similar manner.

"The approvals confirm the quality of our systems and make it simple for our customers to purchase the CCT120 with no need for individual verification of RF performance prior to entering the satellite operators' systems," said Bruce King, vice president and general manager of communications products for Rockwell Collins.

Before issuing the type approval, the satellite operators performed a thorough evaluation of the CCT120 with onsite review of production and manufacturing processes, along with an audit of quality assurance work.

Rockwell Collins SWE-DISH CCT represents a major advancement in compact, quick-to-air, portable SATCOM technology.

The flexibility of the CommuniCase Technology enables military personnel, broadcasters and emergency first responders to easily interchange components in the field to establish a new system configuration.

The modular system architecture creates a significant cost advantage when compared to competing solutions.

Rockwell Collins – USA
Email: info@rockwellcollins.com
Website: www.rockwellcollins.com

International presence

Violi Srl specialises in the design and production of industrial machinery dedicated to the manufacture of tubes, bars and wires, typically used in the processes of drawing, winding, straightening and cutting.

Founded in 1992, Violi boasts an established presence on the main international markets offering a range of comprehensive and very reliable drawing machines able to process metal profiles.

Violi srl – Italy
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Top player worldwide

PRYSMIAN Cables & Systems has confirmed its position among the top global players in the telecommunications optical fibre and cables sector, with overall production of around 10 million km of optical fibre in 2010 – equal to 5 per cent of the total worldwide industry production, and with a significant growth on 2009.

As a manufacturer of optical fibre, Prysmian has two active plants for its production, in Italy and Brazil. The group's technological and manufacturing centre of excellence is FOS Fibre Ottiche Sud, based in Battipaglia (near Naples) in Italy, one of the most advanced facilities in this sector.

In FOS, which began its activity in 1981, Prysmian concentrates most of its research and production activities in the field of optical fibre.

These fibres are used in the manufacture of cables at ten Prysmian plants worldwide, supporting the development of the main telecom operators' broadband projects, from BT, Telefonica and Telecom Italia in Europe, to Verizon in America, to Asia and Oceania, where Prysmian partners with Bharti Airtel in India, Telstra in Australia and China Mobile.

In particular, Prysmian has been recently chosen by the Australian Government and by the telecom operator Telstra for the development of the new national telecom broadband network.

Leveraging on its market and technological leadership, Prysmian is ready to play a leading role in future broadband projects in Italy.

After having deployed the first access optical cable network in Milan, together with Metroweb/Fastweb, followed closely by Rome, Florence and Bologna, Prysmian has been chosen as a partner for the new experimental national broadband projects launched by the country's main operators.

In another important project, Prysmian worked with Fastweb, Vodafone and Wind to install its FTTH optical cables to more than 7,400 users at Fleming Hill in Rome in what was the first mass testing of fibre optic deployment in Italy.

These have seen optical fibres installed into the existing duct infrastructure – demonstrating how high capacity broadband can be delivered in an economical and smart way.

Attention is now focused on the "Fibre for Italy" project which has been signed by Telecom Italia, Vodafone, Fastweb, Wind, H3G, Tiscali and BT in order to implement a new fibre optic network that will deliver 100 megabits/s connections.

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▲ *Emirates Steel 1.6 million tpy HYL Energiron plant with HYTEMP System, Abu Dhabi*

World's largest DR module

NUCOR Corporation, the premier steel producer in the United States, has signed a contract with Tenova HYL for the world's largest single DR module ever to be constructed.

Nucor will install a 2.5 million ton per year Energiron ZR plant using Tenova HYL's state-of-the-art reformerless process design.

The plant will be built in Louisiana, and will supply highly metallised, high carbon DRI to Nucor steel plants.

The plant will be designed to produce cold-discharge DRI of 96% metallisation and 3.0% carbon in the form of iron carbide, which will be shipped to the various Nucor producing facilities that will use the DRI in their steel making process.

Nucor, which has a long history of leading the industry in its innovative practices, continues to solidify its position with this new project and to further advance in its commitment to secure its long-term supply of quality iron feedstock.

The Energiron ZR process provides significantly low plant operating costs and through intrinsic characteristics of the process, allows the selective capture of CO_2 which can be commercialised as a valuable by-product. The DR plant will also comply with the strictest environmental regulations by the EPA in terms of NOx, SOx and other pollutants, having already been granted the corresponding air permit in Louisiana.

This new project covers the full supply of the DR plant, licence, training and technical assistance in commissioning and start-up.

With the support and backing of the Tenova Group, Tenova HYL will supply the full DR plant equipment manufacture and delivery to the client, mainly from USA and NAFTA, and will supervise the project implementation in the USA.

Roberto Pancaldi, chief executive of Tenova HYL, said: "This is a perfect fit in terms of providing the vanguard steel company in the US with what we feel is the vanguard technology in production of direct reduced iron for steelmaking".

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A look at the future . . .

One hundred and fifty young people from schools in South Yorkshire, UK, were given the opportunity to find out more about educational qualifications and careers in engineering at a special event at Sheffield Hallam University, which was supported by NAMTEC (the National Metals Technology Centre) and the Industrial Trust.

The event involved an inspirational talk by engineer and former Tomorrow's World TV presenter Kate Bellingham, with the whole event designed to inform, involve and inspire young people about the wide range of career opportunities.

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EMO Hannover

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Transatlantic Cable

Energy

After Japan, the American nuclear power industry takes stock

Writing from Washington in the *New York Times*, Matthew L Wald reported on a 24th March conference call in which John W Rowe, chief executive of Exelon Corp, sought to reassure investors – and the American public – about the safety of the company's nuclear reactors. Chicago-based Exelon is the largest operator of nuclear power plants in the US, with 17 reactors in 10 nuclear power plants. There are 104 such reactors in place nationwide.

Mr Rowe declared that his company is well prepared to "respond to emergencies not contemplated in the original [reactor] design." Even so, he said, after the Japanese crisis American regulators can be expected to impose new safety requirements on nuclear plants. He warned the investors that this could entail "significant costs" to the utilities that operate the plants. ("Exelon, Largest US Reactor Owner, Seeks to Reassure," 25th March). As to the safety aspect, Mr Rowe's views reflect those held by others in the domestic nuclear industry, who note that American reactors generally do not face the same risks that figured prominently in the problems at the Fukushima Daiichi complex in Japan. While seismic activity resists accurate prediction, most nuclear plants in the US stand on higher ground and are farther inland than their Japanese counterparts.

Christopher M Crane, Exelon's president and chief operating officer, told the *Times*'s Mr Wald that nuclear plants in the US also have some design features that he believes were absent at Fukushima Daiichi, including a system to control hydrogen buildup and a hardened vent system to safely remove the gas from the building. In addition, diesel fuel for the emergency generators at US plants is normally kept in buried tanks to prevent its being swept away, as happened in Japan.

Limited prospects for reactors

In the matter of fiscal stability, however, the nuclear power industry in the US is less well situated, and firms that had already struggled with financing problems are now likely to face new hurdles in the wake of Japan's troubles. Mr Rowe, whose company Exelon is focused on upgrading the output of its existing plants, told the *Times*, "I believe that there is little opening for new nuclear plants in the near future. But that view has come from economics, not from safety."

NRG Energy Inc had intended to add two new reactors at its South Texas project with a Japanese partner, Toshiba. But the New Jersey-based company said on 22nd March that it was "reducing the scope of development" to give the US Nuclear Regulatory Commission time to assess the lessons from Japan. Mr Wald wrote: "While NRG said it did not expect any changes in the design it planned to use, it faces other issues."

In May 2010, Tokyo Electric Power Co, which owns Fukushima Daiichi, took a nine per cent stake in the Texas project and said it might increase that to 18 per cent. Noted Mr Wald: "It is unclear whether the Japanese company can still afford the American commitment, given the multibillion-dollar cost of the Japan disaster."

- A further inhibiting factor in the South Texas project is that, even before the Japanese crisis, NRG was having trouble attracting buyers for the power. The US Energy Department requires proof of a customer base before it will guarantee a construction loan.

  Similar uncertainty hangs over a project at Calvert Cliffs, Maryland, about 60 miles from Washington, stalled since last year. The owner of two nuclear reactors there – Maryland-based Constellation Energy – was in a partnership with Électricité de France to build a third, but pulled out on grounds that the government's fee for a loan guarantee was too high. The French utility has said it will seek another partner.

- Reporting again a day later – this time from Athens, Alabama – Mr Wald described a tour hosted by the Tennessee Valley Authority of its Browns Ferry nuclear plant there. The plant's reactors are of the same design and vintage as those damaged in Japan, but with many more safety features in place. The agency, Mr Wald wrote, "seemed to be seeking to project a balance of confidence and openness to improvements, a challenge now faced by the entire American nuclear industry as the nation watches the Japanese struggle to contain their crisis."

More on Pacific Gas and Electric and those of its customers who want wireless radiation kept out of their homes

"Customers afraid of the radiation from the company's wireless SmartMeter may soon have a choice. Accept the device as-is. Or ask PG&E to turn off the meter's transmitter – and pay higher monthly bills."

Writing in the *San Francisco Chronicle*, David R Baker outlined the Pacific Gas and Electric Co solution to an issue reported in this space last time: the belief of many of the utility's customers that radiation from cell phones, laptops and other wireless devices can pose a health threat. The company, based in San Francisco, has faced increasingly strong protests against its installations of new electricity and gas meters throughout Northern and Central California. ("SmartMeters: PG&E Wants to Charge Users to Opt Out," 25th March).

The meters – which continuously deliver information to the energy grid – also enable customers to monitor their energy use online. But PG&E customers in the suburban counties north and south of San Francisco and the coastal regions near Santa Cruz and Monterey have complained that the signals cause headaches, nausea and dizziness.

In November, PG&E indicated that it might offer customers a way out of the $2.2 billion programme. The president of the California Public Utilities Commission ordered the company to submit its plan by 24th March, which it in fact did. But Mr Baker reported that the SmartMeter opt-out plan, which would need the commission's approval to take effect, has served only to further incense critics of the company.

"We consider PG&E's proposal to be one more false solution," Joshua Hart, with the group Stop Smart Meters, told the *Chronicle*. "We need to have public health hearings to get to the bottom of this. In the meantime, we need to stop installing these meters. It's insane."

Transatlantic Cable

The PG&E plan calls for the company to go on installing SmartMeters in houses, over the objections of the customer. The customer could, however, exercise an option to have the new meter's transmitter disabled, cutting off the wireless signal. Anyone who has already received a SmartMeter could do likewise – at a price.

- Since 2006, PG&E has installed nearly eight million SmartMeters in its service area. Predicting that as many as 145,800 of its customers would choose to have the signal turned off, the company would charge for sending a technician to disable the transmitter. A new, continuing, charge would also show up on the customer's monthly bill.

  Mr Baker described one of the payment plans proposed by PG&E, under which the customer would pay $270 up front and a monthly fee of $14 thereafter.

  A lower initial payment of $135 would entail a $20 monthly fee going forward. Opt-out customers moving to another residence could face an "exit fee" to cover reactivation of the transmitter on the SmartMeter at the previous address.

  A PG&E spokesman explained: "For those folks who don't want to participate, there are additional costs, and this will help recuperate those costs."

A major item is, of course, the necessity for a meter reader to check each opt-out household's electricity and gas usage every month. A fully operational SmartMeter bypasses this expensive function by sending data to the utility via wireless communication.

Metals

Historic high prices for copper prompt a switchover to aluminium for some important wire applications

As the global economic recovery gets up steam, a surge in the price of copper is prompting some US manufacturers to turn to another conductor of electricity: aluminium.

Makers of automobiles, such large appliances as air conditioners, and industrial components are switching in greater numbers to the much cheaper metal to help offset rising costs. Other products ripe for the change in allegiance include building wire and evaporator and condensing coils for commercial refrigerators.

As noted by Matt Whittaker of *Dow Jones Newswires*, the differential in price between copper and aluminium is now wide enough to justify the costs both to retool some manufacturing processes and to pay for the extra aluminium required to conduct the same amount of electricity as copper.

"There is a lot more engineering and development activity as these companies think about how to replace copper with aluminium," Mr Whittaker was told by Charles Belbin, spokesman for Atlanta-based aluminium producer Novelis Inc, a unit of India's Hindalco Industries Ltd. ("Record Copper Prices Prompting a Switch to Aluminium," 24th March).

A corroborating opinion was offered by Joe Walton, owner of Williams Metals & Welding Alloys Inc (Wayne, Pennsylvania), a processor and distributor of metals including copper and aluminium. He predicted "a new wave of relooking at products and seeing if there is a substitution available."

In fact, such substitution has been on the rise over the past decade as constrained mine output and demand from China boosted copper prices.

From February 2001 to February 2011, copper rose more than fivefold in price while aluminium gained only 66 per cent.

Concerns about Japan's nuclear crisis and high oil prices have clipped copper's recent record-setting rally to more than $4.60 a pound. But Mr Whittaker pointed out that that price is still well above the key $3.50 point at which it often becomes economical for a customer to switch to aluminium (now at around $1.15 a pound).

❉ Sales patterns at Graybar, a St Louis-based distributor of electrical products for the construction industry, suggested to Mr Whittaker that builders are likely to use more aluminium wiring during this summer's construction season than they have in recent years.

Graybar's sales of a type of copper wire commonly used in construction slipped six per cent from the last half of 2009 to the same period last year, while sales of similar aluminium cable rose six per cent, said Kent Duran, national product manager with Graybar.

"It's reasonable to think that our aluminium building wire sales will go up a minimum of 10 per cent" this year over last, Mr Duran told *Dow Jones Newswires*.

❉ Talbot Gee is chief operating officer with Heating, Airconditioning & Refrigeration Distributors International (HARDI), the trade organisation whose members represent 80 per cent of the dollar value of HVACR products sold through distribution. In Mr Gee's view, condenser coils and heat exchangers in commercial refrigeration applications are likely candidates for copper-to-aluminium substitution.

To this point, commercial customers have shown themselves willing to spend on large refrigeration units; thus these items have been less sensitive to high copper prices. Now, however, Mr Whittaker wrote, the price of copper has risen to such heights that aluminium will probably crowd out copper even here.

❉ According to estimates by major aluminium maker Alcoa Inc (Pittsburgh), if copper prices keep rising aluminium could displace copper to the extent of 20 per cent of the global refined copper market of 19 million metric tons annually. At current copper prices, that figure is 4-5 per cent, or about 800,000 fewer tons of copper being used.

Over the last five years annual copper losses-through-substitution have averaged 425,000 metric tons, or about two per cent of the market, according to estimates by Anglo-Australian mining giant Rio Tinto cited by Mr Whittaker. The mining company expects those losses to deepen to around three per cent of the market in 2010 and 2011.

Steel in particular . . .

❉ With the global economy in recovery since late 2009, the World Steel Association expects the industrial sector to drive an increase of 5.3 per cent in steel demand worldwide. In the US, where steel demand was down 41.6 per cent (to 57.4 million tons) in 2009, the steel industry should continue on a gradual improving trend as global demand picks up. During this period, highly efficient and cost-effective steel making technologies are enhancing the appeal of American steel in Asia and the Middle East, in particular.

Transatlantic Cable

As noted by Zacks Investment Research (24th March), nearly 55 per cent of the steel produced by minimill operator Nucor Corp (Charlotte, North Carolina) is under long-term price contracts, which should help maintain profitability for the company during even a prolonged economic recovery. Nucor's Castrip technology, Zacks said, "will structurally lower its cost of production and lead to meaningful long-term savings."

Another firm mentioned by the ratings and advisory service was AK Steel Corp (West Chester, Ohio), which for first-quarter 2011 expected a seven per cent production increase (to 1.45 million tons) as well as an eight per cent increase in its average per-ton selling price. The company, which also posted strong results for the last quarter of 2010, attributed its brightening outlook to a better product mix and anticipated higher contract and spot market prices.

- The World Trade Organization on 25th March agreed to rule on the legality of Chinese dumping and countervailing duties applied in 2009 to more than $200 million of imported American-made flat-rolled electrical steel products. The US had complained to the WTO that China failed to disclose the facts on which its conclusions rely and to explain its method of calculating penalties as high as 25 per cent.

In brief . . .

- Citing "significant and relentless cost increases in raw material feedstocks," Dow Wire & Cable on 18th March announced a price increase of $567 per metric ton on its wire and cable compounded products and elastomers in Europe, Russia, Africa and the Middle East. The Horgen, Switzerland-based business unit of Dow Chemical Co (Midland, Michigan) said the increase took effect with 1st April shipments.

Telecom

How the advent of the iPhone helped derail Deutsche Telekom's American project

When AT&T on 20th March announced that it had agreed to buy T-Mobile USA from Deutsche Telekom for $39 billion, it proposed a deal that will greatly alter the mobile telephone industry in the United States. The merger would combine the nation's second- and fourth-largest cellular carriers and bring together AT&T's 95.5 million wireless subscribers with T-Mobile's 33.7 million customers.

Immediately the proposed transaction raised alarms about higher prices for American consumers. Only three major cellular carriers would remain standing: AT&T, Verizon and the much smaller Sprint, which might then be forced to look for a merger partner of its own. The deal characterised by Randall Stephenson, AT&T's chairman and CEO, as "a major commitment to strengthen and expand critical infrastructure for our nation's future" must be approved by regulators in Washington.

One certainty is that, except for an eight per cent equity stake that it will hold in AT&T, Deutsche Telekom is no longer in the picture, and Kevin O'Brien of the *International Herald Tribune* has a theory about that. The title of his DealBook blog for 21st March says it all: "How the iPhone Led to the Sale of T-Mobile USA."

Until Apple introduced its highly popular touchscreen device in 2007, Mr O'Brien wrote, the German company had been generating "decent" sales from its American operation, with growth in some years surpassing that achieved at home.

But the iPhone, which famously would go on to become the world's leading smartphone, was an omen for Deutsche Telekom from the beginning.

"After the iPhone became available, sold exclusively at first by AT&T in the United States," noted Mr O'Brien, "T-Mobile USA began to lose its most lucrative customers." These were the subscribers on fixed monthly plans who defected to AT&T and later to Verizon Wireless, which began selling the iPhone in February 2011.

According to T-Mobile USA's annual reports, the percentage of the company's contract customers fell from 85 per cent in 2006 to 78.3 per cent in 2010. In 2010 alone, T-Mobile USA said, it lost 390,000 contract customers to rivals.

- "The iPhone effect cannot be underestimated," DealBook was told by Theo Kitz, an analyst at Merck Finck, a private bank in Munich. "Without being able to sell the iPhone, T-Mobile was in an unsustainable position and T-Mobile USA became a problem child." In the end, Mr Kitz said, that decline in contract customers was decisive for Deutsche Telekom. He estimated that, after factoring in the costs and profit generated by T-Mobile USA over the course of its engagement, Deutsche Telekom will see a profit from the sale of about $710 million. The Deutsche Telekom chief executive, René Obermann, said the operator would use those proceeds to modernise its European networks, which extend from Germany to Britain, the Netherlands, Austria, Poland, the Czech and Slovak Republics, Hungary, the Balkan peninsula and Greece.

- While media coverage has emphasised the benefits to AT&T, the proposed merger would also confer a significant benefit on T-Mobile USA. Both companies operate on the same wireless standard, GSM. With access to AT&T's forthcoming 4G LTE (Long Term Evolution) standard, T-Mobile gains a way into the next generation of cellular development.

Automotive

- Notices of production cutbacks, not shutdowns, in the US auto industry began to appear soon after the 11th March earthquake and tsunami that ravaged Japan. Toyota Motor Corp on 23rd March warned employees to expect a halt in some American and Canadian production. Together with General Motors Co, of the US, and Paris-based PSA Peugeot-Citroën, Toyota said it planned to curb output of some vehicles in the US and Europe due to concerns about a shortage of critical parts made in Japan, mainly a small electronic part that measures airflow to car engines.

  In a statement released in New York, Toyota – which was the first Japanese car maker to enter the US market – said the impact in North America should be mild because most parts used by its 13 plants there come from suppliers nearby.

- Most analysts of the US auto industry tended to concur with Toyota's expectation of a limited effect. They looked for only sporadic production problems for several months, mainly deriving from shortages that had developed before the Japanese disaster. Tight supplies of microchips and other electronics, sensors, and rubber and forged metal parts had already caused auto makers to slow or even temporarily halt production lines before the emergency.

  "You are going to see a somewhat higher rate of plant shutdowns, but I don't think it's going to be widespread," Craig Fitzgerald, an automotive supplier analyst with the accounting and consulting firm Plante & Moran (Southfield, Michigan) told the *Wall Street Journal* (23rd March). In his view, the plant shutdowns and supply shortages are unlikely to affect overall production volumes but could hurt profit margins for American auto makers and suppliers. "It's going to be sporadic and moving around," said Mr Fitzgerald.

Elsewhere in automotive . . .

- The United Auto Workers announced a new push to recruit US workers at one or more foreign auto makers, and will train activists and send them abroad to organise rallies and protests in chime with the union's campaign. On 22nd March, in Detroit, UAW leaders outlined plans to reach out to foreign unions and consumers in what would be their first major campaign since failed efforts in Japan over the last decade: at Nissan Motor Co and the automotive components manufacturer Denso Corp, a member of the Toyota group. This time, the union is hoping for success with its overtures to foreign unions at the auto makers' overseas plants.

The economy

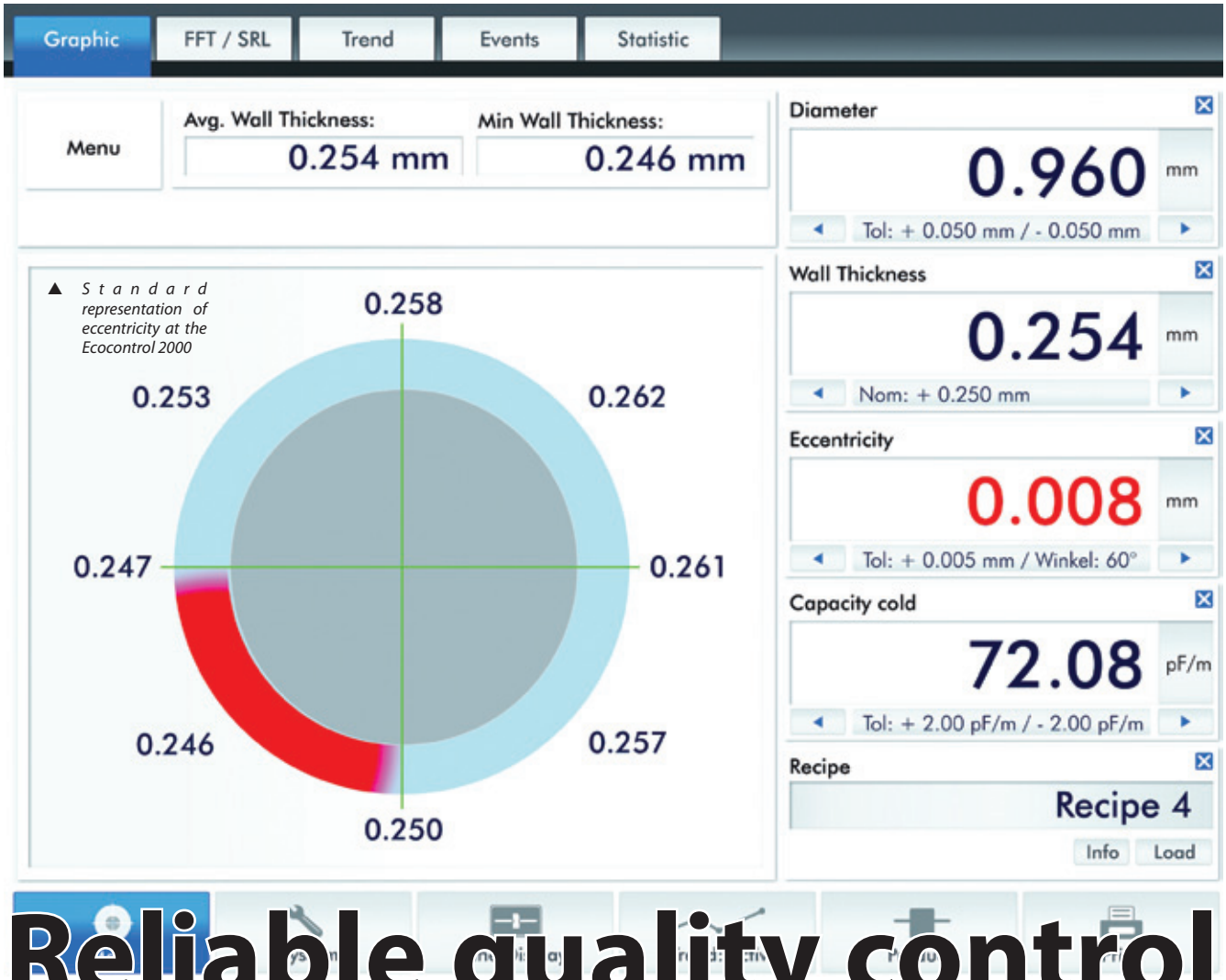
The recovery in the US is still sluggish, but GDP keeps growing and employment continues to pick up

The UCLA Anderson Forecast is published quarterly by the Anderson School of Management of the University of California (Los Angeles). In its latest edition, released 9th March, the report "On the Mend" by senior economist David Shulman calls for real growth in US Gross Domestic Product (GDP) of 3.8 per cent in the first quarter, with three per cent growth expected through the end of 2013. Mr Shulman wrote, "The US economy is getting better. Slowly, in fits and starts, real GDP is growing and employment is increasing."

The "cautiously sanguine" forecast envisions payroll employment increases of 1.9 million in 2011, 2.6 million in 2012, and 3 million in 2013. It sees the economy being propelled by strong increases in corporate spending and software, with the impetus for this spending coming from extraordinarily low interest rates, a rapidly recovering stock market, and investment incentives coming out of Washington DC. Mr Shulman wrote: "Independent of policy, investment is being spurred by technological advances in wireless and cloud computing, along with new natural gas drilling and technologies that are reshaping the nation's energy map. As a result, the real business investment share of GDP will increase from 12.8 per cent in 2010 to 15.4 per cent in 2013."

- A 25th March report from the US Commerce Department, showing more robust economic growth last year than had been estimated, appeared to justify the Anderson Forecast optimism. For an increase revised upward from the previous estimate of 2.8 per cent, the nation's GDP was found to grow at a 3.1 per cent annual rate in the fourth quarter of 2010. Consumer spending, accounting for some 70 per cent of the economy, rose at a 4 per cent pace in the fourth quarter, the most since the same period of 2006 and up from a 2.4 per cent rate in the third quarter. The upward revision to growth was paced by a bigger increase in business investment and a smaller decrease in stockpiling than previously estimated. For all of 2010, the economy expanded 2.9 per cent, the most in five years, after shrinking 2.6 per cent in 2009.

Dorothy Fabian – USA Editor



Reliable quality control

THE Sikora Centerview 8000 is the successor of the successful Centerview 2000 and is equipped with unique functions such as the 8-point-eccentricity and ovality measurement, a patent-pending cloud diagram and numerous improvements of precision and performance.

Centerview 8000 is a non-contact gauge head providing continuous online measurement. The 8-point eccentricity, 4-axis diameter and 8-point ovality measurements ensure highest accuracy. The system is perfectly suitable for the production of coaxial cables, LAN cables as well as automotive and installation cables. Sikora offers two versions, each specifically designed for the product: Centerview 8010 for product diameters from 0.1 to 10mm and Centerview 8025 for product diameters from 0.5 to 25mm.

Centerview 8000 combines an optical and inductive measuring technique. With the inductive measuring circle the position of the conductor is determined and the gauge head automatically centered to the cable position. Guide rollers and manual configuration are unnecessary. This unique characteristic makes for easier set-up, handling and operation of the unit. The reliability and undemanding usage are appreciated by every operator.

The optical part of the system is based on the principle of the diffraction analysis combined with pulse-driven laser diodes, whose light beam projects a picture of the cable on CCD-line sensors in each of the four measuring axis. Within microseconds eccentricity, diameter and ovality are calculated from the image of the product.

In order to achieve precise single values in the sub micrometre range the design of the gauge head does not include rotating mirrors or optical lenses. The lack of moving parts in the system ensures freedom from maintenance and guarantees reliability at all line speeds.

Calibration is done only once and is unnecessary thereafter. Accurate measuring values, high quality and production optimisation combined with substantial cost reductions are the principal benefits.

The cloud diagram is an additional way of presenting the measured values of the ongoing measurement at the Ecocontrol.

The cloud diagram provides information on the distribution of short term variation of eccentricity in graphical form. Each dot corresponds to a single measured value of eccentricity in relation to the amount and angle.

The extension of the cloud diagram is an indicator of the standard deviation of eccentricity.

A circle type distribution of the single values of the eccentricity indicates their fluctuation range. This display is helpful to optimise the process in terms of minimising standard deviation.

A ring type cloud diagram indicates that there is a permanently rotating eccentricity value.

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Increasing network efficiency

ADVA Optical Networking has added a coherent express layer to its flagship FSP 3000 platform.

The new technology has been optimised for 100Gbit/s transmission speed and enables service providers to use optical network resources flexibly and on-demand. Close interworking with the IP/MPLS layer allows a massive increase in network scalability and efficiency.

The feature set represents a new generation of agile optical core networks and includes the following three critical elements:

- Optical layer fully optimised for 100Gbit/s coherent transmission technology – Besides the obvious benefit of increasing the capacity per wavelength, the true power of the technology lies in the extra link budget gained with coherent detection. To benefit from the extra link budget, the 100Gbit/s capabilities are complemented by cost-effective, compact and performance-optimised amplification schemes, all fully integrated into the control plane. The new 100Gbit/s "pipes" are not only bigger, but smarter as well.

- Latest ROADM technology – ADVA Optical Networking's Reconfigurable Optical Add/Drop Multiplexer (ROADM) solution is based on modular building blocks that support colourless, directionless, contentionless and gridless configurations. Customers can opt to deliver any transport service on any port, over any wavelength, to any direction in a network. Integrated amplification provides lowest nodal loss and highest transmission performance.

- End-to-end service and bandwidth management – To make full use of 100Gbit/s and ROADM technologies, ADVA Optical Networking has fully integrated them with a powerful control plane. The control plane acts as the messaging layer for ADVA Optical Networking's Service Manager and allows providers to provision a service from end to end in a network, removing stress from the IP/MPLS layer.

"Today's present solution – simply adding more bandwidth – does not sufficiently solve the underlying capacity and efficiency problems," stated Eve Griliches, managing partner at ACG Research. "Instead, service providers are asking for an agile and scalable approach with fewer sites, which will enable operators to architect networks with intelligence to increase their profitability in this increasingly competitive market. ADVA Optical Networking is addressing all of these issues."

"The bandwidth demand in the core of our network is increasing at an accelerating pace," said Joachim Bellinghoven, chief operating officer at Versatel.

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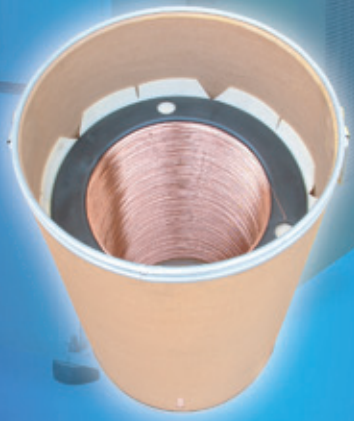
GIMAX group

EXPERIENCE, KNOWHOW AND RELIABILITY IN THE HANDLING OF FERROUS & NON-FERROUS WIRE

Solutions for solid
and tubular welding wires
(MIG/MAG, flux cored,
stainless steel, aluminium,
bronze, titanium)



GIMAX group

RESPOOLING

POLIDIGITAL

Extremely flexible semi-automatic precision layer respooling, with versions available for sub-arc wire and for spoolless coils. Digital control with multilanguage touch screen user interface, possibility of ethernet or modem connection, and highest degree of flexibility in terms of wire or spool types and sizes.

ROBOBINA

Totally automated precision layer respooling, designed for high speed and maximum production. Capable of handling plastic and fibre spools as well as wire baskets. No operator required. Digital control with multilanguage touch screen user interface and possibility of ethernet or modem connection.

DRUM PACKING

INF-2 PAIL PACKER

Highly versatile, no-twist coiling of wire into drums. Round, square, octagonal drums, up to 1000kg.

INF-4 PAIL PACKER

High speed no-twist coiling of wire into drums. Extremely compact unit. Round, square, octagonal drums, up to 1000kg.

INF-6 PAIL PACKER

No-twist coiling of large diameter wire.

DRAWING, COPPERING, SHAVING, CLEANING

WET DRAWING & COPPERING for steel wire.
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Steelmaster products extended

ZUMBACH Electronic AG has recently extended its range of Steelmaster rod and bar gauges with a further and larger model.

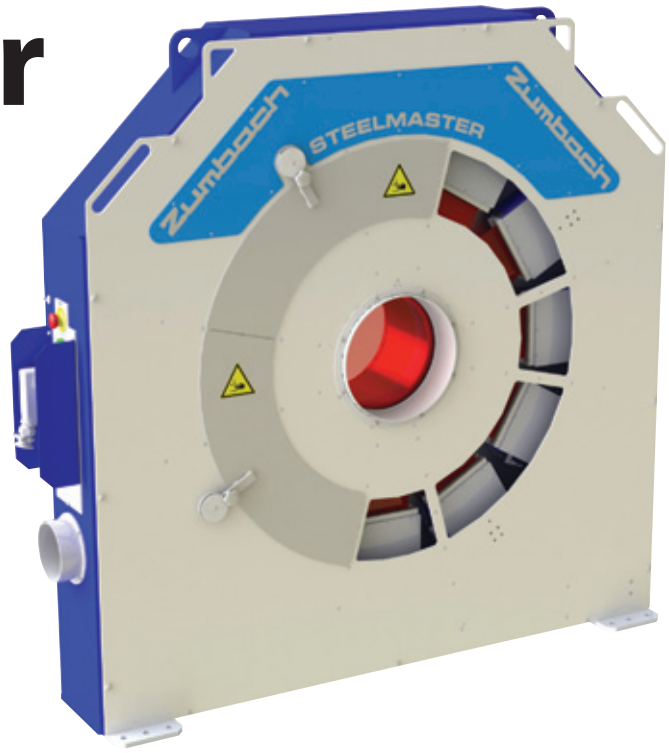
The new gauge, SMO 160-S6, is equipped with six high-speed laser scanners ODAC® 160 and delivers up to 6,000 measurements/s ie 1,000 processed profiles/sec. It also features Zumbach's calibrated single scan system (CSS) and the unique EPM method and software.

The gauge is able to measure rounds, hex, squares, flats and various shapes with outside dimensions up to approximately 140mm (depending on product vibration) in multiple modes:

- Static, orientable mode: measures in six directions, 30 degrees spaced
- Partial oscillation mode: programmable start and stop angle, eg for squares or flats
- Full 180° oscillation: standard mode for rounds, every 30° rotation delivers a full profile

The new EPM method and software, in combination with CSS, makes the gauge a very effective tool at three roll blocks or when the bar has polygonal or asymmetric shape deviations, eg asymmetric underfill or overfills. It calculates the typical values DT and GT for the initial roll settings.

It can also calculate and displays "Roundness" RON t according the official ISO definition for any shape.



▲ *The SMO 160-S6 measuring unit, shown partially open in maintenance mode*

The mechanical system is the same as the well proven design of the smaller gauges and requires minimal maintenance and periodic cleaning only.

Smaller gauge models for wire rod and smaller sizes are also available.

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Beating the cold conditions for wind turbines

Two high-performance vinyl jacketing compounds from Teknor Apex withstand the harsh cold, exposure to lubricants, and other challenging conditions encountered by control and power cables within the nacelles atop wind turbine towers.

Drawing on its expertise in compounding elastomeric materials, Teknor Apex has taken two different approaches to meeting the rigorous requirements of wind turbine applications:

- Flexalloy® 9609-80 is an 80 Shore A PVC-based elastomer that provides superior long-term UV resistance. It exhibits a brittle point of -60 °C.
- Apex® N-56001 is a 76 Shore A blend of PVC and nitrile rubber that provides superior long-term low-temperature flexibility and oil resistance. It exhibits a brittle point of -54°C.

Besides exceeding application standards for impact resistance at temperatures down to -40°C, both compounds pass required tests for UV resistance, 60-day oil aging at 75°C, and flammability performance as specified in UL 1685-F4. The two compounds are rated at 105°C for maximum continuous operating temperature.

"Teknor Apex has developed Flexalloy 9609-80 and Apex N-56001 to provide cable manufacturers with different options for meeting application requirements," said industry manager Mike Patel.

"Both products are high-performance alternatives to the standard flexible vinyl compounds used in cable jacketing and are particularly valuable for their cold-impact and oil-resistance properties."

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New range on offer

DAETWYLER Cables presented a newly developed range of 19" high-density ODFs (Optical Distribution Frames) for use in FTTH backbone and distribution networks at the FTTH Conference in Milan, Italy.

With up to 6,624 LC connectors on 47 rack units (U) the optical distribution frames allow the highest port density on the market to date.

Despite high packing densities the ODFs offer clear patch cable management and ample space for convenient assembly, splicing and patching.

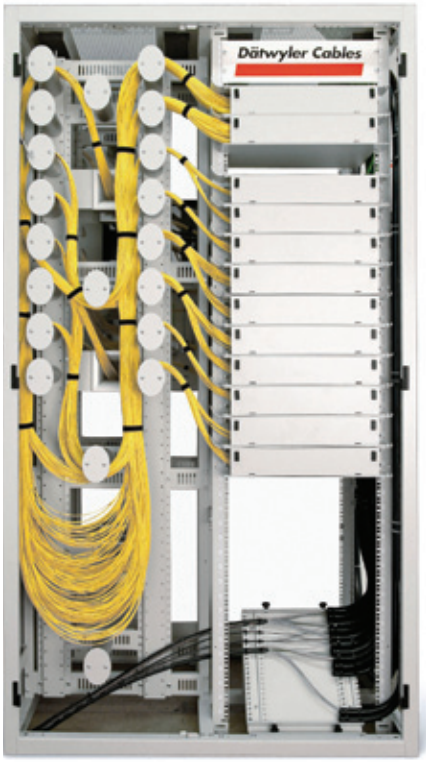
The standard version ODFs are supplied as a 19" rack of 42U and 47U at heights of 2,000 and 2,200mm, respectively, both of them 1,200mm wide and 800mm deep.

In the 42U standard model up to 2,880 optical fibres, and in the back-to-back version as many as 5,760 fibres, can be connected to LC ports. The 47U model has space for 3,312 and 6,624 LC connectors.

Daetwyler Cables can also supply the ODFs in other dimensions, for example in a depth of 400 or 600mm, or in individual heights.

The ODFs provide a sophisticated patch cable management system which allows the easy vertical and horizontal organisation of patch cables and adequate space for routing and storing surplus lengths.

In addition to storage space for spare conductors they have an integrated cable splitter box which can also be mounted in the floor cavity, on the roof or on the side wall as required, semi-circular and circular bend radius control devices on all fibre guideways to prevent excessively tight bend radii, and splice panels preloaded with pigtails.



▲ *Part of the new range from Daetwyler*

The basic equipment also includes top and bottom cable entries, an earth rail on the front, pre-assembled levelling feet and variably mountable depth profiles.

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Sylvin develops NSF 51 approved compound

Sylvin Technologies has received NSF International approval on a newly developed flexible vinyl compound.

The compound has been specifically approved for compliance to NSF/ANSI Standard 51 which regulates what materials are suitable for use in food equipment products. The compound, Sylvin 2942-75 is approved for food zone – non food contact applications.

Sylvin 2942-75 is a 75 Shore A profile extrusion grade compound that incorporates ingredients sanctioned for use by the FDA.

Typical applications for this product would be commercial or residential refrigeration and freezer gaskets.

NSF International certifies products and writes standards for food, water and consumer goods.

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Third generation Interface to Advaris

iiM AG – the specialist for offline measurement of geometrical cable insulation features – has introduced the third generation of its software products this year.

With a new, improved handling and new options and possibilities, not only the cable measuring software "FlexMeasureCable 3" stands out, but most of all the compact CAQ system "iiM ProCable 3" and the iiM cable database set a complete new quality standard.

Both the data security and the performance have increased significantly through the new database platform (MS SQL server).

On the one hand the internal database structure reflects a higher security requirement and on the other it reflects more than ten years experience in the field of "CAQ for cable producers".

As with the previous versions "iiM ProCable 1" and "iiM ProCable 2", the management of orders and products with their testing plans cover the practical requirements of the cable industry, wherein there is normally a large variety of different products often with very similar test requirements.

The possibilities of database queries and filters for the most different, practice-oriented criteria have clearly increased.

For this development, great importance was attached to a close and intensive cooperation with many important cable producers.

The results are graphically displayed in bar chart diagrams. Additionally to this, distribution displays and histograms have been added. The additional logistical information is very easily selectable and therefore optimal for each purpose.

iiM AG still leaves the ongoing data analyses for the available special programs so that "iiM ProCable" remains compact and slim. The export-interfaces to qsstat® (QDAS) and MS Excel have been further improved.

Another highlight in the field of measurement data security and traceability is the interface between the geometrical measuring devices of the VisioCablePro® family and the very common and popular ERP system ADVARIS® in the cable industry.

With the complete kit from cable construction to industrial data acquisition and right up to quality modules, the company ADVARIS® is also specialised for the requirements of the cable industry.

Therefore it is also an important and logical step to be able to use an easy, automatic and secure data transfer between the VisioCablePro devices and the Q-module from ADVARIS®.

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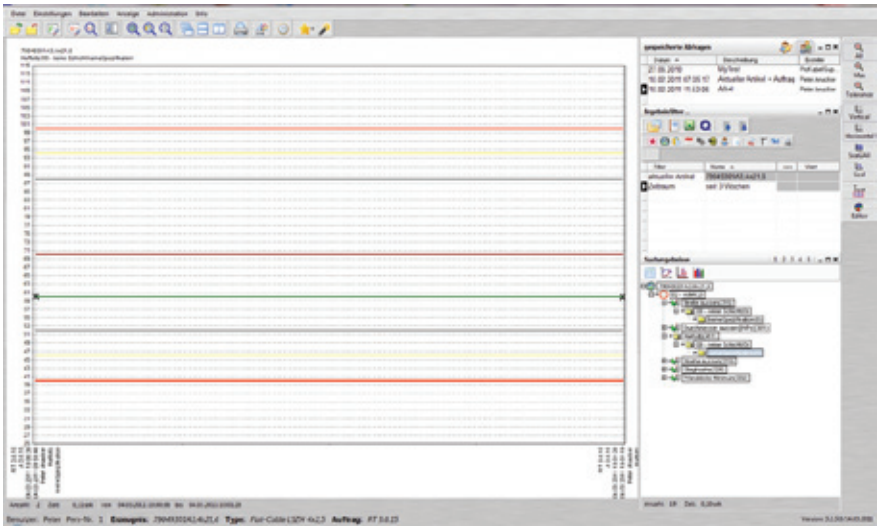
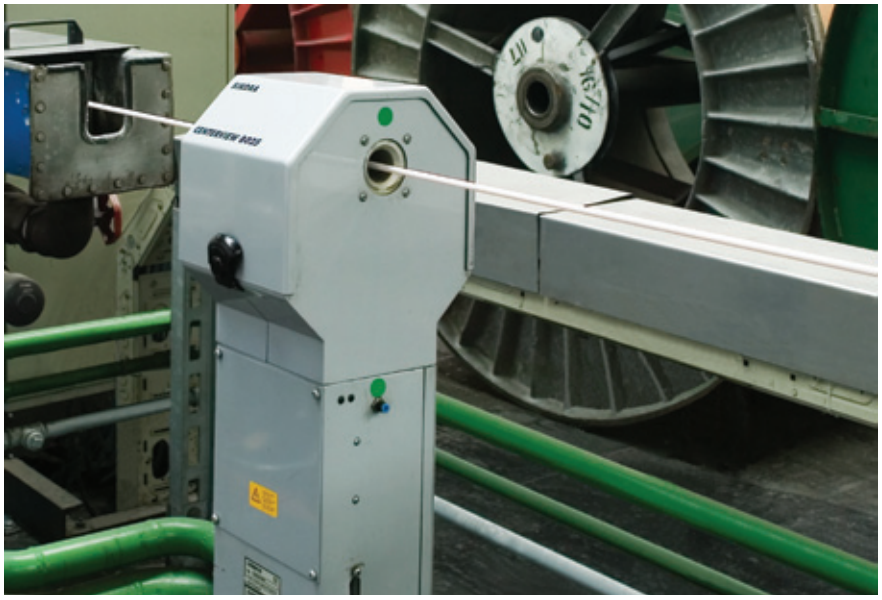


▲ *Covering the practical requirements of the cable industry – iiM*



▲ *Centerview 8000 installed in-line*

Cables without data loss

THE manufacture of data cables demands a consistent control of the cable diameter, eccentricity and capacitance regarding periodic variations. Sikora offers innovative, user-friendly measuring systems, which are specifically developed for quality control of data cables during the production process.

The diameter gauge heads of the Laser Series 2000 and 6000 operate with the patented Laser Shadow projection principle. By evaluating diffraction information for the diameter determination, a single reading precision as high as 0.2µm besides a measuring rate of 2,500 measurements per second is achieved. This precision is maintained because no moving parts are included in the gauges. By means of the integrated measuring value display in the gauge head the operator gets the accurate diameter value at a glance.

The Centerview 8000 combines diameter and eccentricity measurement. Using optical and inductive measuring technologies, high-precision single eccentricity readings with a high measuring rate at the same time are also supplied by these gauges.

The cloud diagram is an innovative display format of the ongoing measurement at the processor system Ecocontrol. It provides information on distribution of short term variation of eccentricity in graphical form. Each dot corresponds to one single measuring value of the eccentricity in relation to the amount and direction. The extension of the cloud diagram is the indicator for the standard deviation of the eccentricity. For example, a circular distribution of the single values shows its range of variation. The display helps to optimise the extrusion process with regard to a minimum standard deviation.

In Sikora's capacitance gauges, Capacitance 2000, a short and a long measuring electrode are integrated in one tube. The short sensing electrode of 10mm length allows for a reliable measurement of fast periodic capacitance fluctuations for the FFT-analysis and prediction of the structural return loss (SRL). The long electrode allows for a precise measurement of the mean value of the capacitance. Thus, the defined impedance of the cable can reproduced exactly. SRL predictions up to 3GHz are feasible at line speeds up to 2,400m/min respectively 8GHz up to 1,300m/min.

Powerful digital signal processors are included in all Sikora measuring heads. Because of this computational power, a complete SRL prediction is realised just inside the gauge heads. Ten years ago, Sikora integrated this technology in the measuring devices of the Inline 2000 Series. This means that the online prediction of the SRL performance is entirely executed where the input data (ie diameter, eccentricity, or capacitance readings) is available in high resolution and high precision. Due to the all-digital signal processing inside the Sikora gauges noise is kept at a minimum allowing the detection of even minor periodic cable parameter fluctuations.

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Rod dry preparation and direct drawing

ADVERTORIAL ON BEHALF OF DECALUB

THE DCCD (Dry Cleaning, Coating and Drawing) process offers substantial cost savings in the most demanding drawing applications from mechanically descaled bare rod, drawn directly without wet pre-coating chemicals, including spring wire, PC strand wire, cold heading wire, plating wire, etc.

The process operates at 'zero' maintenance cost as there is no acid, no hot liquid tanks for rod pre-coating, no hot air blowers to dry wet rod, and it operates at virtually zero energy consumption.

An added benefit is the automatic control of lubrication parameters, including lubricant pressure, temperature and viscosity, enabling the use of standard high melting lubricants (+220°C/428°F) which are converted from solid into liquefied state and deposited on bare rod in a few microseconds, generating exceptional thermal stability at the highest drawing speed, eliminating phosphate, borax and their wet substitutes.

▲ *Rod cleaning and wire drawing by DCCD process*

In operation, all these parameters 'communicate' together in a sensitive and automatic multi-way interaction to form a hard and strongly adherent full-film anti-wear lubricant coat, weight-adjustable, enabling frictionless drawing by physical separation of wire-die contact in all drafts, eliminating friction heat.

Typical applications of the DCCD process are: output of 2.2 tonne/hour with 5.5mm 0.83/0.88%C rod, in a 'frictionless' drawing application with die life of 200 tonnes/die in the first draft and a die wear of 0.1 to 0.3 micron/tonne of wire drawn in the last draft.

Spring wire is drawn from mechanically descaled bare rod, without pre-coating chemicals, at 18m/s (3,600ft/min); 5.5mm 0.72%C rod drawn to 2.35mm at 16m/s (3,200ft/min); 10.5mm 0.85/0.88%C rod drawn to 4.22mm at 9m/s (1,800ft/min).

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Website: www.decalub.com

Decalub's pressure-die anti-wear lubrication

The PDH lubrication system is used in the most demanding drawing applications, allowing highest drawing speeds, with all carbon steel rods/wires, mechanically descaled or acid cleaned, bare or pre-coated, including spring wire, high-tensile rope wire, plating wire, cold heading wire, etc.

The system is highly regarded for its unique ability to convert a solid lubricant into a liquefied solution and maintain its thermal stability (at 200 to 240°C) at all drawing speeds.

The PDH system achieves a high-performance wire rod dry coating/lubrication with completely fused lubricant deposited instantaneously on rod/wire surface, operating at zero energy consumption, performing a high-density strongly adherent anti-wear multi-layer coat with adjustable weight, completely eliminating the need for phosphate and borax wet pre-coating chemicals.

The PDH lubrication system prevents metal-to-metal contact at wire-die interface, enabling frictionless drawing, providing superior surface quality and improved wire ductility.

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IN THIS ISSUE

No data loss from cables

The essential wire in 'wireless' applications

Wi-Fi, WiMAX, WLAN, 3G network… Wireless communication seems to be the trend of the Internet network.

Despite Wi-Fi adapters/cards and USB wireless dongles replacing and minifying the wireless networking device, there are still some practical problems like signal receiving/transmitting range and ability on wireless networking PCB device without the auxiliary of an external antenna.

Coaxial cable was originally used for networking but is applied in fields that require high conductivity and low attenuation of signal such as antenna cable, speaker audio cable, CATV cable, etc.

In WLAN application, you can find the presence of coaxial cable as the linkage of antenna.

It may also be found embedded within AP routers, laptops, cell phones and other electronics.

Weiyang Co, Ltd is dedicated to coaxial cable manufacturing, focusing on flexible RF coaxial cable like RG 174/178/179/316, mini FEP Teflon coax 0.81/1.13/1.32/1.37/1.48mm, and low loss WY 100/195/200.

Stable quality, flexible quantity, and short L/T are the most competitive features.

Weiyang Co Ltd – Taiwan
Fax: +886 2 22693325
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Website: www.weiyang.com.tw

New technology from Zumbach

Zumbach's broad range of measurement and control systems for wire insulating and jacketing, wire drawing and rod mill applications includes an extensive range of proven measurement solutions and the latest technological advancements.

These include Odac® laser diameter scanners, Wallmaster ultrasonic wall thickness measurement and control system, Odex® laser/magnetic non-contact concentricity gauge, Capac® measurement system for foamed and solid insulated datacomm and coax applications, FFT/SRL software for structural return loss analysis, Zumbach/WST Tempmaster preheaters and AUTAC temperature sensors, and Profilemaster®.

New technology includes Zumbach's Simac®, a modern surface inspection system for extruded products like pipe, cable and hose, where machine vision technology is used consistently. The Profilemaster system will provide an accurate and economical solution to measuring dimensions or even the complete cross-section of profile shaped products (such as figure 8 cable) that must be continuously measured and monitored in the manufacturing process. One or up to six laser/camera modules measure the cross-section of the moving profile.

The compact, heavy-duty and industrial designed Speel 3000 is designed for applications requiring very high accuracy even at very high velocities, and is available for a measuring distance of 300mm (11.81"). Considering the length measurement, it reaches an accuracy of 0.05% or better.

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Email: sales@zumbach.com **Website**: www.zumbach.com

Diameter gauges with integrated fault detection

ZUMBACH Electronic has introduced the new ODAC® F line of laser gauges. The new series offers high-precision, non-contact laser diameter measurement with high scan rates and an integrated fault detection function.

Combined with the powerful Zumbach USYS processors they can process up to 4,500 measurements per second from 3-axis scanners. A special laser beam geometry enables the detection and process of very small defaults or diameter variations.

Up to 333 data packets per second can be processed forward to a higher level system. Data packets can include, amongst others, minimum and maximum diameter values, ovality, etc. A complete line of gauges is available for dimensions between 0.25 and 550mm (0.01" to 21.65").

▲ *The new line of laser gauges from Zumbach*

Advantages include double or even higher scan rates than before, ie more measurements per time unit; maximum fault detection (lumps/neckdowns) at increased line speeds; and FFT/SRL analysis with higher bandwidths.

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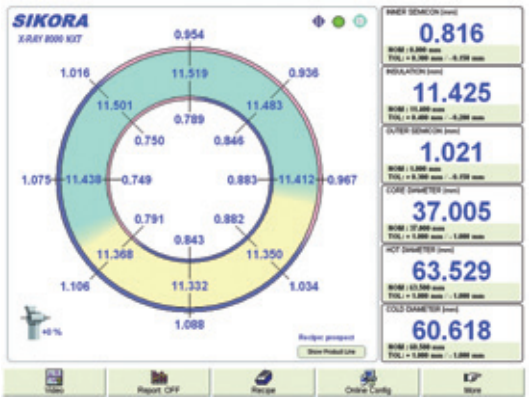

▲ *The X-RAY 8000 NXT monitor image*

X-RAY 8000 NXT: Sovereign quality control in CV-lines

WITH the innovative measuring system X-RAY 8000 NXT Sikora provides the tool for an efficient concept in quality control, production optimisation and reduced material consumption in power cable production.

X-RAY 8000 NXT is suitable for permanent quality control at the production of MV-, HV- and EHV-cables in CCV-, VCV- and MDCV-lines. Sikora holds an outstanding precursor position in the field of EHV-cable production.

Specifically developed for this application area the X-RAY 8000 NXT is ideal for extremely big cable diameters up to 180mm for CCV-lines and 220mm for VCV-lines.

The X-RAY 8000 NXT measures the wall thickness, eccentricity as well as the diameter and ovality with an incomparable measuring accuracy and repeatability. Only one scan is necessary to calculate all measuring values.

X-RAY 8000 NXT allows the operator a fast centring of the extrusion tools as well as optimum control of the production line in automatic mode.

Multi-sensor semi-conductor detectors are incorporated into the high-end variant of the X-RAY 8000 NXT.

This multi-sensor technology assures reliable readings in case the cable may vibrate and provides four measuring values at each scanning process for a precise measurement.

A masterpiece of engineering is the integration of ceramic windows* and NTX windows (Non Toxic X-Ray), which separate the scanners from the pressure of the CV-line.

The surface of the windows does not react with any by-products resulting from the cross linking process and always remains clean. *Patent pending

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IN THIS ISSUE

New range on offer from Daetwyler

NIEHOFF GRUPPE

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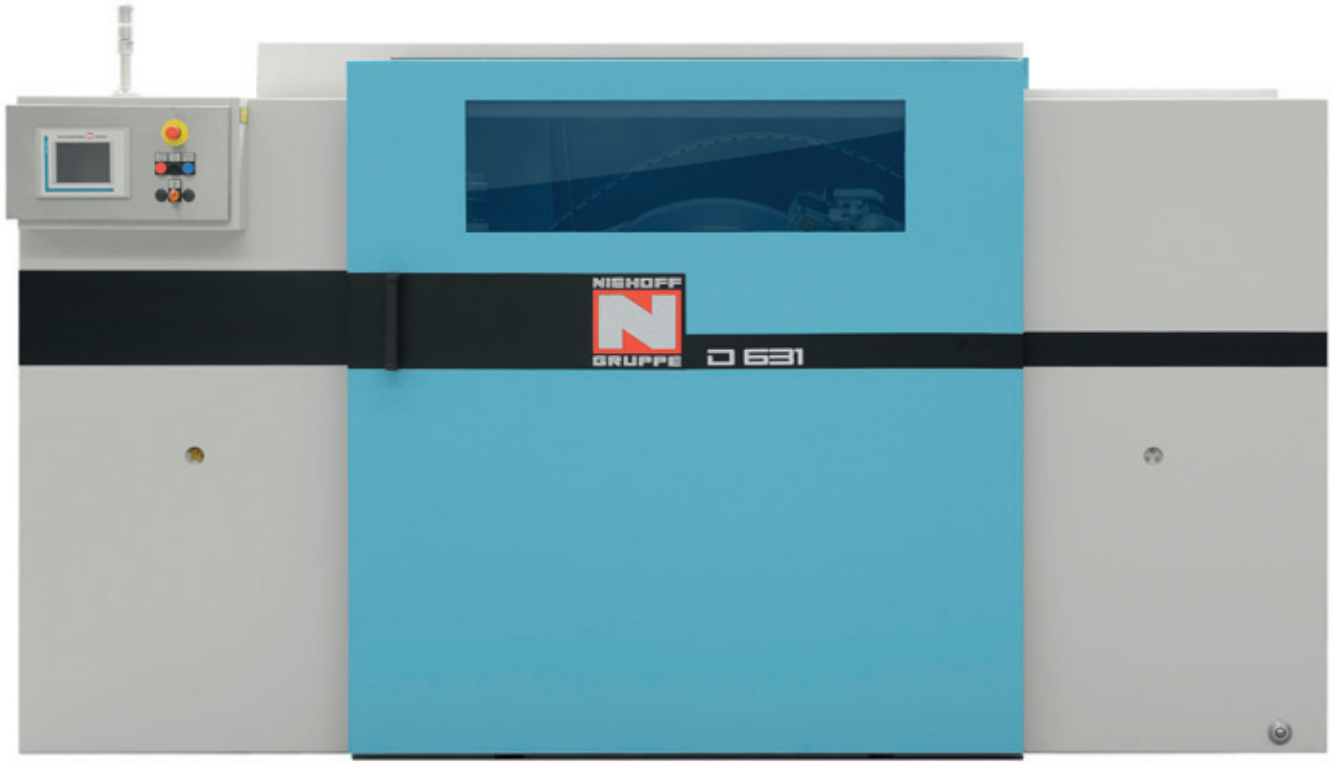
Improve your production and save more than energy.



New design – proven technology

High efficiency
High quality
Less consumption

Sophisticated machinery –
made by NIEHOFF

NIEHOFF ECO-BOW
The new generation for your benefit

Saves more than 60 % of energy compared to conventional bunchers, and features considerably reduced noise emission and heat generation. For all strand constructions and less scrap – enabled by the open system.

Drawing dies & cones

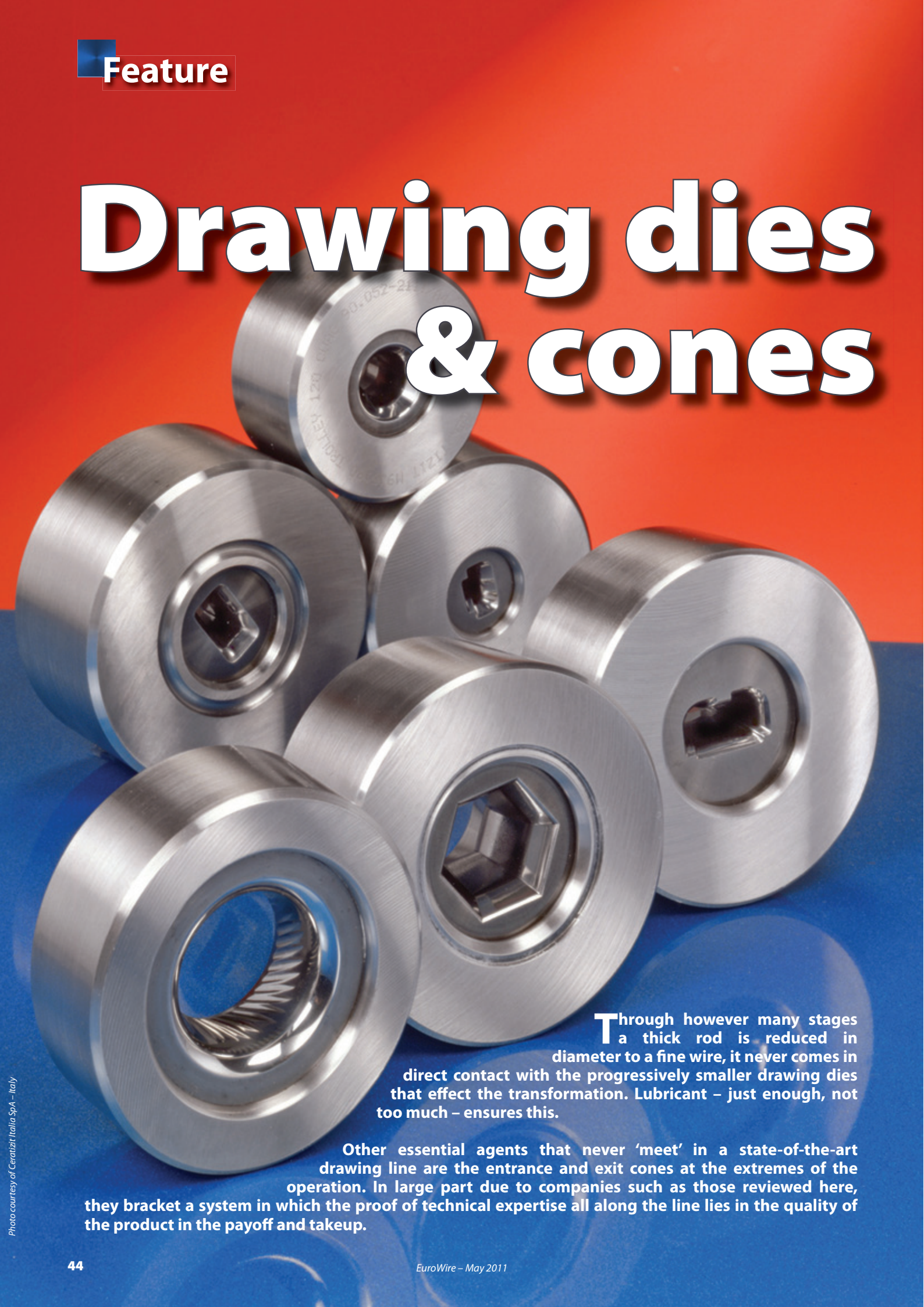


Photo courtesy of Ceratizit Italia SpA – Italy

Through however many stages a thick rod is reduced in diameter to a fine wire, it never comes in direct contact with the progressively smaller drawing dies that effect the transformation. Lubricant – just enough, not too much – ensures this.

Other essential agents that never 'meet' in a state-of-the-art drawing line are the entrance and exit cones at the extremes of the operation. In large part due to companies such as those reviewed here, they bracket a system in which the proof of technical expertise all along the line lies in the quality of the product in the payoff and takeup.

Esteves Group releases updated website

Esteves Group has launched an updated website, which features its main products and services, and is available in five languages.

The improved website includes more information about the Drawing Die Wizard™ and an online version of the eWizard™ handbook, as well as an improved customer area section. After sign-in, visitors will notice that the download section has been redesigned and downloads are easier to find.

Esteves Group is a supplier of consumables for the wire drawing industry, manufacturing high precision tools for drawing and extruding metal wires, customised to each customer's requirements.

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▲ *The new Esteves website*

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Making dies since 1870

French company Balloffet has been manufacturing dies since 1870 and now has several subsidiaries around the world, including the USA Balloffet Die Corporation, UK BDWD and Balloffet GmbH in Germany.

The full range includes:
- natural diamond dies from 6µ to 3mm
- synthetic mono-crystalline dies from 6µ to 1mm
- poly-crystalline (PCD) dies from 50µ to 30mm
- compacting, stranding and special shaped dies
- enamelling guides
- extrusion tooling (guides and dies)
- special tooling with diamond insert
- repolishing machines and equipment

▲ *Part of the dies range from Balloffet*

Services include:
- repolishing
- training of operators/technicians in Balloffet training centre and showroom
- training of operators/technicians at customer plant
- control and technical report of customers dies

Offering quality and service, Balloffet provides excellent surface conditions, diameter accuracy and the technical characteristics of wire and cables.

Balloffet – France
Fax: +33 474 357 901
Email: balloffet@balloffetdie.com
Website: www.balloffetdie.com

The benefits of in-house die shops

The economic pressure on wire mills has resulted in reviewing all non-production overhead costs, including in-house die shops. There are many issues to consider when looking at outsourcing the re-working of dies.

Reduction of overhead is often the motivating reason to close an internal die shop. It is not possible to get rid of all the personnel, since someone will need to keep track of inventory to prevent running out of dies.

An inspection programme must be implemented to ensure the quality being supplied to prevent premature failures, inconsistent results and to be able to qualify different suppliers. This will require at least one operator in the die shop or added to the quality department.

Since few wire mills inspect incoming dies, there can be inconsistencies with the dies' internal geometry, complete non-conformance to specified die angles and bearing lengths and poor surface finishes.

With outsourced or throw away dies usage is increased since operators rarely inspect dies that have limited wire drawn through them for wear; they are just discarded with worn dies. Shipping costs increase since every die must be shipped to the mill, and when there is an emergency, next day air charges add up quickly.

An internal shop can quickly produce dies to meet a customer's demand for a new size, reduce lead-time by not waiting for a supplier, and provide the ability to adjust die geometry to solve drawing problems. These abilities will reduce scrap and make the mill more efficient.

▲ *Equipment from Die Quip*

The key to operating a successful internal die shop is equipment that makes it easy and accurate to set the geometry of the die the same every time without operator influence, proper training to understand the correct procedures for reworking worn dies into high quality dies and die designs to match the reductions, material and equipment.

Die Quip can supply machines, training programmes and design knowledge to make in-house die shops a production tool, rather than an overhead expense.

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Wide range of wires

A wide range of wires from Manfisa

Manfisa is a Spanish company specialised in aluminium wire-drawing and casting since 1973, and this has enabled it to develop a wide range of highly productive wires. Manfisa draws pure aluminium and aluminium alloys in a variety of diameters from 0.6mm to 10mm, suitable for mechanical and electrical applications such as fasteners, nails, rivets, screws, bolts, nuts, aerials, clips, electrical fencing, fences and metallisation.

The company specialises in the production of pure aluminium wire for metallised films in all diameters and purity grades from 99.50% up to 99.99% suitable for all applications as flexible packaging, solar film, capacitors, labels, holograms and other special applications.

Aluminium wire for metallising is wound layer by layer (high precision winding) to ensure a smooth deposition in the vacuum metallising process. Each spool is individually identified which guarantees the total traceability of the material.

In addition to a wide product range, including large capacity spools developed in-house, these are suitable for most well-known brands of metalliser machines.

Manfisa Manufacturas Irular – Spain
Email: manfisa@manfisa.com
Fax: +34 948 500 725
Website: www.manfisa.com

Earning respect the world over

Poland's Nota Precision Engineering has earned respect from customers the world over in the diamond dies industry.

The company's main activity is the manufacturing of tools with superhard materials.

Nota has many years' experience in diamond dies for drawing wires of carbon steel, stainless steel, copper, bronze, brass, aluminium, nickel and silver, and can also regenerate diamond drawing dies.

The company offers clients diamond and CBN wheels, cutters and other tools with PCD and PCBN, diamond grain and diamond micropowders, diamond pastes, titanium carbide, boron nitride grains and calibres enamel, insters for cutting PCD, PDC and PCBN, and diamond dressers.

Nota Precision Engineering Company – Poland
Fax: +48 814 417 396
Email: nota@nota.pl
Website: www.nota.pl

At the forefront of die technology

In today's competitive wire drawing industry, a well equipped and efficiently functioning modern die-workshop is a necessary instrument to maintain a company's own strength, independence and potential of die stocks within its own premises.

EDER-Austria, aside from die-tools, offers a variety of easy to understand and operate die-reconditioning machines. The high degree of automation has considerably reduced the number of personnel and the level of skills formerly needed, while at the same time offering considerably longer die-life, higher tonnages of drawing wire and lower operational costs.

The correct refurbishment of dies regularly undertaken in time can prolong the service life of costly die-tools considerably and as such can contribute a lot to the economic welfare.

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Crucial factor for quality of drawn wire

The lubrication is one of the crucial factors for the quality of the drawn wire.

An interrupted lubrication in the steel wire drawing process causes an increase of surface tension in the wire, strong pressures inside the die, rapid die wear, breakage of the drawing nib and consequent non-programmed interruptions in the wire drawing process.

In order to avoid these problems, Koner has studied a new concept line of drawing dies – K. 340 and K.370 pressure drawing die (patented worldwide), specially constructed and designed to greatly improve lubrication in dry drawing of steel wire.

For the drawing the K.320 tool has been created, which allows wet drawing process characteristics and also a great economic saving.

The K.340/K.370/K.320 methods provide considerable operating advantages:

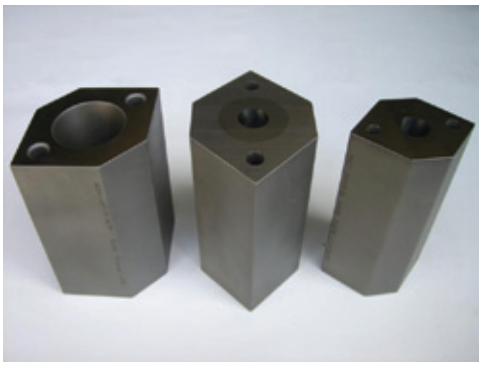
- Production at maximum drawing speeds
- Less machine down-time for die replacement
- Better and more homogeneous wire quality
- Wire drawing under optimum quality control
- Nib life increased by 30% and more to traditional dies
- Overall costs reduced by around 40% (you only change the nib and not the entire die)
- Application of the requested quantity of lubricant coating to the wire
- Better wet or dry redrawing operations
- The overall dimensions of K.340/ K.370/K.320 tools are the same as for traditional dies
- Savings on transport – even large quantities of nibs can be delivered rapidly in small packages directly to customers in any part of the world
- Elimination of die rejects and the accumulation of no longer useable drawing dies in the warehouse.

A return can also be gained from the sale of worn tungsten carbide parts.

Koner – Italy
Fax: +39 025 455 832
Email: tkt@tktgroup.it
Website: www.tktgroup.it

Carbide dies and steel tools

Hedalloy is a tool and die machine shop formed in 1947. The company's equipment includes manual and CNC lathes, hones, mills, surface grinders, ID grinders, OD grinders, machining centres, sinker EDM, wire EDMS and hydraulic press.



▲ *Carbide assembled quills for wire*

The company manufactures all tooling necessary for nut and bolt makers, hot and cold headers, presses, hammers, upsetting, extruding, forging, metal forming, wire draw equipment and others. It can design, engineer and manufacture part development packages on multi-station machines to efficiently produce special cold formed parts from coiled wire.

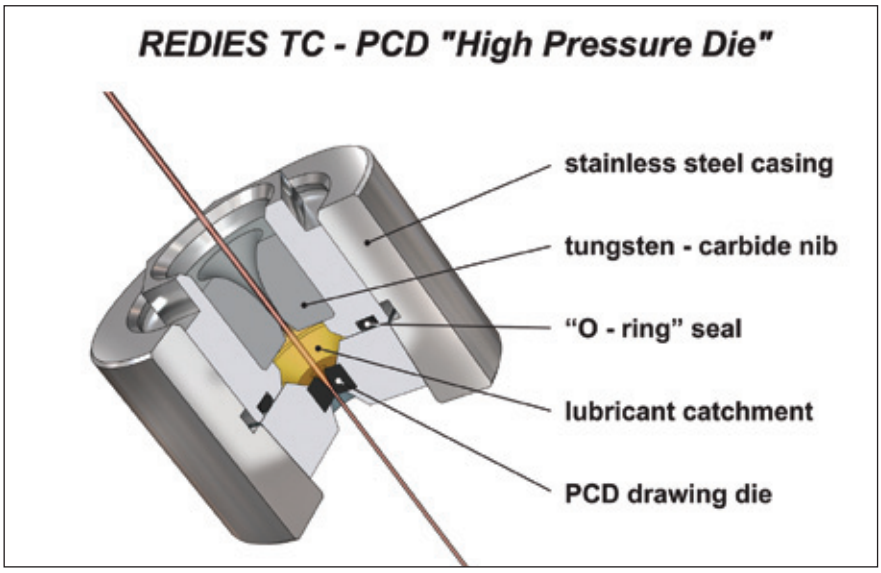
Hedalloy manufactures quality carbide and steel tooling such as carbide die and punch assemblies – new and rework or repair, casings, holders, sleeves, inserts, wafers, plates, strippers, shedders, die kick-out pins and punches (piercing, extruding, stamping, round, square, hex, torx, lobed, slotted, phillips, spline, raised lettering, characters, engraved, 12-point, socket and customised/special).

Hedalloy Die Corp – USA
Fax: +1 216 341 5393
Email: hedalloy@sbcglobal.net

High pressure die from Redies

Redies – the central European die maker – has developed a High Pressure Die (HPD) combined from TC and polycrystalline diamond inserts.

The die consists of three interchangeable/renewable parts screwed and tightened into a mounting with standard outer size 43 x 30mm. The drawing part is made from MANT® PCD.



▲ *The Redies TC-PCD high pressure die*

The HPD has proved to give a better surface and a longer lifetime with drawing wet as well as dry the following materials: stainless steel, high carbon steel and spring wire.

Redies Srl – Italy
Email: info@redies.com
Fax: +39 0362 852 078
Website: www.redies.com

Customer value

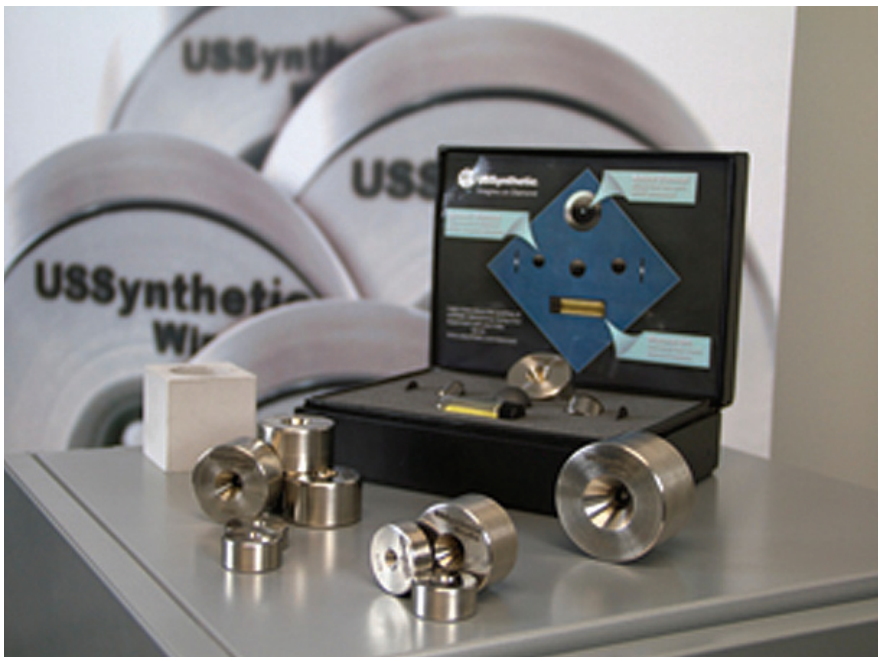
US Synthetic Wire Die manufactures long-lasting polycrystalline diamond (PCD) wire dies, which allows wire mills to pull more pounds of wire per dollar spent on dies.

Customers value the long-lasting diamond dies, advanced process trouble-shooting, and consistency in wire die geometry.

Precise laser-cut geometry (improved entrance, reduction angle, bearing length, bearing diameter) also gives customers fewer wire breaks, less problems setting up a line, and the ability to replace dies with less downtime.

The technical expertise in PCD enables development of the unique material used in the wire dies.

US Synthetic is the only wire die manufacturer that presses its own PCD inserts.



▲ *Examples of the dies from US Synthetic Wire Die*

Pressing the diamond core and finishing the die to exact specifications offers customers a durable, high-performance product that draws more pounds of wire per dollar.

State-of-the-art diamond sintering processes – including proprietary cubic presses that apply nearly 1 million pounds of uniform pressure and generate temperatures of 1,400°C – are used to synthesise the dies.

US Synthetic Wire Die – USA
Fax: +1 801 235 9141
Email: info@usswiredie.com
Website: www.usswiredie.com

Multiple furnaces from Tenova

The Pos-Himetal project in Gwanyang, South Korea, is under construction where multiple furnaces will be used to produce a refined manganese product.

In January last year Tenova Pyromet began design and supply on electrodes, copper bustubes, hydraulics and control systems for their two submerged arc furnaces, and this year, Dongbu Corporation asked Tenova to design and supply a ladle furnace and a slag holding furnace for the project.

The slag holding furnace comprises a furnace whose complete shell tilts on a set of rollers. The electrodes are retracted from the furnace when the tilting operation occurs.

Tenova Pyromet has supplied furnace equipment for many manganese operations, but this project is unique in the methods and processes used to produce a low phosphorous and low carbon manganese product.

The delivery period for the equipment is extremely short, which prompted Tenova Pyromet to make use of the wealth of expertise within the Tenova group. Furnace equipment will be fabricated at Tenova Timec, and various equipment will be purchased from other international suppliers. The ladle furnace and the slag holding furnace are intended to be switched in later this year, which will complement the operation of the two submerged arc furnaces.

Tenova – Italy
Fax: +39 024 693 026
Email: tenova@tenovagroup.com
Website: www.tenovagroup.com

More than 50 years' experience

▲ *Examples of the dies from Ceratizit Italia SpA*

Ceratizit Italia SpA Italian plant in Alserio, Como, has been manufacturing tungsten carbide dies for more than 50 years.

Produced at the site are standard profile drawing dies – round, hexagonal and square – and special profile drawing dies, in addition to processing profiles based both on drawings specifically requested by the customer or on internal developments, aimed at solving the customer's problems.

The entire production chain is performed on the spot, starting from the processing of raw materials to the finishing of each item. Tungsten and cobalt powders are pressed and treated according to specifications and processed through sintering furnaces; a first check ensures the metallurgical suitability of the product.

At this point the outer and side parts are ground in order to enable the assembling through shrinking-on of the cores into steel casings.

According to the type of geometric section required, the following step consists in the internal grinding for diametrical profiles, while for shaped profiles the processing goes on with spark electroerosion, where the complete internal profile is cut, to ensure that the product geometry is up to the requested attributes.

All products marked Ceratizit are checked by the quality inspection staff, who verify in detail all the dimensions, using modern and high-precision measuring instruments. It is also possible, on request, to have a measurement report, certifying the product quality.

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Analysis of surface flaws on drawn wire and wire breaks

By Kazunari Yoshida, Tetsuo Shinohara, Tsutomu Yamashita and Atsuhiro Tanaka of Tokai University, Japan

Abstract:

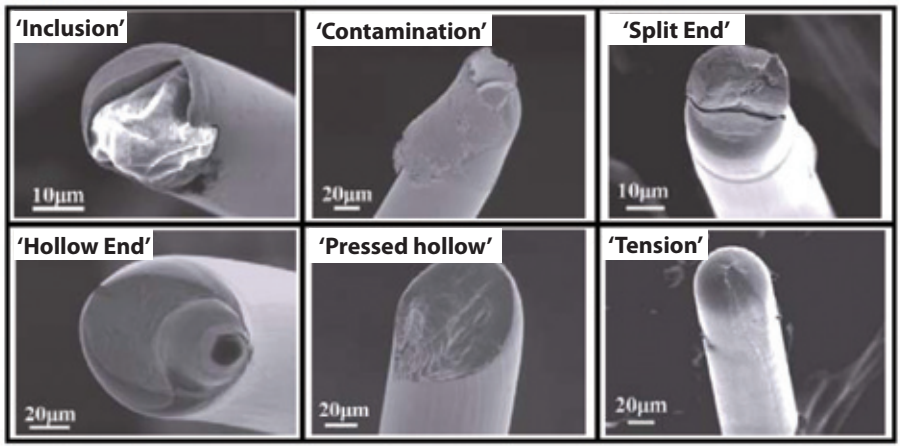
Using experiments and finite element method (FEM) analysis, this paper examines whether surface cracks on wire rods grow or are removed during drawing. The deformation behaviour of V-shaped, concave, and U-shaped transversal cracks were observed upon repeated drawing. The authors clarified the conditions under which these transversal cracks are removed in order to achieve a surface condition similar to that of the area without cracks.

1 Introduction

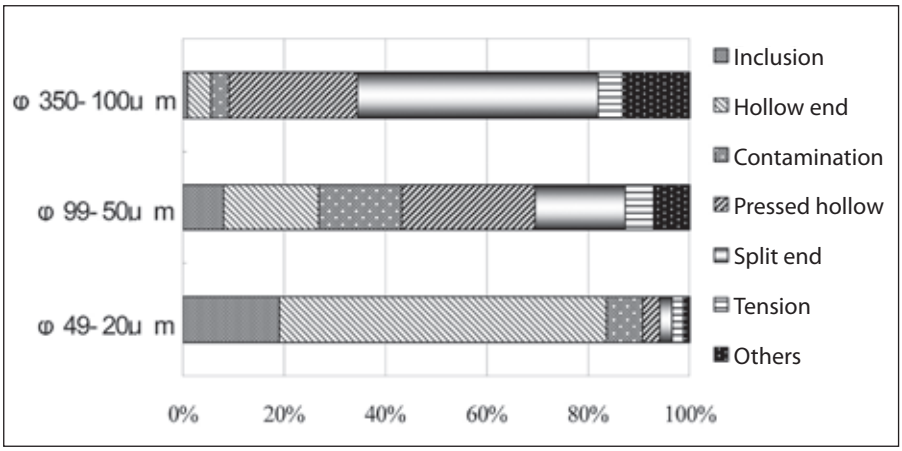
The diameter of wires and bars produced by drawing varies from about 10µm to 100mm. For any diameter of wire, breaking during drawing has a direct effect on productivity. Also, flaws on the surface of wires often cause fatigue breaking, the deterioration of mechanical properties, and loss of commodity value. This is why surface flaws are the most common complaint of users. Furthermore, finer and longer wires have recently been requested for use as the bonding wires of semiconductors and in medical devices. Therefore, wire breaking and surface flaws are problems that must be solved.

Many researchers have investigated the optimal die shape to reduce drawing force, measures to prevent wires from internal cracking (through the formation of central burst defects or cupping), the optimal lubricant, measures for reduction of residual stress and so forth. Useful findings have been obtained, but there have been few studies of measures to prevent wire breakage and on the effects of inclusions and surface flaws on wire drawing[1,4].

In this study, the causes of wire breakages in drawn wires of different diameters were examined. Analyses of wires with surface flaws and inclusions were performed experimentally and by a finite element method (FEM) to determine whether surface flaws and inclusions cause wire breakages or remain as surface flaws when drawing is repeated.



▲ **Figure 1**: *Types of wire breaking*



▲ **Figure 2**: *Percentages of causes of wire breaking during drawing of superfine gold wires*

2 Types of wire breakage caused by drawing

Recently, the occurrence of wire breaking during drawing has greatly decreased due to reduced particulate segregation and fewer inclusions in bars and wires brought about by effective material cleaning and because of the improvement of drawing conditions. However, the finer the diameter of a wire, the higher the frequency of occurrence of wire breakage during drawing. There are several causes of wire breaking (*Figure 1*). Two types of breaking are caused by inclusions. One occurs when inclusions are found on the fracture surface, and the other, called "hollow end" breaking, occurs when traces of concave inclusions are found but the inclusions themselves are not found.

Two types of breaking are caused by foreign materials introduced during a process other than the casting process. One is called "contamination" breaking, when foreign materials are found on the fracture surface, and the other is called "pressed hollow" breaking, when no foreign materials are found. Additionally, "split end" breaking is considered to be caused by surface flaws, and "tension" breaking is caused by applying a stress stronger than the wire strength[5].

Types of wire breakage that occur when gold bonding wires are drawn were examined. *Figure 2* shows the frequency of occurrence of each type of wire breaking, with the diameters of the drawn wires divided into three groups, 100-350µm, 50-99µm and 20-49µm[4].

Figure 1 and *Figure 2* show that surface flaws, foreign materials and the occurrence of excessive drawing stress caused by seizing are causes of wire breaking. However, many of the causes of wire breaking for wires with a diameter of less than 50µm are speculated to be due to inclusions inside wires that form during casting[5].

Considering the above it can be concluded that for wires to be resistant to breaking during drawing they should have no surface flaws and any inclusions be as small and as few as possible.

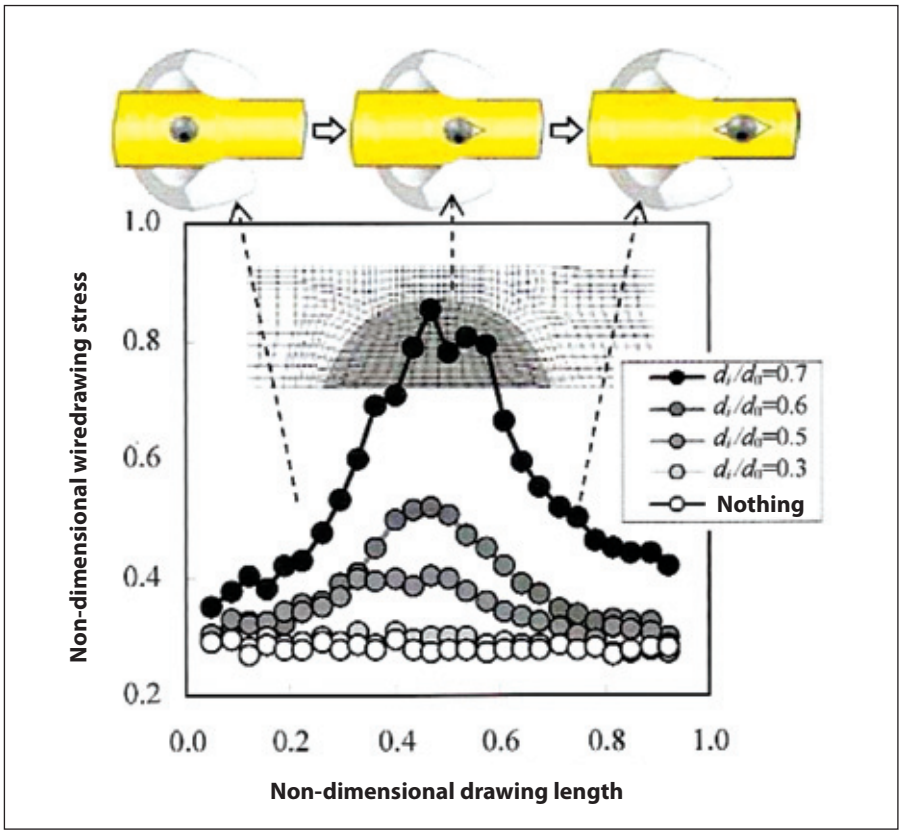
3 FEM analysis of drawing of a wire with inclusions or foreign materials

3.1 Effect of inclusions inside a wire

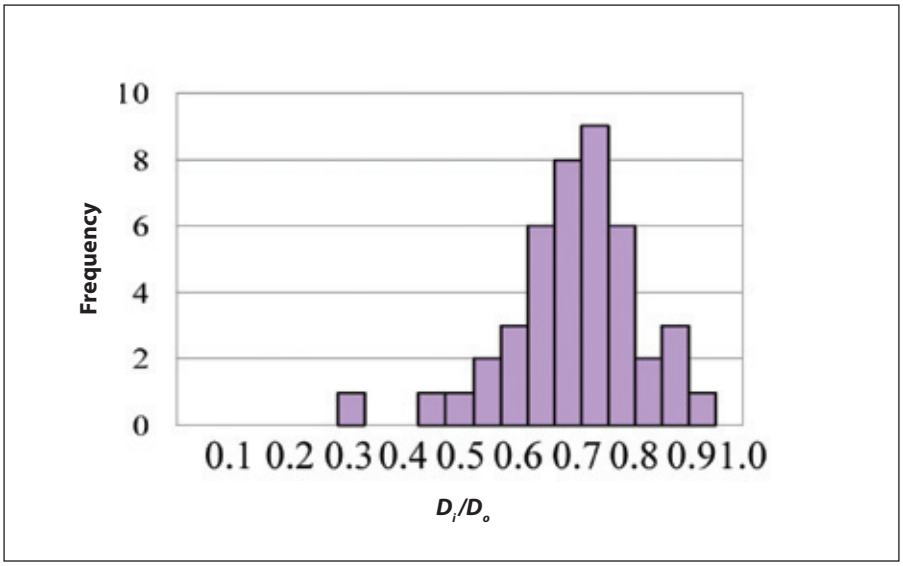
Most inclusions in wires are hard materials. The results of the analysis of inclusions on the fracture surfaces of wires by Energy Dispersive Spectrometer (EDS) showed that many of them were $A1_2O_3$ or SiO_2, and the rest were foreign materials formed by abrasion of the die and equipment. Therefore, assuming that there are inclusions of alumina and foreign materials inside wires, an FEM analysis of wire drawing was carried out. The ratio of inclusion size to wire diameter, Di/Do, was set to vary from 0.3 to 0.7. The material constants and drawing condition for FEM are shown in *Table 1*.

The changes in drawing stress on the inner side of the die were examined by FEM analysis, using wires with various sizes of inclusions. The results are shown in *Figure 3*. It was found that drawing stress moves rapidly upwards when an inclusion passes through the die. It can be seen that the higher the ratio of inclusion size to wire diameter, Di/Do, the more the drawing stress rises. In the case of a wire with an inclusion for which Di/Do is 0.7, the drawing stress reaches the strength of the wire. This means that there is a high probability that the wire will break. Taking the safety factor into account, it is thought that there is a danger that the wire breaks when Di/Do is higher than 0.4.

The sizes of inclusions were measured at the fracture surface when gold wires with the diameters of 20-50µm were drawn. *Figure 4* shows the frequency of wire breaking for different values of Di/Do. This figure suggests that there is a danger of wire breakage if Di/Do is 0.3 or higher, and the highest frequency of wire breakage is when Di/Do is approximately 0.7.



▲ **Figure 3**: *Variation of drawing stress when inclusion passes through die (examined by FEM(R/P=10%))*



▲ **Figure 4**: *Frequency of wire breaking vs D_i/D_o*

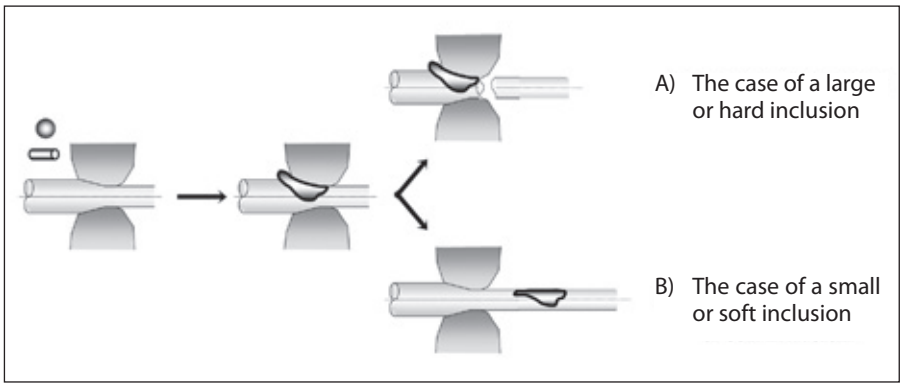
3.2 Effect of foreign particles

In some cases foreign materials are present on the wire surface during drawing, or foreign materials may enter the die via the lubricant. These foreign materials are mainly formed by erosion of the wire or of the die or equipment, or may originate from dust in the air. Depending on the shape and hardness of the foreign material wire breakage, as shown in *Figure 5*, may occur. As an example, *Figure 6* shows scanning electron microscope (SEM) images and EDS photographs of a wire after drawing with foreign materials on the wire surface. The material of the wire is austenite stainless steel.

Analysis by EDS revealed that the foreign material was composed of iron carbide, which included a scarce Ni component.

Mechanical constants for gold	
Young's modulus	80GPa
Poisson's ratio	0.44
Work-hardening curve	$\sigma=475\varepsilon^{0.07}$
Material condition for inclusion	
Material	$A1_2O_3$, SUS304
Young's modulus	300, 194GPa
Poisson's ratio	0.23, 0.30
Yield stress	4.3, 0.205GPa
Die half angle, reduction	$_{\alpha}$=7°, R/P=10%
Friction factor	0.05μm

▲ **Table 1**: *Condition of materials and drawing for FEM*



▲ **Figure 5**: *Schematic diagram of wire breaking caused by foreign material*

The size was 0.53x0.27mm, and Di/Do was about 0.2. It is presumed that the wire did not break because of the low value of Di/Do. *Figure 7* shows the results, gained by FEM analysis, of drawing a wire with a foreign material near the wire surface.

At the interface of the foreign material and the wire, they are bonded mechanically. Upon repeated drawing, stress acts on the interface and causes separation at the interface, generating an empty space. Three dimensions FEM code MSC/Marc Mentat 2008r1 was used in this study. The results of FEM analysis are consistent with the experimental results. Regardless of whether the foreign material is located in or on the wire, it does not undergo deformation because of its hardness, even if drawing is repeated. This leads to a high value of Di/Do, increasing the drawing stress and increasing the chance of wire breakage.

4 Analysis of a wire drawing with surface cracks

Surface cracks develop on rods or wires because of mishandling during casting, hot rolling, drawing or transport, or because of the improper winding of wires[6]. The surface cracks that develop on wire rods during upstroke rolling are classified as shown[7] in *Table 2*; however, there is no clear solution to this problem. In particular, only a small number of studies have reported on surface cracks formed during drawing[8–11].

In this study, wire rods that developed circumferential cracks during casting and rolling are used as mother wires and drawn repeatedly. The growth and removal of these cracks are examined in the experiments and by FEM analysis.

Stainless steel (SUS304) rod wires were mechanically scratched in the axial direction using a lathe and analysed by experiments and FEM. Rod wires that were mechanically marked to form V-shaped, concave, and U-shaped cracks in the circumferential direction were used as specimens.

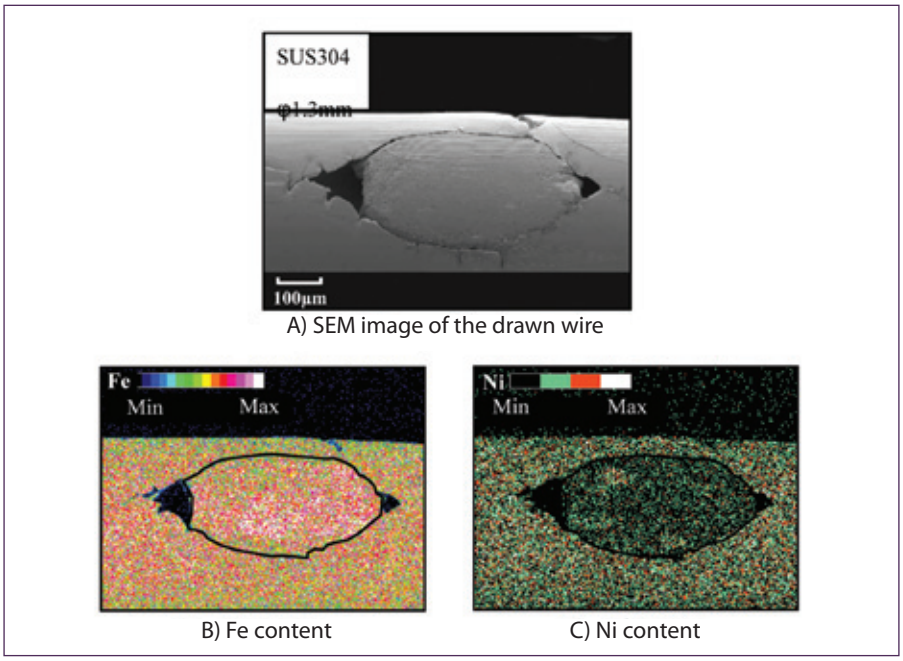
FEM software, MSC/Marc Mentat 2008 R1, was used in this study. *Figures 8* and *9* and *Table 3* show the model used in the FEM analysis, its material constant and the parameters of the V-shaped crack, respectively. Coefficient of friction(μ) was set at 0.05. Moreover, the model was assumed to be axis-symmetric in the FEM analysis to save calculation time.

4.1 Comparison of results of experiment and FEM analysis

A crack with a depth of h=0.8mm (8%) was cut on an 8mm diameter wire and the change in its shape was experimentally and analytically examined after each drawing pass. The initial crack on the mother wire was asymmetrically V-shaped.

The shape of the initial crack was observed using a microscope, and a mother wire with a crack of the same shape was modelled in the FEM analysis. It is clear that the FEM analysis result agrees with the experimental result. As shown in *Figure 10*, the crack appears to be removed because side AB is pushed up into the wire; however, side BC of the crack is tilted so that it overhangs side AB, forming an overlapping crack (defect).

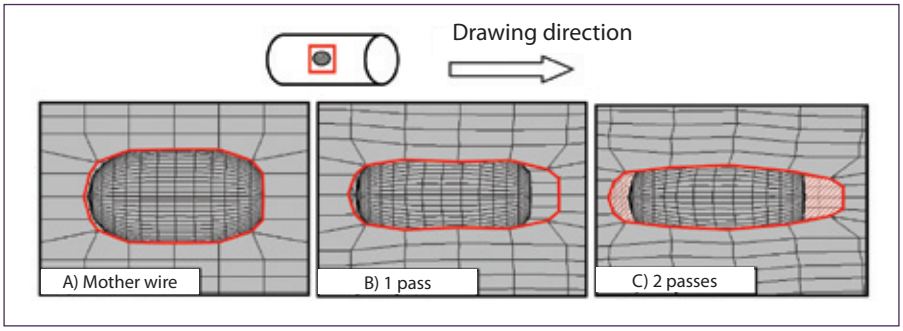
▼ **Figure 6**: *SEM image and componential analysis of wire with foreign material*



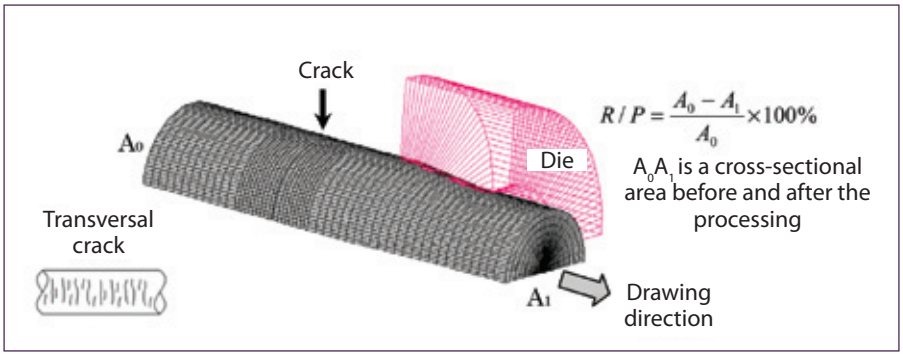
A) SEM image of the drawn wire

B) Fe content

C) Ni content



▲ **Figure 7**: *Mesh deformation after repeated drawing of wire with foreign material on the surface examined by FEM*



▲ **Figure 8**: *Drawing model of wire*

Appearance	Name	Morphology and features
	Scab	Foliate mark; rod surface is rubbed bare
	Transversal crack	Crack perpendicular to rolling direction
	Bump	Scale-like cracks on surface
	Scratch	Concave crack due to scratching in rolling direction
	Rolled in material	Dent resulting from pressing against foreign substances such as metal chips
	Over-filled	Defect resulting from continuous indenting in rolling direction

▲ **Table 2**: *Classification of surface cracks on wire rod* [7]

The three-pass drawing of a mother wire with a surface crack was repeated in the experiment and FEM analysis. The obtained crack deformation behaviour for each drawing pass is also shown in *Figure 10*.

4.2 FEM analysis of U-shaped crack deformation behaviour during repeated drawing

Next, a wire with a U-shaped crack was modelled and the drawing process was similarly analysed by finite element analysis. *Figure 11* shows examples of crack deformation behaviour for 10mm diameter wires with a crack of breadth (a)=0.73mm and depth (h)=0.10mm (1%) and with a crack of a=0.73mm and h=0.60mm (6%) during repeated drawing at α=6° and R/P=20%.

As shown in *Figure 11*, under condition I, the bottom of the crack rises during repeated drawing, and thus the surface crack is removed after the first pass.

Under condition II with the greater depth, however, the right side of the crack is tilted so that it overhangs the left side and forms an overlapping crack (defect), indicating that the crack cannot be removed by drawing. Moreover, a deep crack develops in the wire although it appears to be small. Namely, the behaviour of the U-shaped crack during drawing depends on the depth (h).

The results for the concave and U-shaped cracks were compared. An overlapping defect develops from the concave crack, regardless of the depth (h), whereas for the U-shaped crack the depth (h) serves as a parameter; that is, the crack with a shallow (h) is removed, but the crack remains on the wire when (h) is greater.

It is considered that the shape of both sides of the crack significantly affects its removal under condition I in *Figure 11*.

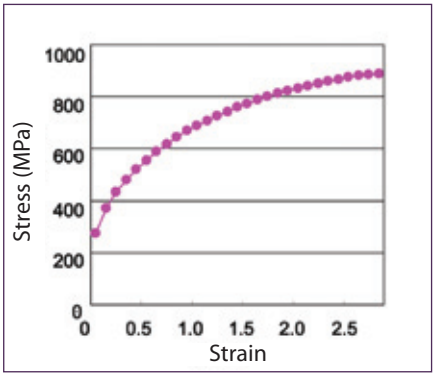
5 Conclusion

Wire breakage was investigated using experimentation and finite element method analysis. A focus was on wire breakages caused by the presence of a foreign substance, in or on the wire, or by transversal cracks that develop on the surface of wires due to the effect of fatigue, inclusions or surface flaws.

The obtained results are summarised below.

1) Surface flaws, foreign materials and excessive drawing stress generated by seizing are the causes of wire breaking. However, many of the causes of breakage in wires with a diameter of 50μm or less are speculated to be due to the presence of inclusions that are formed during casting
2) It is thought that there is a danger of wire breakage when Di/Do is 0.3 or higher, and that the highest frequency of wire breakage is where Di/Do is approximately 0.7. This was found to be because drawing stress moves rapidly upward when an inclusion passes through the die
3) The result of FEM analysis agrees with the experimental result; therefore, it is possible to estimate crack deformation behaviour by FEM analysis to predict the state after drawing
4) The mechanism underlying the removal of a crack in a wire rod is the rise of the bottom of the crack during drawing
5) The behaviour of a U-shaped crack during drawing depends on the depth (h)
6) Where there is a greater depth, however, the right side of the crack is tilted so that it overhangs the left side and forms an overlapping crack (defect), indicating that the crack cannot be removed by drawing. Moreover, a deep crack develops in the wire, although it appears to be small

▼ **Figure 9**: *Work hardening diagram of tested stainless steel wire*



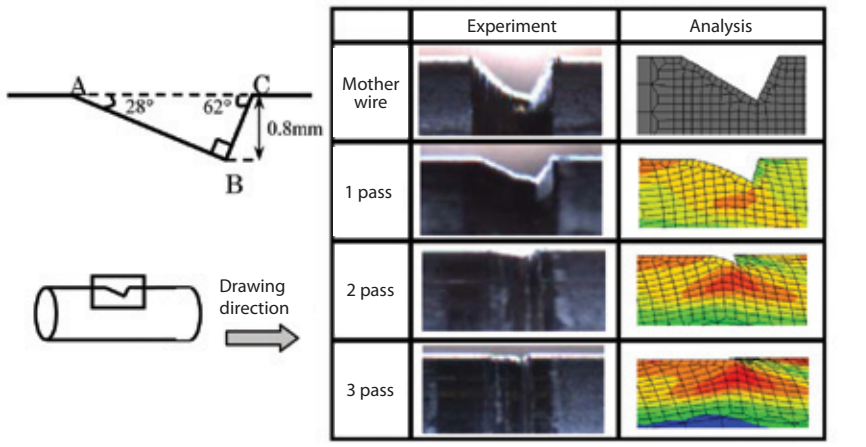


Figure 10: *Changes of crack after each drawing pass in experiment and analysis*

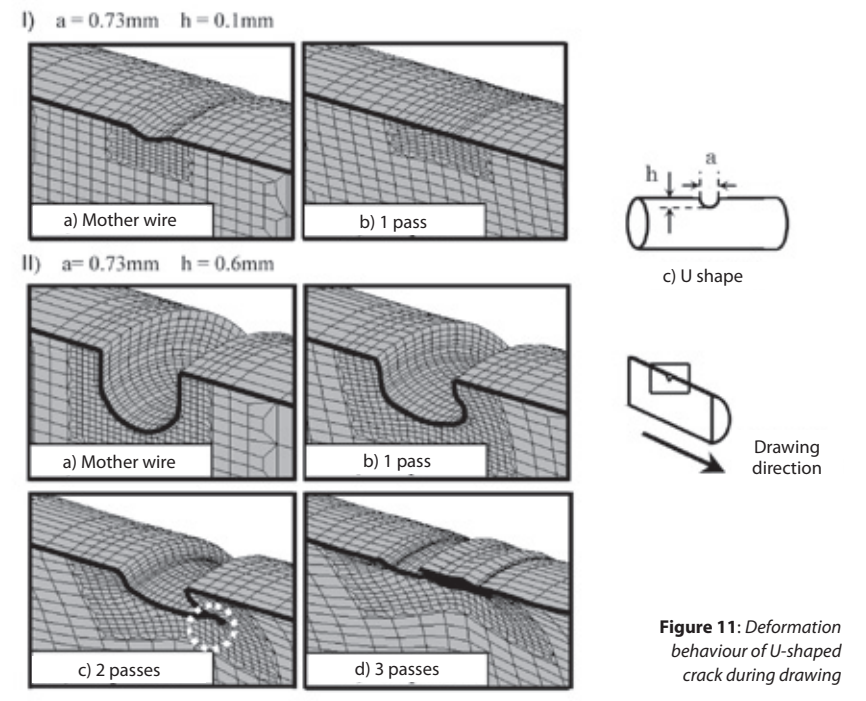


Figure 11: *Deformation behaviour of U-shaped crack during drawing*

▼ **Table 3**: *Parameters of crack*

Parameters of crack	
Shape-related parameter	V-shaped, concave shaped, U-shaped cracks
Depth (h)	0.10, 0.35, 0.60, 1.0mm
Breadth (a)	0.73, 0.93, 1.15, 1.40mm
Angle (θ)	60°, 70°, 80°, 90°, 100°, 110°, 120°
Direction	Circumferential direction
Material condition for wire	
Material	SUS304
Young's modulus	206GPa
Diameter	10mm, 8mm
Die half angle, reduction	$_{\alpha}$=6°, R/P=20%
Friction factor	0.05μm

This paper was presented at Istanbul Cable & Wire '09. It is reproduced here by kind permission of the IWMA and WAI.

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Rekordumsatz von fast 3 Mrd. Euro

Leoni, der führende Anbieter von Kabeln und -systemen für die Automobilbranche und weitere Industrien, hat im Geschäftsjahr 2010 nach vorläufigen Berechnungen, einen Rekordumsatz von etwa 2,96 Mrd. Euro (Vorjahr: 2,16 Mrd. Euro) erwirtschaftet.

Grund für das deutliche Überschreiten der Prognose von rund 2,8 Mrd. Euro war neben einem nochmals gestiegenen Kupferpreis eine bis zum Jahresende dynamisch verlaufende Nachfrage sowohl der Automobilindustrie als auch aller anderen relevanten Märkte.

Hervorzuheben ist der sehr stark erhöhte Absatz von Kabelsätzen und Bordnetz-Systemen für Fahrzeuge in den BRIC-Staaten sowie den USA.

Auch beim Ergebnis vor Zinsen und Steuern (EBIT) konnte Leoni mit rund 131 Mio. Euro (Vorjahr: –116 Mio. Euro) den zuletzt angepeilten Wert von 120 Mio. Euro klar überschreiten. In diesem Ergebnis sind weitere Restrukturierungsaufwendungen des vierten Quartals bereits verkraftet.

Des Weiteren ist es Leoni gelungen, das Ziel eines mindestens ausgeglichenen Free Cashflows deutlich zu übertreffen. Infolgedessen konnten die Nettofinanzschulden den vorläufigen Zahlen zufolge um rund 50 Mio. Euro reduziert werden; sie lagen zum Jahresende erstmals seit Beginn der Wirtschaftskrise wieder unterhalb des Eigenkapitalniveaus.

Für das Jahr 2011 hält Leoni an seiner bisherigen Umsatzprognose von mehr als 3,1 Mrd. Euro fest. Das Unternehmen ist zuversichtlich, weiter deutlich steigende Erträge zu erzielen. Die jüngsten Beeinträchtigungen von Produktion und Logistik an den Standorten in Tunesien und Ägypten werden nach heutigem Stand zu keinen wesentlichen finanziellen Belastungen führen.

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Neue Auswahl im Angebot

Auf der FTTH Conference in Mailand stellte Dätwyler Cables eine neu entwickelte Baureihe von 19-Zoll High-Density-ODFs (Optical Distribution Frames - Optische Verteilerschränke) für den Einsatz in FTTH-Backbone- und Distributionsnetzwerken vor.

Die optischen Verteilerschränke ermöglichen mit bis zu 6624 LC-Steckern auf 47 Höheneinheiten (HE) die bislang höchste Portdichte am Markt. Trotz der hohen Packungsdichten bieten die ODFs ein übersichtliches Patchkabel-Management und ausreichend Platz für komfortable Montage-, Spleiss- und Patcharbeiten.

Die ODFs sind als 19-Zoll-Rack in den Standardausführungen mit 42 HE und 47 HE beziehungsweise in den Höhen 2000 und 2200mm, beide 1200mm breit und 800mm tief, lieferbar.

Im Standardmodell mit 42 HE lassen sich bis zu 2.880 Glasfasern, in der Back-to-back-Ausführung sogar 5.760 Fasern auf LC-Ports anschliessen.

Im 47-HE-Modell finden 3312 und 6624 LC-Stecker Platz. Die ODFs sind bei Dätwyler Cables auch in anderen Massen erhältlich, etwa mit 400 oder 600 mm Tiefe oder in individuellen Höhen.

Die ODFs bieten ein Patchkabel-Managementsystem, so dass horizontal und vertikal gepatcht werden kann und genügend Platz für das Führen und Ablegen von Überlängen vorhanden ist.

Neben einer Ablage für Reserveadern verfügen sie über eine integrierte Kabelaufteilbox, die je nach Bedarf auch im Hohlboden, auf dem Dach oder an der Seitenwand montiert werden kann, halbrunde und runde Biegeradienkontrollen an allen Faserführungswegen, die zu enge Biegeradien verhindern, sowie fertig mit Pigtails ausgerüstete Spleisspanel.

Zur Grundausstattung zählen weiterhin Kabeleinführungen von oben und unten, eine Erdungsschiene an der Frontseite, fertig montierte Nivellierfüsse und variabel montierbare Tiefenprofile.

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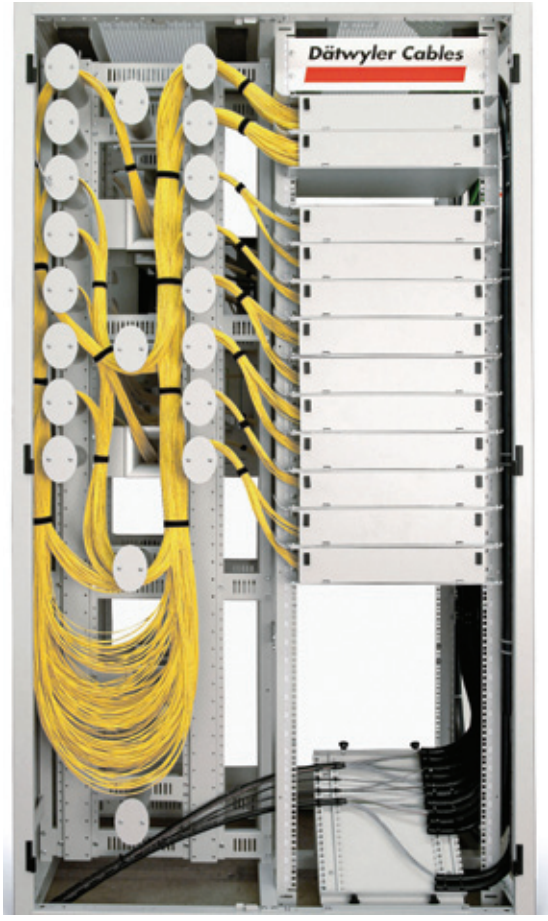


▲ *Ein Teil der neuen Auswahl von Daetwyler*

X-RAY 8000 NXT: Hochwertige Qualitätskontrolle in CV-Linien

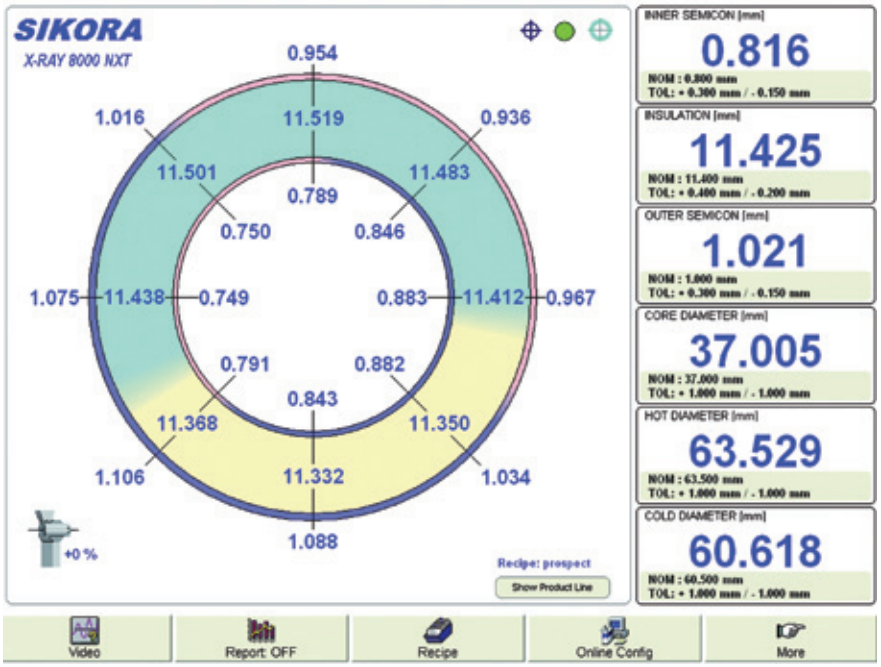
Mit dem innovativen Messsystem X-RAY 8000 NXT bietet SIKORA das Tool für eine konsequente Strategie für Qualitätskontrolle, Produktionsoptimierung und reduzierten Materialverbrauch in der Kabelfertigung.

Das X-RAY 8000 NXT eignet sich für eine permanente Qualitätskontrolle bei der Produktion von MV-, HV- and EHV-Kabeln in CCV-, VCV- und MDCV-Linien.

Sikora besetzt eine Spitzenposition als Vorläufer im Feld der EHV-Kabelproduktion. Speziell für diesen Anwendungsbereich entwickelt, eignet sich X-RAY 8000 NXT ideal für Kabel mit extrem großen Durchmessern bis zu 180mm für CCV-Linien und 220mm für VCV-Linien.

Das X-RAY 8000 NXT misst die Wanddicke, Exzentrizität sowie den Durchmesser und die Ovalität mit einer unvergleichlich hohen Mess- und Wiederholgenauigkeit.

Nur ein Scanvorgang ist nötig, um alle Messwerte zu berechnen. Das X-RAY 8000 NXT ermöglicht dem Bediener somit eine schnelle Positionierung der Extrusionswerkzeuge sowie eine optimale Kontrolle der Produktionslinie im Automatikbetrieb.



▲ *X-RAY 8000 NXT Monitorbild*

In der High-End-Ausführung des X-RAY 8000 NXT sind Multisensor-Halbleiterdetektoren eingesetzt. Diese Multisensor-Technik sichert zuverlässige Messwerte auch falls die Ader vibriert, ermöglicht die Aufnahme von vier Messwerten bei jedem Scanvorgang und bietet damit präzise Messergebnisse.

Eine echte Pionierleistung ist der Einsatz von Keramikfenstern* und NTX-Fenstern (Non Toxic X-RAY), welche die Scanner vom Druck der CV-Linie trennen.

Die Oberfläche der Fenster reagiert nicht mit Spaltprodukten aus dem Vernetzungsverfahren und bleibt stets sauber. * Patent angemeldet

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Neuer Vorsitzender für IWMA

Nach drei Jahren endete im Februar die Amtsdauer von Stephen Wood als IWMA-Vorsitzender, als er vom stellvertretenden Vorsitzenden Colin Dawson, Whitelegg Machinery Ltd, abgelöst wurde. Das Vorstandsmitglied Steve Rika wurde zum neuen stellvertretenden Vorsitzenden ernannt und Terry Robinson wurde wieder als Ehrenkassenführer gewählt.

Stephen Wood wurde für sein hervorragendes Engagement als Vorsitzender geehrt und IWMA freut sich sehr darauf, daß er weiterhin im Vorstand bleiben wird, wo seine Ratschläge für den neuen Vorsitzenden und den stellvertretenden Vorsitzenden von unschätzbarem Wert sein werden. Genaue Details zum Vorstand und zu den Vorstandsmitgliedern für das Jahr 2011/2012 können Sie auf der Website von IWMA www.iwma.org finden.

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▲ *Colin Dawson, der neue IWMA-Vorsitzender*

Chemetall übernimmt Artech Technologies

Chemetall (Australasia) Pty Ltd hat das Geschäft der Artech Technologies Pty Ltd, ein Unternehmen von Spezialchemikalien, mit Sitz in Geelong, Victoria, Australien, übernommen.

Artech Technologies ist ein führender Hersteller im Bereich Spezialchemikalien für die Metallbearbeitung und Oberflächenbehandlung. Im Jahr 2002 wurde Artech Technologies als privates Unternehmen gegründet und beliefert heute hauptsächlich Kunden in Australien und Neuseeland.

Mit der Übernahme baut Chemetall seine Präsenz in Australasien und Südostasien weiter aus und erweitert ihr Portfolio um zusätzliche Produkte der Metallbearbeitung und der Oberflächentechnik.

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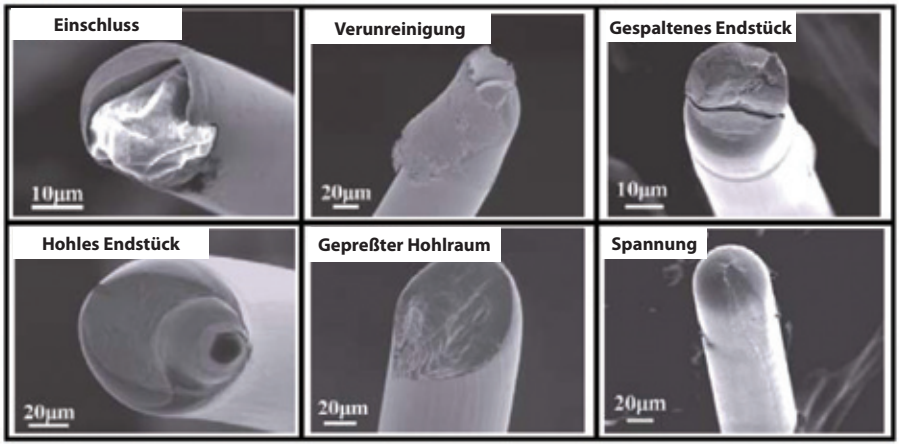
Analyse der Oberflächenfehler bei gezogenem Draht und bei Drahtbrüchen

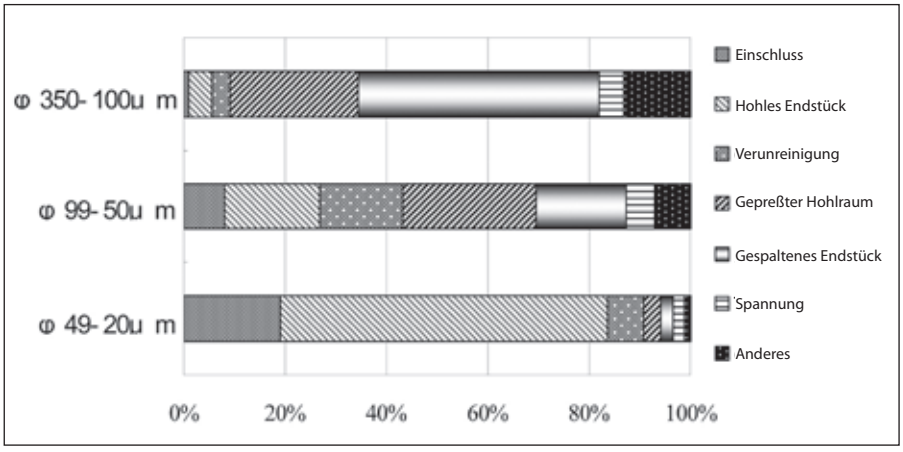
Von Kazunari Yoshida, Tetsuo Shinohara, Tsutomu Yamashita und Atsuhiro Tanaka, Universität Tokai, Japan

Übersicht

Anhand von Versuchen und der FEM-Analyse (Finite-Elemente-Methode), wird in dieser Studie überprüft, ob die Oberflächenrisse am Walzdraht während des Ziehens zunehmen oder dadurch beseitigt werden. Das Verformungsverhalten von V-förmigen, konkaven und U-förmigen Querrissen wurde nach wiederholten Ziehverfahren beobachtet. Die Autoren klärten die Bedingungen auf, unter denen diese Querrisse beseitigt werden, um eine Oberflächenbedingung zu erzielen, die jener des Bereichs ohne Risse ähnlich ist.



▲ **Bild 1**: *Arten von Drahtbrüchen*



▲ **Bild 2**: *Prozentsatz der Gründe von Drahtbrüchen während des Ziehverfahrens von Feinstgolddraht*

1 Einleitung

Der durch Ziehen hergestellte Draht- und Stabdurchmesser variiert von zirka 10µm bis 100mm. Bei allen Drahtdurchmessern hat der Bruch während des Ziehverfahrens einen direkten Einfluß auf die Produktivität.

Fehler an der Drahtoberfläche verursachen außerdem oft Ermüdungsbrüche, eine Verschlechterung der mechanischen Eigenschaften sowie einen Verlust des Produktwerts. Aus diesem Grund sind Oberflächenfehler die verbreitetste Beschwerde der Benutzer.

Darüber hinaus werden neuerlich dünnere und längere Drähte für den Einsatz als Verbindungsdraht von Halbleitern und für die Medizintechnik gefordert. Deswegen sind Drahtbrüche und Oberflächenfehler Probleme, die gelöst werden müssen.

Viele Forscher haben die optimale Ziehsteinform untersucht, um die Ziehkraft zu reduzieren, Maßnahmen zur Vermeidung der Bildung von Innenrissen im Draht (durch die Bildung zentraler Bruchfehler - central burst - oder durch Tiefziehen - cupping), das optimale Schmiermittel, Maßnahmen zur Senkung der Eigenspannung, usw. Es ergaben sich nützliche Ergebnisse, jedoch gab es nur wenige Studien über Maßnahmen um Drahtbrüche zu vermeiden und über die Wirkungen der Einschlüsse und der Oberflächenfehler beim Drahtziehen[1,4].

In dieser Studie wurden die Ursachen der Drahtbrüche bei gezogenen Drähten mit unterschiedlichen Durchmessern untersucht.

Die Analysen von Drähten mit Oberflächenfehlern und Einschlüssen wurden probeweise sowie durch eine FEM durchgeführt, um festzustellen, ob Drahtbrüche von Oberflächenfehlern und

Einschlüssen verursacht werden oder als Oberflächenfehler verbleiben, wenn das Ziehverfahren wiederholt wird.

2 Durch Ziehen verursachte Arten von Drahtbrüchen

Kürzlich hat das Auftreten von Drahtbrüchen während des Ziehverfahrens stark abgenommen, dank der reduzierten Partikeltrennung und den geringeren Einschlüssen in Stäben und Drähten, was wiederum durch eine wirksame Materialreinigung und einer Verbesserung der Ziehbedingungen bewirkt wurde.

Dennoch, je dünner der Drahtdurchmesser ist, desto höher ist die Auftrittshäufigkeit des Drahtbruchs während des Ziehverfahrens.

Drahtbrüche können aus mehreren Gründen verursacht werden (*Bild 1*). Zwei Arten von Brüchen entstehen durch Einschlüsse.

Eine davon tritt auf wenn Einschlüsse an der Bruchfläche gefunden werden, und die andere, die als Bruch mit "Hohlem Endstück" bezeichnet wird, entsteht, wenn Spuren von konkaven Einschlüssen gefunden werden, ohne daß jedoch die Einschlüsse selbst gefunden werden.

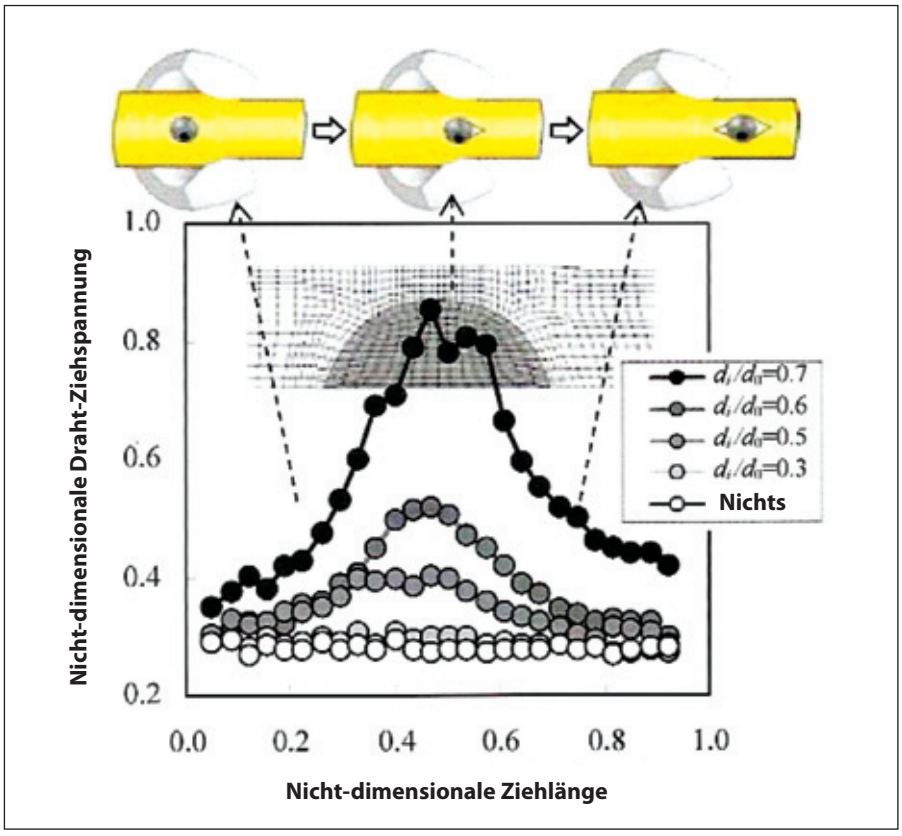
Zwei Arten von Brüchen werden durch Fremdmaterial verursacht, das während eines Verfahrens - anderes als das Gießverfahren - eingearbeitet wird.

Davon wird eine "Verunreinigungs"-Bruch genannt, wenn Fremdmaterial an der Bruchfläche gefunden wird, und die andere wird Bruch mit "gepreßtem Hohlraum" genannt, wenn kein Fremdmaterial festgestellt werden kann.

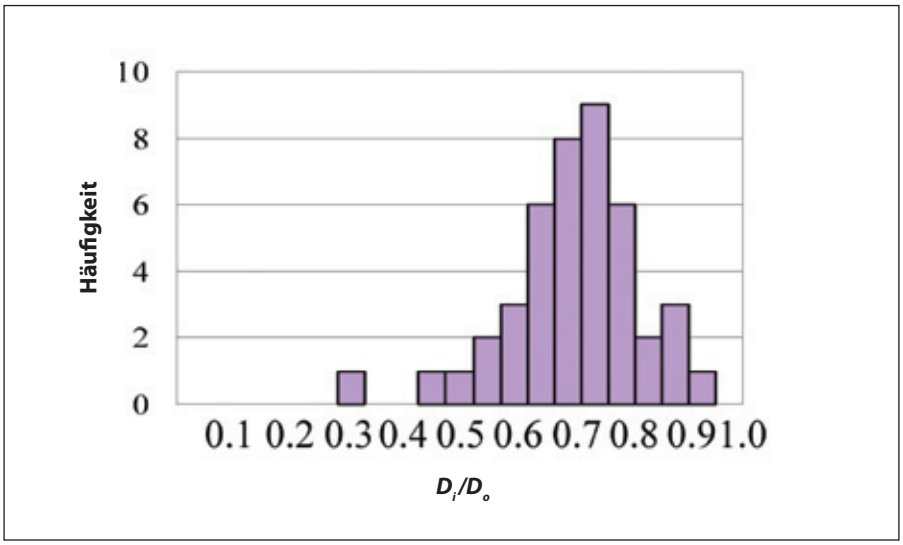
Darüber hinaus betrachtet man den Bruch mit "gespaltenem Endstück" als durch Oberflächenfehler verursacht und den "Spannungs"-Bruch als durch die Anwendung einer Spannung verursacht, die stärker als die Drahtfestigkeit ist[5]. Untersucht wurden Arten von Drahtbrüchen, die auftreten wenn Goldverbindungsdraht gezogen wird.

Bild 2 zeigt die Auftrittshäufigkeit jeder Art von Drahtbrüchen, mit Angabe der in drei Gruppen aufgeteilten Durchmesser der gezogenen Drähte d. h. 100-350µm, 50-99µm und 20-49µm[4].

Bild 1 und *2* zeigen, daß Oberflächenfehler, Fremdmaterial und das Auftreten einer übermäßigen Ziehspannung wegen dem Fressen, die Gründe des Drahtbruchs



▲ **Bild 3**: *Veränderung der Ziehspannung, wenn der Einschluss durch den Ziehstein läuft (mit FEM untersucht (Reduzierungsprozentsatz R/P=10%))*



▲ **Bild 4**: *Häufigkeit des Drahtbruchs verglichen mit D_i/D_o*

darstellen. Jedoch wird spekuliert, daß viele der Gründe des Bruchs von Drähten mit einem Durchmesser unter 50µm den Einschlüssen im Draht zuzuschreiben sind, die sich während des Gießens bilden[5].

Demzufolge kann zusammengefaßt werden, daß Drähte keine Oberflächenfehler haben sollten und die Einschlüsse so gering und so klein wie möglich sein sollten, um somit während des Ziehverfahrens den Brüchen widerstehen zu können.

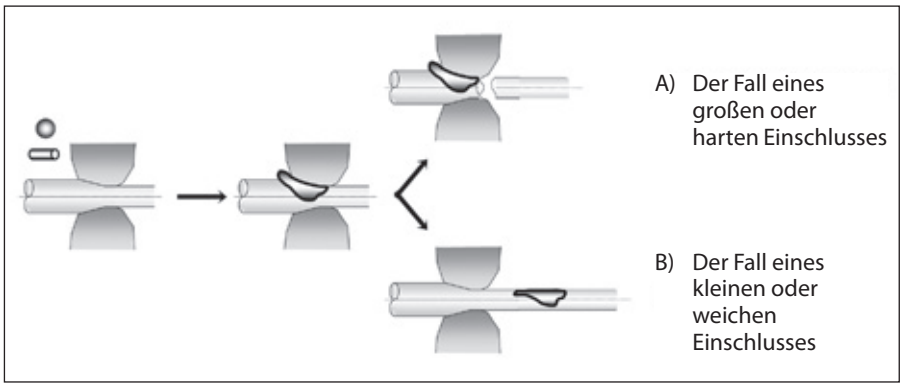
3 FEM-Analyse des Ziehens eines Drahts mit Einschlüssen oder Fremdmaterial

3.1 Wirkung der Einschlüsse im Draht

Die meisten Einschlüsse im Draht sind harte Werkstoffe. Die Ergebnisse zur Analyse von Einschlüssen an Bruchflächen von Drähten mittels eines energiedispersiven Spektrometers (EDS) zeigten, daß viele davon $A1_2O_3$ oder SiO_2 waren, und die

Mechanische Konstanten für Gold	
Young-Modul	80GPa
Poisson-Verhältnis	0.44
Verfestigungskurve	$\sigma=475\varepsilon^{0.07}$
Materialbedingung für Einschluss	
Material	$A1_2O_3$, SUS304
Young-Modul	300, 194GPa
Poisson-Verhältnis	0.23, 0.30
Streckgrenze	4.3, 0.205GPa
Ziehstein-Halbwinkel, Reduzierung	$_{\alpha}$=7°, R/P=10%
Reibungsfaktor	0.05µm

▲ **Tabelle 1**: *Bedingung der Werkstoffe und des Ziehverfahrens für FEM*



▲ **Bild 5**: *Schema des durch Fremdmaterial verursachten Drahtbruchs*

restlichen aus Fremdmaterial bestanden, das sich durch den Abrieb von Ziehsteinen und Ausrüstungen bildete.

Da angenommen wurde, daß Einschlüsse von Aluminiumoxid und Fremdmaterial im Draht bestehen, wurde eine FEM-Analyse des Drahtziehens durchgeführt.

Das Verhältnis zwischen Einschlussgröße und Drahtdurchmesser, Di/Do, wurde, variierend zwischen 0,3 und 0,7 festgelegt.

Die Materialkonstanten und die Ziehbedingung für die FEM-Analyse sind in der der *Tabelle 1* dargestellt.

Die Veränderungen der Ziehspannung in der Innenseite des Ziehsteins wurden durch eine FEM-Analyse mit Einsatz von Draht mit verschiedenen Einschlussgrößen untersucht.

Die Ergebnisse sind in *Bild 3* dargestellt. Es wurde herausgefunden, daß sich die Ziehspannung schnell aufwärts bewegt, wenn ein Einschluss durch den Ziehstein läuft. Es ist ersichtlich, dass, je höher das Verhältnis zwischen Einschlussgröße und Drahtdurchmesser - Di/Do - ist, desto mehr die Ziehspannung steigt.

Im Falle von Draht mit einem Einschluss, bei dem das Verhältnis Di/Do 0,7 entspricht, erreicht die Ziehspannung die Drahtfestigkeit. Das bedeutet, daß eine hohe Wahrscheinlichkeit besteht, daß der Draht brechen wird.

Unter Berücksichtigung des Sicherheitsfaktors wird angenommen, daß die Gefahr besteht, daß der Draht bricht, wenn Di/Do 0,4 überschreitet. Die Einschlussgrößen wurden an der Bruchfläche gemessen, während Golddraht mit Durchmessern zwischen 20 und 50µm gezogen wurde. *Bild 4* zeigt die Häufigkeit des Drahtbruchs bei unterschiedlichen Di/Do-Werten. Dieses Bild lässt darauf schließen, daß die Gefahr eines Drahtbruchs besteht, wenn Di/Do 0,3 entspricht oder wenn dieser Wert überschritten wird, und daß sich die höchste Häufigkeit eines Drahtbruchs ergibt wenn Di/Do zirka 0,7 entspricht.

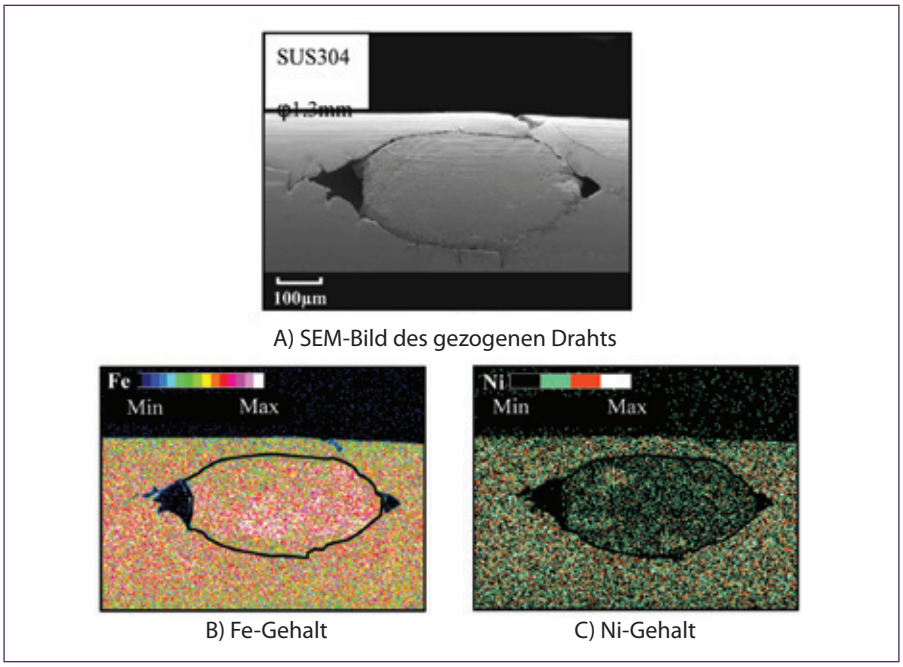
3.2 Wirkung von Fremdpartikeln

In manchen Fällen ist Fremdmaterial auf der Drahtoberfläche während des Ziehverfahrens vorhanden, oder Fremdmaterial könnte im Ziehstein durch das Schmiermittel eintreten. Dieses Fremdmaterial bildet sich hauptsächlich durch Erosion des Drahts oder der Ausrüstung, oder könnte aus dem in der Luft schwebenden Staub entstehen. Abhängig von der Form und Härte des Fremdmaterials könnte ein Drahtbruch entstehen, wie in *Bild 5* dargestellt.

Als ein Beispiel zeigt *Bild 6* Abbildungen vom Rasterelektronenmikroskop (REM) sowie EDS-Fotos eines Drahts nach dem Ziehen mit Fremdmaterial an der Drahtoberfläche. Das Drahtmaterial ist austenitischer Edelstahl.

Die Analyse mit EDS zeigte, daß das Fremdmaterial aus Eisenkarbid besteht, das eine geringe Ni-Komponente einschließt. Die Größe war 0,53x0,27mm, und Di/Do entsprach zirka 0,2. Es wird vermutet, daß der Draht wegen des niedrigen Di/Do-Werts nicht gebrochen ist. *Bild 7* zeigt die Ergebnisse, die durch die FEM-Analyse erfaßt wurden, bezüglich des Ziehens eines Drahts mit einem Fremdmaterial in der Nähe der Drahtoberfläche.

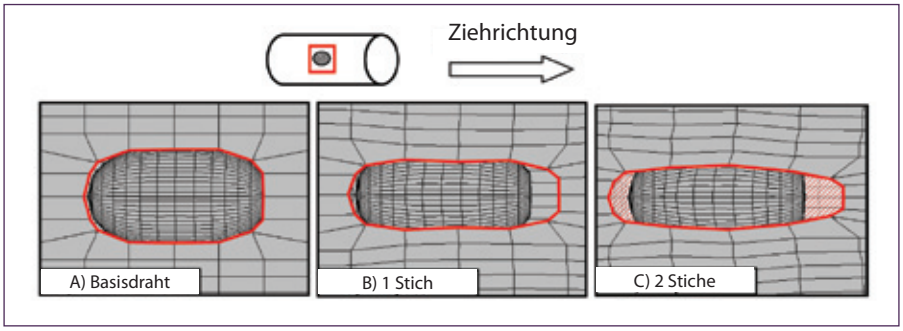
▼ **Bild 6**: *SEM-Bild und Kontrastanalyse des Drahts mit Fremdmaterial*



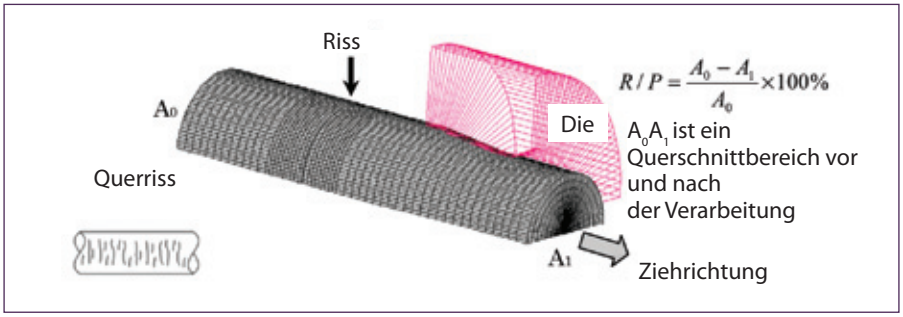
A) SEM-Bild des gezogenen Drahts

B) Fe-Gehalt

C) Ni-Gehalt



▲ **Bild 7**: *Maschenverformung nach wiederholtem Drahtziehen mit Fremdmaterial auf der Oberfläche, mittels FEM untersucht*



▲ **Bild 8**: *Ziehmodell des Drahts*

Aussehen	Name	Morphologie und Merkmale
	Verkrustung	Blattartiges Zeichen; Staboberfläche ist blank poliert
	Querriss	Riss senkrecht zur Walzrichtung
	Beule	Zunderähnliche Risse an der Oberfläche
	Kratzer	Konkaver Riss wegen Kratzens in Walzrichtung
	Im Material gewalzt	Kerbe, die sich aus dem Drücken gegen Fremdstoffe ergibt, wie z. B. Metallsplitter
	Überfüllt	Mangel, der sich aus dem kontinuierlichen Einkerben in Walzrichtung ergibt

▲ **Tabelle 2**: *Klassifizierung der Oberflächenrisse am Walzdraht*[7]

Das Fremdmaterial und der Draht sind an deren Schnittstelle mechanisch verbunden. Nach wiederholtem Ziehverfahren wirkt die Spannung an der Schnittstelle und bewirkt dort eine Trennung, was wiederum einen leeren Raum schafft.

Der dreidimensionale FEM-Code MSC/Marc Mentat 2008r1 wurde in dieser Studie verwendet. Die Ergebnisse der FEM-Analyse stimmen mit den Versuchsergebnissen überein.

Unabhängig davon ob sich das Fremdmaterial im Draht oder auf dem Draht befindet, wird es wegen seiner Härte keinen Verformungen unterworfen, selbst wenn das Ziehverfahren wiederholt wird.

Dies führt zu einem hohen Di/Do-Wert, der die Ziehspannung erhöht sowie die Möglichkeit eines Drahtbruchs.

4 Analyse eines gezogenen Drahts mit Oberflächenrissen

Bei Stäben oder Drähten entwickeln sich Oberflächenrisse wegen einer falschen Durchführung während des Gießens, des Warmwalzens, des Ziehens oder des Transports oder wegen eines unsachgemäßen Drahtaufwickelns[6].

Die Oberflächenrisse, die sich am Walzdraht während des Aufwärtswalzens entwickeln, sind nachfolgend[7] in *Tabelle 2* klassifiziert; jedoch gibt es hierzu keine eindeutige Lösung. Im Besonderen berichten nur sehr wenige Studien über Oberflächenrisse, die sich während des Ziehverfahrens bilden.[8–11]

In der vorliegenden Studie wurde Walzdraht - in dem sich Umfangsrisse während des Gießens und des Walzens entwickelten - als Basisdraht eingesetzt und wiederholt gezogen. Der Zuwachs und die Beseitigung dieser Risse wurden durch Versuche und die FEM-Analyse untersucht.

Walzdraht aus Edelstahl (SUS304) wurde mechanisch in Axialrichtung gekratzt. Dabei wurde eine Drehbank benutzt und analysiert durch Versuche und FEM.

Walzdrähte, die mechanisch markiert wurden, um V-förmige, konkave und U-förmige Risse in der Umfangrichtung zu bilden, wurden dann als Probe benutzt.

In dieser Studie wurde die FEM-Software, MSC/Marc Mentat 2008 R1, verwendet. *Bild 8* und *9*, und die *Tabelle 3* zeigen das in der FEM-Analyse benutzte Modell, bzw. dessen Materialkonstante und die Parameter des V-förmigen Risses. Der Reibungskoeffizient (μ) wurde auf 0,05 festgelegt. Darüber hinaus wurde für die FEM-Analyse ein axial-symmetrisches Modell angenommen, um Berechungszeiten einzusparen.

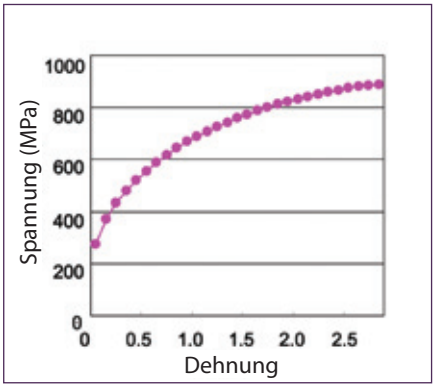
4.1 Ergebnisvergleich zwischen Versuch und FEM-Analyse

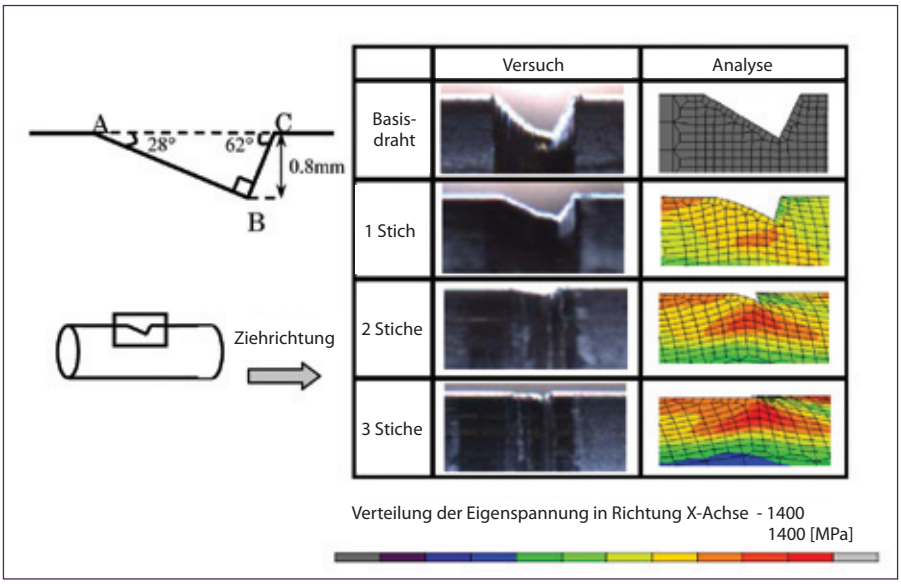
An einem Draht mit einem Durchmesser von 8mm wurde ein Riss mit einer Tiefe von h=0,8mm (8%) eingeschnitten und die Änderung dessen Form wurde probeweise und analytisch nach jedem Stich untersucht. Der Anfangsriss am Basisdraht zeigte eine asymmetrische V-Form auf.

Die Form des Anfangsrisses wurde mit einem Mikroskop beobachtet, und ein Basisdraht mit einem gleichförmigen Riss wurde in der FEM-Analyse modelliert. Es ist klar ersichtlich, daß das Ergebnis der FEM-Analyse mit den Versuchsergebnis übereinstimmt.

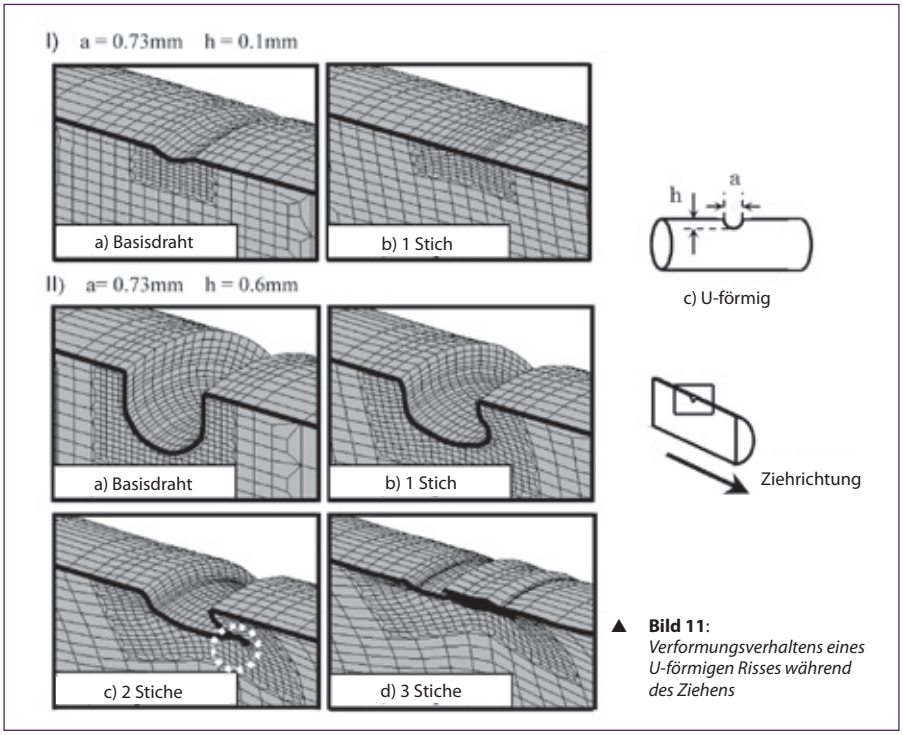
Wie in *Bild 10* dargestellt, scheint der Riss beseitigt worden zu sein, weil die Seite AB in den Draht hochgeschoben wird; jedoch ist die Seite BC des Risses schief, so daß sie über die Seite AB ragt und einen überlappenden Riss bildet (Mangel).

▼ **Bild 9**: *Verfestigungsdiagramm des geprüften Edelstahldrahts*





▲ **Bild 10**: *Änderungen beim Riss nach jedem Stich im Versuch und in der Analyse*



▲ **Bild 11**: *Verformungsverhaltens eines U-förmigen Risses während des Ziehens*

▼ **Tabelle 3**: *Parameter des Risses*

Parameter des Risses	
Formbezogene Parameter	V-förmige, konkave, U-förmige Risse
Tiefe (h)	0.10, 0.35, 0.60, 1.0mm
Breite (a)	0.73, 0.93, 1.15, 1.40mm
Winkel (θ)	60°, 70°, 80°, 90°, 100°, 110°, 120°
Richtung	Umfangsrichtung
Materialbedingung für den Draht	
Material	SUS304
Young-Modul	206GPa
Durchmesser	10mm, 8mm
Ziehstein-Halbwinkel, Reduzierung	$_{\alpha}$=6°, R/P=20%
Reibungsfaktor	0.05µm

Das 3-zügige Ziehen eines Basisdrahts mit einem Oberflächenriss wurde im Versuch und in der FEM-Analyse wiederholt. Das erzielte Rissverformungsverhalten wird je Stich ebenfalls in *Bild 10* dargestellt.

4.2 FEM-Analyse des Verformungsverhaltens des U-förmigen Risses während sich wiederholender Ziehverfahren

Darauf folgend wurde ein Draht mit einem U-förmigen Riss modelliert und das Ziehverfahren wurde durch die FEM-Analye auf ähnliche Weise analysiert.

Bild 11 zeigt einige Beispiele von Rissverformungsverhalten für Drähte mit einem Durchmesser von 10mm bei einem Riss mit einer Breite (a)=0,73mm und einer Tiefe (h)=0,10mm (1%) und bei einem Riss a=0,73mm und h=0,60mm (6%) während des wiederholten Ziehverfahrens bei α=6° und R/P=20%.

Wie in *Bild 11* dargestellt, unter Bedingung I, wächst der untere Teil des Risses während des wiederholten Ziehverfahrens, und demzufolge wird der Oberflächenriss nach dem ersten Stich beseitigt.

Dagegen wird unter der Bedingung II, mit einer größeren Tiefe, die rechte Seite des Risses schief, so daß sie über die linke Seite rangt und einen überlappenden Riss (Mangel) bildet.

Dies zeigt wiederum, daß der Riss nicht durchs Ziehen beseitigt werden kann. Außerdem entwickelt sich ein tiefer Riss im Draht, obwohl er klein erscheint.

Das bedeutet, daß das Verhalten des U-förmigen Risses während des Ziehens von der Tiefe abhängt (h).

Die Ergebnisse für die konkaven und U-förmigen Risse wurden verglichen. Ein überlappender Mangel entwickelt sich vom konkaven Riss, unabhängig von der Tiefe (h), während beim U-förmigen Riss, die Tiefe (h) als Parameter dient; was bedeutet, daß der weniger tiefe Riss (h) beseitigt wird, jedoch der Riss am Draht bestehen bleibt wenn (h) größer ist.

Es wird angenommen, daß die Form auf beiden Seiten des Risses dessen Beseitigung unter der Bedingung I in *Bild 11* wesentlich beeinflußt.

5 Schlussfolgerung

Drahtbrüche wurden durch Versuche und der Analyse der Finite Element Methode untersucht. Ein Schwerpunkt betraf Drahtbrüche, die durch das Vorhandensein von Fremdstoffen im oder am Draht verursacht werden, oder durch Querrisse,

die sich auf der Drahtoberfläche entwickeln wegen der Auswirkung von Ermüdung, Einschlüssen oder Oberflächenfehlern.

Die erzielten Ergebnisse sind nachfolgend zusammengefaßt.

1) Oberflächenfehler, Fremdmaterial und eine übermäßige Ziehspannung wegen Fressen stellen die Gründe des Drahtbruchs dar. Jedoch wird spekuliert, daß viele der Gründe des Drahtbruchs mit einem Durchmesser von oder unter 50µm dem Vorhandensein von Einschlüssen zuzuschreiben sind, die sich während des Gießens bilden[5]
2) Es wird angenommen, daß die Gefahr eines Drahtbruchs besteht, wenn Di/Do 0,3 entspricht oder wenn dieser Wert überschritten wird, und daß sich die höchste Häufigkeit des Drahtbruchs ergibt wenn Di/Do zirka 0,7 entspricht. Dies wurde festgestellt, weil die Ziehspannung sich schnell aufwärts bewegt wenn ein Einschluss durch den Ziehstein läuft
3) Das Ergebnis der FEM-Analyse stimmt mit den Versuchsergebnis überein; daher besteht die Möglichkeit das Rissverformungsverhalten durch die FEM-Analyse einzuschätzen, um somit den Zustand nach dem Ziehen vorhersagen zu können
4) Der Mechanismus, der der Beseitigung eines Risses in einem Walzdraht unterliegt, ist die Steigerung vom unteren Teil des Risses während des Ziehens.
5) Das Verhalten des U-förmigen Risses während des Ziehens hängt von der Tiefe (h) ab
6) Wo jedoch eine größere Tiefe besteht, ist die rechte Seite des Risses schief, so daß sie über die linke Seite rangt und einen überlappenden Riss (Mangel) bildet. Dies zeigt wiederum, daß der Riss nicht durch Ziehen beseitigt werden kann. Außerdem entwickelt sich ein tiefer Riss im Draht, obwohl er klein zu sein scheint

Diese Unterlage wurde während der Istanbul Cable & Wire '09 vorgestellt und ist hier mit freundlicher Genehmigung von IWMA und WAI vervielfältigt worden.

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Рекордные показатели продаж

По предварительным данным, в 2010 финансовом году объемы продаж компании «Леони» (Leoni), являющейся ведущим поставщиком кабелей и кабельных систем для автомобильной и других отраслей промышленности, достигли рекордного уровня почти в 2,96 млрд. евро (в прошлом году этот показатель составил 2,16 млрд. евро).

Наряду с дальнейшим ростом цен на медь, прогнозируемое значение приблизительно в 2,8 млрд. евро было значительно превышено благодаря продолжавшейся до конца года активной тенденции к росту спроса как в автомобильной промышленности, так и во всех других соответствующих секторах рынка.

Особого упоминания заслуживает тот факт, что столь значительное увеличение объемов продаж кабельных жгутов и систем межсоединений для автомобилей зафиксировано в странах БРИК, а также в США. Аналогичным образом компания «Леони» продемонстрировала отличные результаты и по показателю доходности до вычета налогов и процентов (EBIT), который составил около 131 млн. евро (по сравнению с убытками в размере 116 млн. евро в прошлом году), что существенно выше последнего планового норматива компании в 120 млн. евро. Дополнительные расходы на финансовую реструктуризацию, понесенные в четвертом квартале, уже учтены в этой сумме.

Компании «Леони» удалось существенно превысить и показатель свободного денежного потока, который был запланирован, как минимум, на нейтральном уровне. Соответственно, чистые обязательства, по предварительным расчетам, могли бы сократиться приблизительно на 50 млн. евро, впервые с момента начала экономического кризиса достигнув отметки ниже уровня собственного капитала по итогам года.

«Леони» подтверждает прогноз объема продаж более чем в 3,1 млрд. евро, который она сделала на 2011 финансовый год. Компания уверена в том, что ей удастся обеспечить дальнейший значительный рост доходов. При нынешнем положении дел недавние нарушения в производственно-логистической цепочке на предприятиях в Тунисе и Египте не должны привести к сколь-нибудь серьезным финансовым нагрузкам.

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Обновление ассортимента продукции

На Конференции по вопросам развития технологий «волокно до дома» (FTTH), которая состоялась в Милане (Италия), компания «Дэйтвайлер кейблз» (Daetwyler Cables) представила новые модели 19-дюймовых оптических кроссов (ODF) высокой плотности для использования в магистральных и распределительных сетях FTTH.

Оптические кроссы на 47 модульных единиц установочного пространства (U), позволяющие использовать до 6624 разъемов LC, характеризуются самой высокой плотностью портов из предлагаемых сегодня на рынке устройств. Несмотря на высокую плотность компоновки, оптические кроссы обеспечивают четкую систему организации соединительных шнуров и достаточное пространство для облегчения монтажа, сращивания и коммутации.

Оптические кроссы в стандартном исполнении поставляются в виде 19-дюймовых стоек на 42 и 47 модульных единиц и высотой 2000 и 2200 мм соответственно. Ширина стоек обоих типов составляет 1200 мм, а глубина – 800 мм. В стандартной модели на 42 модульные единицы к портам LC могут быть подключены до 2880 оптических волокон, а в спаренной модели с задними стенками, размещенными друг к другу, – целых 5760 волокон.

В модели на 47 модульных единиц достаточно места для размещения 3312 или 6624 разъемов LC. Компания «Дэйтвайлер кейблз» может также поставлять оптические кроссы других типоразмеров, например, глубиной 400 или 600 мм и различной высотой.

Оптические кроссы предлагают усовершенствованную систему организации соединительных шнуров, которая обеспечивает простоту размещения соединительных шнуров в горизонтальной и вертикальной плоскостях, а также достаточное пространство для разводки и хранения излишков кабеля.

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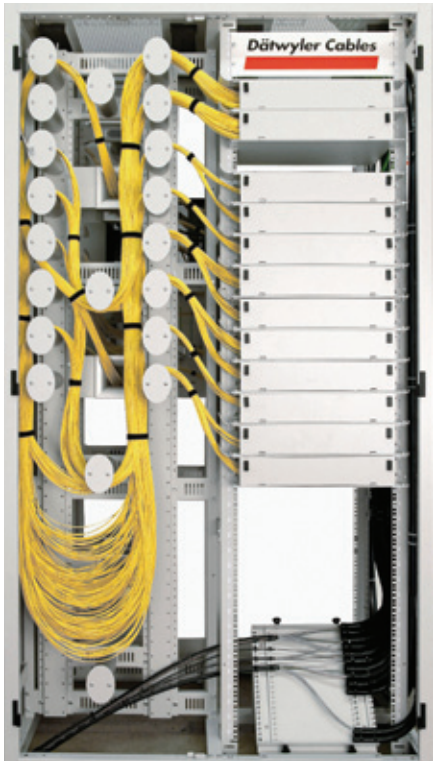

▲ *Образцы новой продукции из ассортимента «Дэйтвайлер»*

X-RAY 8000 NXT: полный контроль качества на линиях непрерывной вулканизации

С выпуском инновационного контрольно-измерительного комплекса X-RAY 8000 NXT компания «Сикора» (Sikora) предлагает инструментальное средство реализации высокоэффективной концепции контроля качества, оптимизации технологического процесса и снижения расхода материалов в производстве силовых кабелей.

Комплекс X-RAY 8000 NXT применяется для непрерывного контроля качества при производстве кабелей среднего, высокого и сверхвысокого напряжения на линиях непрерывной вулканизации типа CCV (наклонные линии непрерывной вулканизации), VCV (вертикальные линии непрерывной вулканизации) и MDCV (линии модифицированного химического парофазного осаждения). Компания «Сикора» занимает лидирующее положение в производстве кабелей сверхвысокого напряжения. Система X-RAY 8000 NXT, разработанная специально для этой задачи, идеально подходит для кабелей исключительно больших диаметров: до 180 мм при использовании на наклонных линиях непрерывной вулканизации и до 220 мм

▲ *Изображение на мониторе системы X-RAY 8000 NXT*

при использовании на вертикальных линиях непрерывной вулканизации.

Система X-RAY 8000 NXT обеспечивает исключительно высокую степень точности и воспроизводимости результатов при измерении толщины стенок изоляции, эксцентриситета, а также диаметра и овальности изделий. Для вычисления всех измеряемых значений требуется только один цикл сканирования. X-RAY 8000 NXT позволяет оператору быстро производить центровку экструзионного инструмента и обеспечивает оптимальное управление производственной линией в автоматическом режиме. Старшая модель комплекса X-RAY 8000 NXT оборудована многосенсорными полупроводниковыми детекторами.

Применение многосенсорной технологии обеспечивает достоверность снимаемых показаний при вибрации кабеля и позволяет получать во время каждого цикла сканирования четыре значения для более высокой точности измерений.

Одним из основных технических достижений стала интеграция керамических окон* и окон NTX (Non Toxic X-RAY), которые изолируют сканеры от воздействия на них давления в линии непрерывной вулканизации. Поверхность окон не вступает в реакцию ни с одним побочным продуктом процесса сшивания макромолекул поперечными связями и всегда остаётся чистой.
* Заявка на патент подана

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Новый председатель IWMA

Завершился трехлетний срок пребывания Стивена Вуда (Stephen Wood) в должности председателя Международной ассоциации производителей кабелей и кабельного оборудования (IWMA): в феврале его сменил Колин Доусон (Colin Dawson) из компании «Уайтлегг машинери лтд» (Whitelegg Machinery Ltd), исполнявший обязанности заместителя председателя. Член исполнительного комитета Стив Райка (Steve Rika) был избран новым заместителем председателя, а Терри Робинсон (Terry Robinson) переизбран на пост почетного казначея.

▲ *Колин Доусон, новый председатель IWMA*

Превосходная работа Стивена Вуда на посту председателя получила высокое признание, и члены ассоциации с удовольствием встретили сообщение о том, что он останется в составе исполнительного комитета, где значение его рекомендаций новым председателю и заместителю председателя будет трудно переоценить. Полную информацию о руководстве ассоциации и членах исполнительного комитета на период 2011-2012 гг. можно найти на Web-странице IWMA, пройдя по ссылке: www.iwma.org .

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«Хеметалл» приобретает «Артек текнолоджиз»

«Хеметалл (Остралэйша) пти лтд» (Chemetall (Australasia) Pty Ltd) приобрела активы «Артек текнолоджиз пти лтд» (Artech Technologies Pty Ltd) – специализированной химической компании, которая базируется в г. Джилонге (шт. Виктория, Австралия).

Компания «Артек текнолоджиз» специализируется на поставках высококачественных технологических масел и средств для обработки поверхностей. «Артек текнолоджиз» была создана в 2002 году как частная компания. Большая часть заказчиков компании – из Австралии и Новой Зеландии.

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Анализ дефектов поверхности тянутой проволоки и обрывов проволоки

Казунари Йошида, Тецуо Шинохара, Цутому Ямашита и Ацухиро Танака (Токайский университет, Япония)

Аннотация

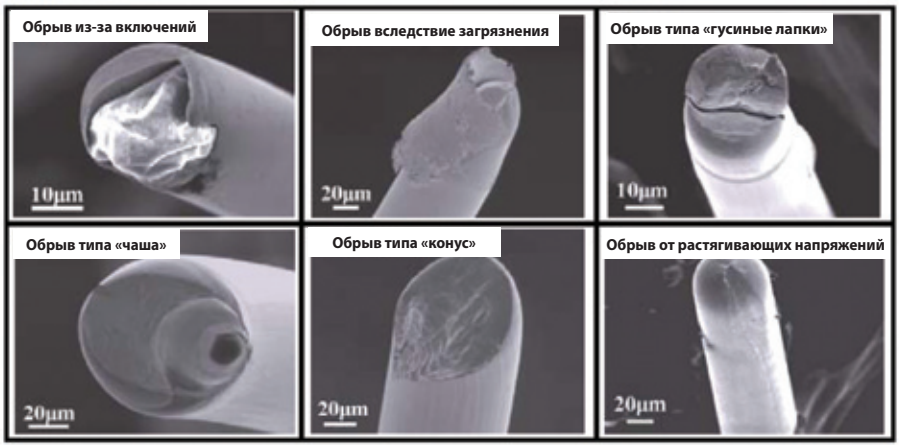
На основе данных экспериментальных исследований и анализа методом конечных элементов (МКЭ) в настоящей работе рассматривается вопрос о том, развиваются или удаляются трещины на поверхности катанки в процессе волочения. В ходе наблюдений при проведении многократного волочения получены данные о реологическом поведении материала V-образных, криволинейных и подковообразных поперечных трещин. Авторами уточнены условия удаления таких поперечных трещин для обеспечения качества поверхности, аналогичного качеству поверхности на участках, не имеющих трещин.

1. Введение

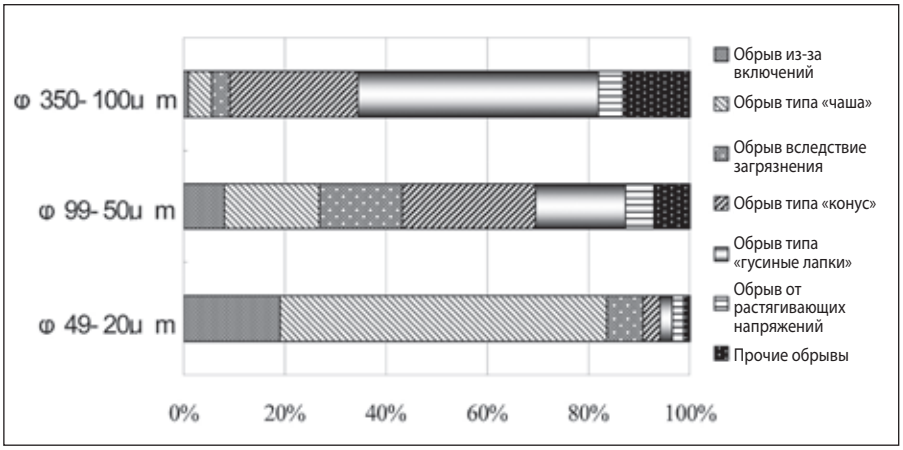
Проволока и катанка, получаемые в процессе волочения, имеют диаметр в диапазоне от порядка 10 мкм до 100 мм. Вне зависимости от диаметра проволоки обрывность при волочении непосредственным образом влияет на эффективность производства. К тому же, дефекты на поверхности проволоки зачастую становятся причиной обрывов из-за усталости материала и приводят к ухудшению прочностных свойств и снижению товарной стоимости продукции. Вот почему поверхностные дефекты являются наиболее частым предметом претензий со стороны потребителей. Кроме того, в последнее время появились заказы на проволоку меньшего диаметра и большей длины для использования в качестве проволоки для термокомпрессионной сварки в полупроводниковой промышленности и при производстве медицинских приборов. Таким образом, проблемы обрывности проволоки и поверхностных дефектов требуют незамедлительного решения.

Целым рядом исследователей проведены работы по изучению вопросов оптимизации формы матрицы для уменьшения силы волочения, мер по предотвращению образования внутренних трещин в проволоке (вследствие появления дефектов в виде центральных разрывов или образования пустот), подбора смазки с оптимальными свойствами, мер для снижения остаточных напряжений и т. д.

▼ **Рис. 1.** *Виды обрывов проволоки*



▼ **Рис. 2.** *Процентное соотношение факторов возникновения обрывов в процессе волочения ультратонкой золотой проволоки*



Получены полезные результаты, однако исследований мер предупреждения обрывов проволоки и вопросов влияния включений и поверхностных дефектов на процесс волочения проволоки проведено немного 1, 4.

В настоящем исследовании изучены причины обрывов тянутой проволоки различных диаметров. Изучение проволоки с поверхностными дефектами и включениями проводилось на основе экспериментальных данных и с использованием метода конечных элементов (МКЭ) с целью определения, приводят ли поверхностные дефекты и включения к обрывам проволоки или сохраняются как таковые при многократном волочении.

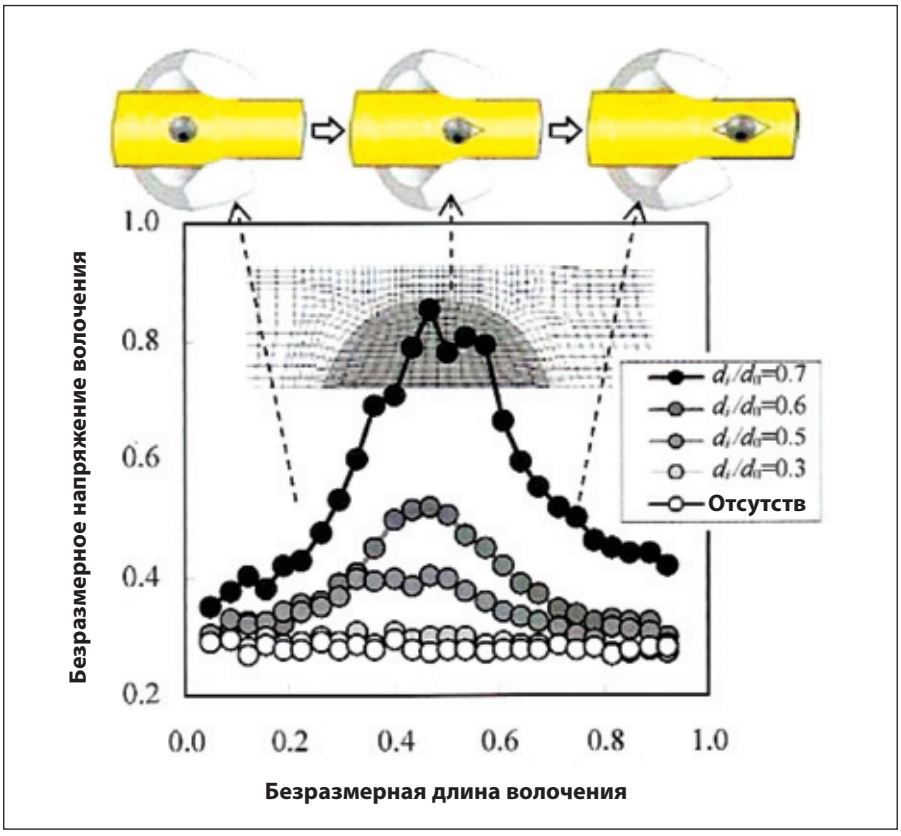
2. Виды обрывов проволоки при волочении

В последнее время за счет снижения степени ликвации и уменьшения количества включений в катанке и проволоке благодаря эффективной очистке металла, а также за счет усовершенствования режима волочения обрывы проволоки при волочении возникают существенно реже. Однако, с уменьшением диаметра проволоки частота возникновения обрывов в процессе волочения возрастает.

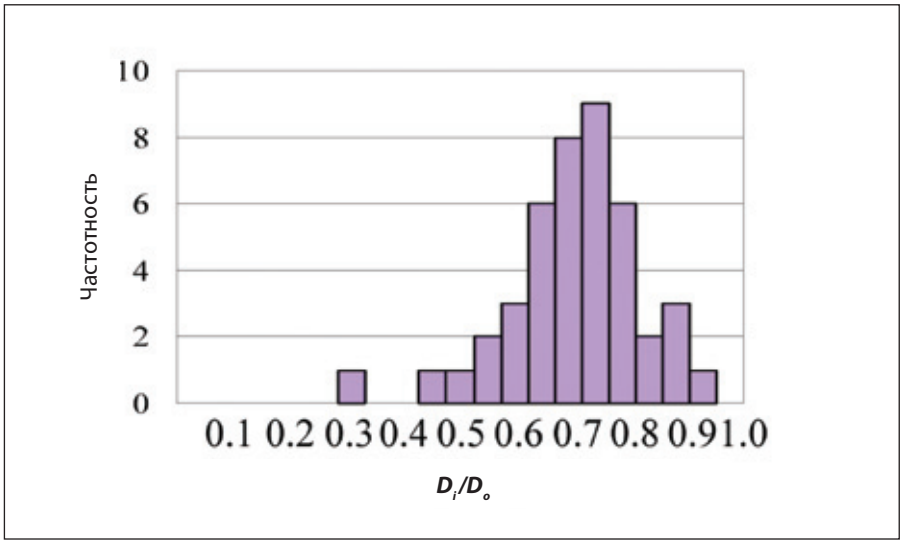
Обрывность проволоки обусловлена несколькими причинами (см. рис. 1). Два вида обрывов обусловлены наличием включений. Один вид обрывов возникает при наличии включений на поверхности разрыва, а другой, так называемый обрыв типа «чаша», возникает при наличии следов криволинейных включений, в то время как собственно включения отсутствуют.

Два вида обрывов обусловлены инородными частицами, которые вносятся во время технологических процессов, отличных от процесса литья. Один вид именуется обрывом вследствие загрязнения, при котором инородные частицы находятся на поверхности разрыва, а другой – обрывом типа «конус», при котором инородные частицы отсутствуют. Кроме того, считается, что причиной обрывов типа «гусиные лапки» являются поверхностные дефекты, а обрывы от растягивающих напряжений возникают под действием усилия, превышающего прочность проволоки 5.

Проведено изучение различных видов обрывов проволоки, возникающих при



▲ **Рис. 3.** *Изменение напряжения волочения при прохождении включения через канал волоки (анализ методом конечных элементов (обжатие за один проход R/P=10 %))*



▲ **Рис. 4.** *Частотность обрывов проволоки в зависимости от величины Di/ Do*

волочении золотой проволоки для термокомпрессионной сварки. На рис. 2 представлены данные о частотности возникновения каждого вида обрывов проволоки, при этом диаметры тянутой проволоки разбиты на три группы: 100-350 мкм, 50-99 мкм и 20-49 мкм 4.

На рис. 1 и рис. 2 показано, что причинами обрывности проволоки являются поверхностные дефекты, инородные частицы и избыточное напряжение волочения, возникающее вследствие заклинивания проволоки в канале волоки. Однако во многих случаях причинами обрывности проволоки диаметром меньше 50 мкм, предположительно, служат включения в проволоке, образующиеся в процессе литья 5.

С учетом вышесказанного можно сделать вывод о том, что для обеспечения стойкости проволоки к обрывам при волочении она не должна иметь поверхностных дефектов, а размер и количество любых включений должны быть как можно меньше.

3. Анализ процесса волочения проволоки с включениями или инородными частицами методом конечных элементов

3.1 Влияние включений в микроструктуре проволоки

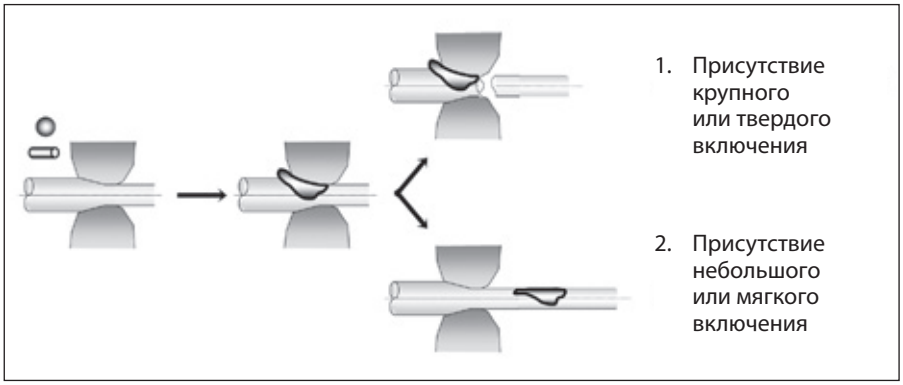
Включения в проволоке по большей части представляют собой твердые частицы. Результаты анализа включений на поверхности разрывов проволоки с помощью энергодисперсионного спектрометра (ЭДС) показали, что многие из них представляют собой $A1_2O_3$ или SiO_2, а остальные – это инородные частицы, образовавшиеся в результате абразивного износа волок и другого оборудования.

Таким образом, конечно-элементный анализ процесса волочения проволоки проводился, исходя из предположения о том, что в микроструктуре проволоки присутствуют включения оксида алюминия и инородные частицы. Отношение размеров включений к диаметру проволоки (Di/Do) было установлено в диапазоне от 0,3 до 0,7. Константы материалов и параметры волочения, используемые при анализе методом конечных элементов, представлены в таблице 1.

Изменения напряжения волочения на внутренней поверхности волоки были изучены методом конечных элементов с использованием проволоки с включениями различного размера. Результаты представлены на рис. 3. Было обнаружено, что напряжение волочения быстро возрастает при прохождении включения через канал волоки. Можно видеть, что напряжение волочения тем выше, чем больше отношение размеров включения к диаметру проволоки (Di/Do). Для содержащей включение проволоки, в которой отношение Di/Do составляет 0,7, напряжение волочения достигает величины прочности проволоки. Это означает, что существует высокая степень вероятности того, что произойдет обрыв проволоки. Принимая во внимание запас прочности, есть основания полагать, что риск обрыва проволоки существует в случае, если Di/Do будет больше 0,4. Измерение размеров включений проводилось на поверхности разрыва при волочении золотой проволоки диаметром 20-50 мкм. На рис. 4 представлены данные о частотности возникновения обрывов проволоки

Физико-механические константы для золота	
Модуль Юнга	80GPa
Коэффициент Пуассона	0.44
Кривая деформационного упрочнения	$\sigma=475\varepsilon^{0.07}$
Физические свойства включений	
Материал	$A1_2O_3$, SUS304
Модуль Юнга	300, 194GPa
Коэффициент Пуассона	0.23, 0.30
Предел текучести	4.3, 0.205GPa
Полуугол рабочего конуса волоки, обжатие	$_\alpha$=7°, R/P=10%
Коэффициент шероховатости	0.05μm

▲ **Таблица 1.** *Характеристики материалов и параметры режима волочения, используемые при анализе методом конечных элементов*



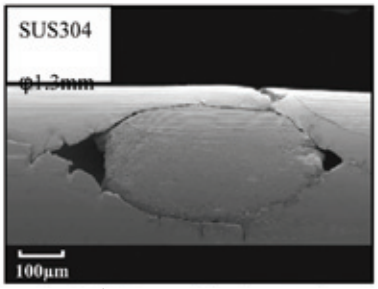
▲ **Рис. 5.** *Схематическое изображение обрывов проволоки, вызванных инородными частицами*

для различных значений Di/Do. Судя по этому рисунку, можно предположить, что риск обрыва проволоки возникает при значении Di/Do от 0,3 и более, а при Di/Do, составляющем около 0,7, частотность обрывов проволоки достигает максимальной величины.

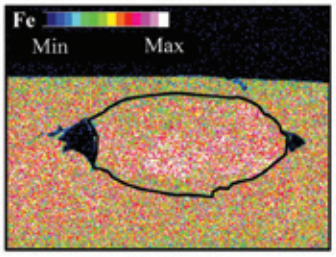
3.2 Влияние посторонних частиц

В ряде случаев инородные частицы уже присутствуют на поверхности проволоки при волочении, в других же инородные частицы могут поступить в канал волоки вместе со смазкой. Эти инородные частицы образуются

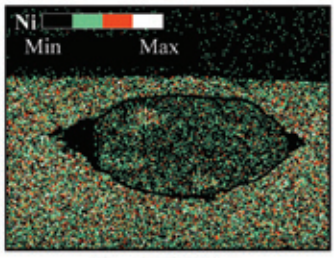
▼ **Рис. 6.** *РЭМ изображение и компонентный анализ проволоки с инородными частицами*



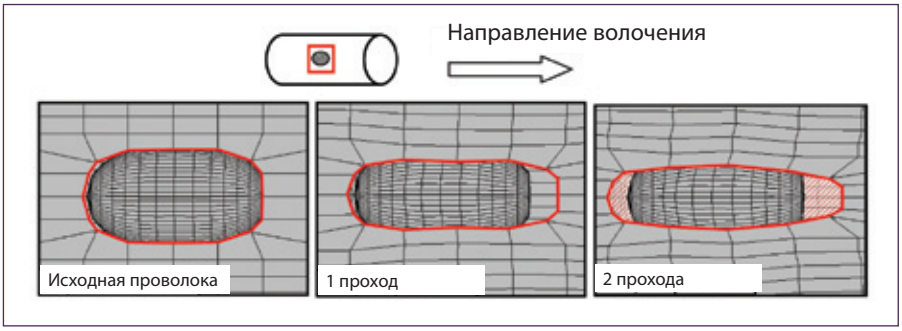
1. РЭМ изображение тянутой проволоки



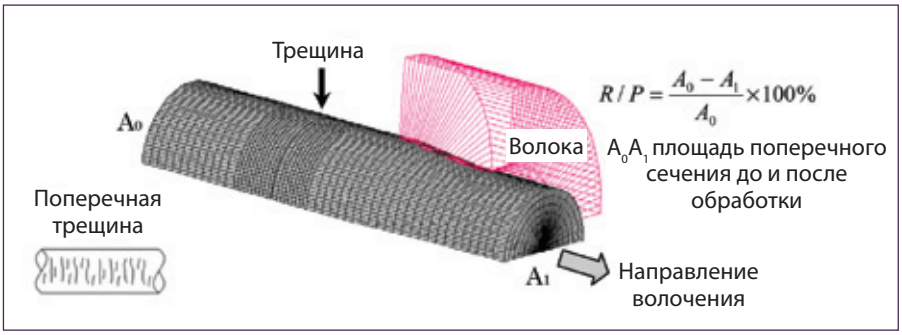
2. Содержание Fe



3. Содержание Ni



▲ **Рис. 7.** *Деформация сетчатой структуры после многократного волочения проволоки с инородными частицами на поверхностном участке по результатам анализа методом конечных элементов*



▲ **Рис. 8.** *Модель волочения проволоки*

Внешний вид	Описание	Морфология и отличительные признаки
	Плена	Расслоение; поверхность катанки зачищена
	Поперечная трещина	Трещина, ориентированная перпендикулярно направлению прокатки
	Наплыв	Ламеллярные трещины на поверхности
	Царапина	Криволинейная трещина, образовавшаяся вследствие царапания поверхности металла в направлении прокатки
	Вкатанные инородные частицы	Риска, образовавшаяся в результате вдавливания посторонних включений, например, металлической стружки
	Подрез	Дефект, образовавшийся в результате непрерывного вдавливания металла в направлении прокатки

▲ **Таблица 2.** *Классификация трещин на поверхности катанки* [7]

главным образом вследствие эрозионного износа проволоки, волоки или сопутствующего оборудования, либо могут формироваться из пыли в воздухе.

В зависимости от формы и твердости инородных частиц существует возможность обрыва проволоки (см. рис. 5).

В качестве иллюстрации на рис. 6 представлены изображения проволоки с инородными частицами на поверхности, полученные с помощью растрового электронного микроскопа (РЭМ) и ЭДС по окончании процесса волочения. Проволока изготовлена из аустенитной нержавеющей стали.

Анализ методом энергодисперсионной спектрометрии показал, что инородные частицы состояли из карбида железа с незначительным содержанием Ni. Размер частиц составил 0,53x0,27 мм, а отношение Di/Do – приблизительно 0,2. Предполагается, что обрыва проволоки не произошло вследствие малой величины Di/Do. На рис. 7 представлены результаты, полученные при конечно-элементном анализе процесса волочения проволоки с инородными частицами в приповерхностной зоне.

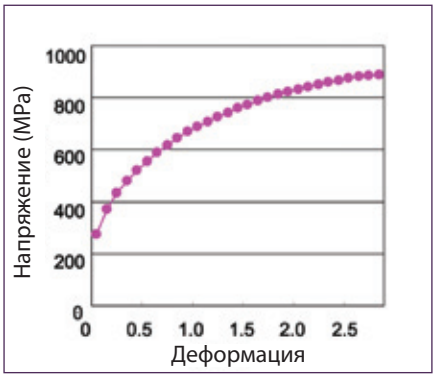
На границе контакта инородных частиц и проволоки между ними существует механическая связь. При многократном волочении на границе контакта под воздействием механического напряжения происходит разделение с образованием пустот. В настоящем исследовании использовался программный комплекс трехмерного конечно-элементного моделирования Marc Mentat 2008r1 компании MSC. Результаты анализа методом конечных элементов соотносятся с результатами экспериментальных исследований. Вне зависимости от того, присутствуют инородные частицы в микроструктуре проволоки или на ее поверхности, они не подвергаются деформации ввиду присущей им твердости, причем даже при многократном волочении. Это дает высокое значение Di/Do, и, как следствие, увеличивается напряжение волочения, и повышается вероятность обрыва проволоки.

4. Анализ процесса волочения проволоки с поверхностными трещинами

Поверхностные трещины образуются на катанке или проволоке вследствие неправильной обработки в процессе литья, горячей прокатки, волочения или транспортировки, либо в результате ненадлежащей намотки проволоки 6. В таблице 2 представлена классификация 7 трещин, которые образуются на поверхности катанки во время прокатки в верхнем горизонте; между тем, четкого решения данной проблемы не существует. В частности, лишь в небольшом числе исследований сообщается о поверхностных трещинах, образующихся при волочении. [8–11]

В настоящем исследовании образцы катанки, на поверхности которых в процессе литья и прокатки образовались кольцевые трещины, используются в качестве исходной проволоки и подвергаются многократному

▼ **Рис. 9.** *Эпюра деформационного упрочнения исследуемых образцов проволоки из нержавеющей стали*



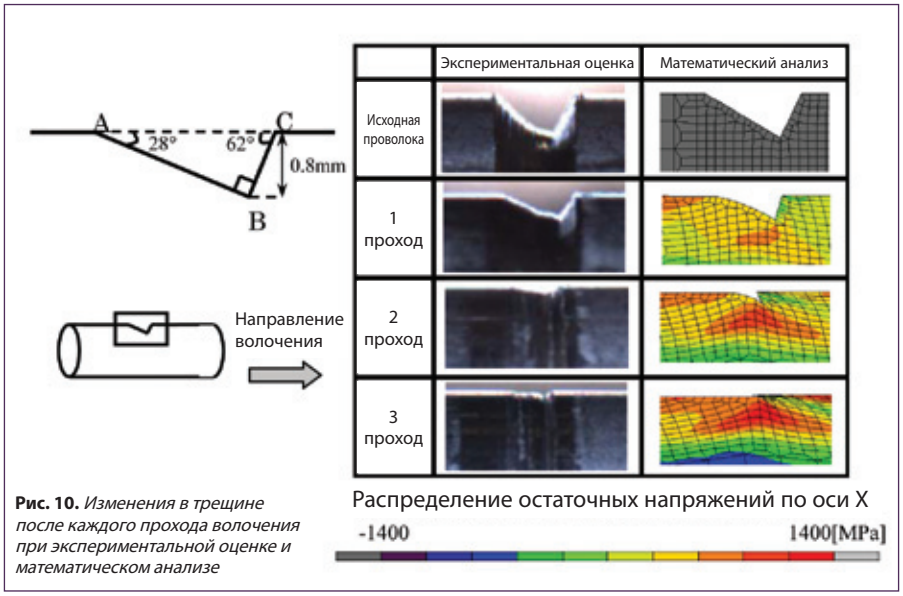
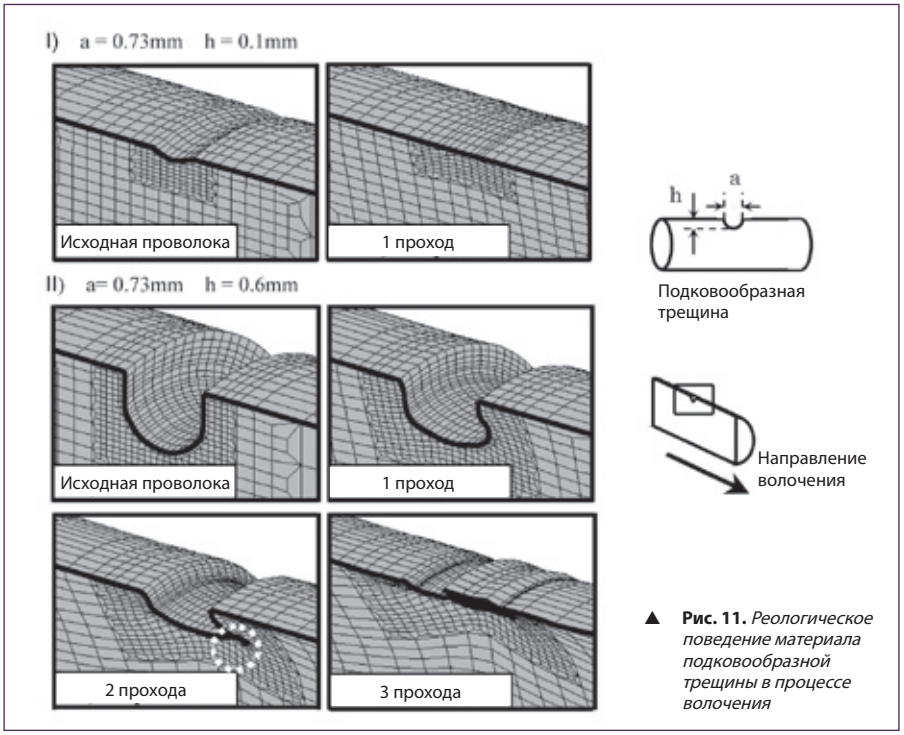


Рис. 10. *Изменения в трещине после каждого прохода волочения при экспериментальной оценке и математическом анализе*



▲ **Рис. 11.** *Реологическое поведение материала подковообразной трещины в процессе волочения*

▼ **Таблица 3.** *Параметры трещины*

Параметры трещины	
Параметр формы	V-образные, криволинейные, подковообразные трещины
Глубина (h)	0.10, 0.35, 0.60, 1.0мм
Ширина (a)	0.73, 0.93, 1.15, 1.40мм
Угол наклона (θ)	60°, 70°, 80°, 90°, 100°, 110°, 120°
Направление	Круговое направление
Физические свойства проволоки	
Материал	SUS304
Модуль Юнга	206GPa
Диаметр	10мм, 8мм
Полуугол рабочего конуса волоки, обжатие	$_{\alpha}$=6°, R/P=20%
Коэффициент шероховатости	0.05μm

волочению. Анализ роста этих трещин и механизма их удаления проводится опытным путем и методом конечных элементов.

На поверхность образцов катанки из нержавеющей стали (SUS304) путем обработки на токарном станке в продольном направлении были нанесены царапины, после чего они были исследованы опытным путем и методом конечных элементов. В качестве контрольных образцов использовались образцы катанки, на которых путем механического воздействия были нанесены риски для образования V-образных, криволинейных и подковообразных трещин в круговом направлении.

В настоящем исследовании использовался программный комплекс конечно-элементного моделирования Marc Mentat 2008 R1 компании MSC. На рис. 8, рис. 9 и в таблице 3 представлена модель, использовавшаяся при анализе методом конечных элементов, и приводятся ее физические константы и, соответственно, параметры V-образной трещины. Для коэффициента трения (μ) было установлено значение 0,05. Кроме того, для экономии времени вычислений при выполнении анализа методом конечных элементов было принято, что модель является осесимметричной.

4.1 Сравнительные результаты экспериментальной оценки и анализа методом конечных элементов

На поверхность проволоки диаметром 8 мм была нанесена трещина глубиной h=0,8 мм (8 %), и после каждого прохода волочения проводилась экспериментальная и аналитическая оценка изменений ее формы. Начальная трещина на поверхности исходной проволоки имела асимметрически V-образную форму.

Изучение формы начальной трещины проводилось с помощью микроскопа, при этом моделирование исходной проволоки с трещиной той же формы было выполнено методом конечных элементов. Очевидно, что результат анализа методом конечных элементов хорошо соотносится с результатом экспериментальной оценки. Как показано на рис. 10, трещина, судя по всему, удаляется вследствие того, что сторона AB вдавливается в микроструктуру проволоки; однако сторона трещины BC ориентирована под углом, нависая, таким образом, над стороной AB и образуя перекрывающую трещину (дефект).

В ходе экспериментальной оценки и анализа методом конечных элементов

повторно выполнялось волочение исходной проволоки с поверхностной трещиной за три прохода. Полученные данные реологического поведения материала трещины для каждого прохода волочения также представлены на рис. 10.

4.2 Конечно-элементный анализ реологического поведения материала подковообразных трещин в процессе многократного волочения

Далее с помощью метода конечных элементов было выполнено моделирование проволоки с подковообразной трещиной, и аналогичным образом проведен анализ процесса волочения.

На рис. 11 проиллюстрировано реологическое поведение материала трещин для образцов 10-мм проволоки с трещиной шириной (a)=0,73 мм и глубиной (h)=0,10 мм (1 %) и с трещиной с параметрами a=0,73 мм и h=0,60 мм (6 %) в процессе многократного волочения при α=6° и R/P=20 %.

Как показано на рис. 11, при условии I нижняя часть трещины во время многократного волочения поднимается, и, таким образом, поверхностная трещина удаляется после первого прохода.

Однако при условии II, т. е. при большей глубине трещины, правая сторона трещины ориентирована под углом, нависая над левой стороной, и образует перекрывающую трещину (дефект), что указывает на то, что трещина не может быть удалена посредством волочения.

Более того, в микроструктуре проволоки развивается глубокая трещина, хотя выглядит она небольшой.

Иными словами, реологическое поведение материала подковообразной трещины в процессе волочения зависит от ее глубины (h).

Сопоставлены результаты оценки криволинейных и подковообразных трещин. Перекрывающий дефект формируется из криволинейной трещины вне зависимости от глубины (h), тогда как для подковообразной трещины глубина (h) служит параметрической характеристикой, то есть трещина, имеющая небольшую глубину (h), поддается удалению, однако при бóльших значениях (h) трещина на поверхности проволоки сохраняется.

Считается, что при условии I (см. рис. 11) на возможность удаления трещины существенным образом влияет форма обеих ее сторон.

5. Заключение

Исследования обрывности проволоки проводились опытным путем и методом конечных элементов. Основным объектом исследований стали обрывы проволоки, вызванные присутствием в микроструктуре или на поверхности проволоки инородных частиц, либо развитием на поверхности проволоки поперечных трещин, обусловленным усталостью металла, наличием включений или поверхностных дефектов. Полученные результаты в обобщенной форме приведены ниже.

1) Причинами обрывности проволоки являются поверхностные дефекты, инородные частицы и избыточное напряжение волочения, вызванное заклиниванием проволоки в канале волоки. Тем не менее предполагается, что во многих случаях причиной обрывности проволоки диаметром 50 мкм и меньше служит наличие включений, образовавшихся в процессе литья.

2) Есть основания предполагать, что риск обрыва проволоки возникает при значении Di/Do, равном 0,3 и больше, а при Di/Do, составляющем около 0,7, частотность обрывов проволоки достигает максимальной величины. Выявлено, что это обуславливается стремительным ростом напряжения волочения в момент прохождения постороннего включения через канал волоки.

3) Результаты анализа методом конечных элементов хорошо соотносятся с результатами экспериментальной оценки; следовательно, можно провести оценку реологического поведения материала трещин с применением метода конечных элементов для прогнозирования их состояния после волочения.

4) Механизм, лежащий в основе возможности удаления трещины, присутствующей в микроструктуре катанки, заключается в поднятии нижней части трещины в процессе волочения.

5) Реологическое поведение материала подковообразной трещины при волочении зависит от значения глубины (h).

6) Однако при большей глубине трещины ее правая сторона ориентирована под углом, соответственно нависая над левой стороной, и образует перекрывающую трещину (дефект), что указывает на то, что трещина не может быть удалена посредством волочения. Более того, в микроструктуре проволоки развивается глубокая трещина, хотя выглядит она небольшой.

Настоящая работа была представлена на выставке Cable & Wire '09 в г. Стамбуле и перепечатывается здесь с любезного разрешения Международной ассоциации производителей кабелей и кабельного оборудования (IWMA) и Международной ассоциации производителей проволоки и кабельной продукции (WAI).

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Record de ventes d'environ 3 milliards d'euros

Leoni, entreprise leader dans la fourniture de câbles pour le secteur automobile et autres industries, d'après les estimations indicatives, a réalisé au cours de l'exercice 2010 une vente record d'environ 2960 millions d'euros (2160 millions d'euros l'année précédente).

À part une augmentation supplémentaire du prix du cuivre, le chiffre prévu d'environ 2800 millions d'euros a été largement dépassé grâce également à une tendance dynamique à la hausse dans la demande dans le secteur automobile et dans d'autres marchés apparentés jusqu'à la fin de l'année.

L'augmentation significative des ventes des câblages et des systèmes de câblage pour véhicules dans les pays BRIC (Brésil, Russie, Inde et Chine) ainsi qu'aux Etats-Unis mérite une mention spéciale.

De façon analogue, en termes de résultat avant intérêts et impôts (EBIT), Leoni a obtenu un grand succès en enregistrant un chiffre d'affaires d'environ 131 millions d'euros (116 millions d'euros l'année précédente), en dépassant largement son dernier objectif de 120 millions d'euros. Les charges de restructuration additionnelles supportées au cours du quatrième trimestre ont déjà été absorbées dans ce résultat.

La société Leoni a réussi à dépasser significativement son objectif d'atteindre au moins un flux de trésorerie neutre. Par conséquent, d'après les estimations préliminaires, la dette nette pourrait être réduite d'environ 50 millions d'euros, en restant encore au-dessous des capitaux propres à la fin de l'année pour la première fois depuis le début de la crise économique.

Leoni confirme encore sa prévision des ventes de plus de 3100 millions d'euros pour l'exercice 2011. La société compte pouvoir continuer à réaliser des augmentations significatives des revenus. Le dommage récent subi par la production et par la logistique dans les établissements en Tunisie et en Égypte n'entraînera, ainsi qu'il apparaît aujourd'hui, aucune charge financière matérielle.

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Nouvelle gamme disponible

Daetwyler Cables a présenté une gamme récemment développée de baies de distribution optique (ODF) à haute densité de 19", pour l'utilisation dans les réseaux de distribution optique et infrastructures FTTH durant la Conférence sur les câbles à fibres optiques destinés aux usagers résidentiels (FTTH) qui s'est tenue à Milan.

Les baies de distribution optique, comprenant jusqu'à 6624 connecteurs LC de 47 unité rack (format 47U), offrent la densité de ports la plus élevée disponible sur le marché actuel.

En dépit des densités de compactage, les ODF permettent une claire gestion des câbles de connexion et un espace suffisant pour faciliter l'assemblage, l'épissurage et la connexion.

La version standard de la baie de distribution optique est constituée d'un bâti de 19", de 42U et 47U, respectivement avec 2000mm et 2200mm de haut, de 1200mm d'ampleur et 800mm de profondeur.

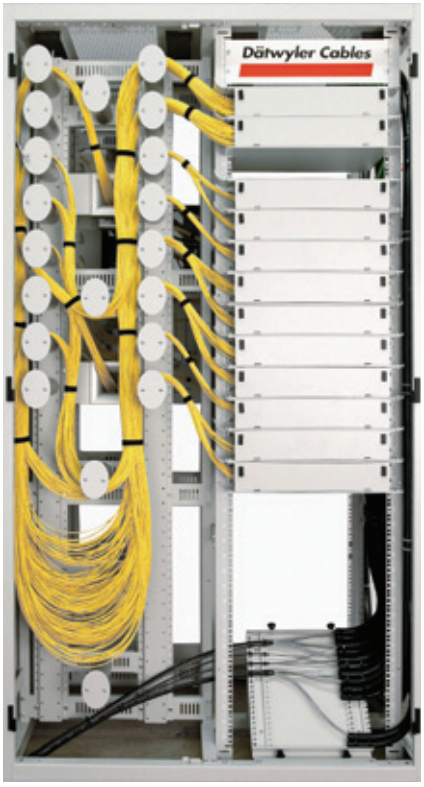
Jusqu'à 2880 fibres optiques peuvent être connectées aux portes LC dans le modèle standard avec 42U et jusqu'à 5760 fibres dans la version back-to-back.

Le modèle 47U est pourvu d'un espace pour 3312 et 6624 connecteurs LC. Daetwyler Cables peut également fournir des baies de distribution optique d'autres dimensions, par exemple de 400mm ou 600mm de profondeur, ou dans des hauteurs spécifiques.

Les baies de distribution optique forment un système sophistiqué de configuration des câbles de connexion permettant d'organiser aisément les câbles de connexion en direction verticale et horizontale et offrent l'espace nécessaire pour acheminer et loger les longueurs en excès.

Outre l'espace de stockage pour les conducteurs de rechange, les baies présentent une boîte de séparation pour les câbles pouvant être installée également dans une cavité du plancher, sur le toit ou sur la paroi latérale en fonction des nécessités, des dispositifs de contrôle du rayon de courbure circulaire et semi-circulaire dans les guides pour fibres afin d'éviter des rayons de courbure excessivement étroits et des panneaux de jonction préchargés avec des connecteurs spiralés.

L'équipement de base présente également des entrées de câbles dans la partie inférieure et supérieure, un rail de terre dans la partie frontale, des pieds de mise à niveau préassemblés et des profils de montage variables en profondeur.



▲ *Partie de la nouvelle gamme de Daetwyler*

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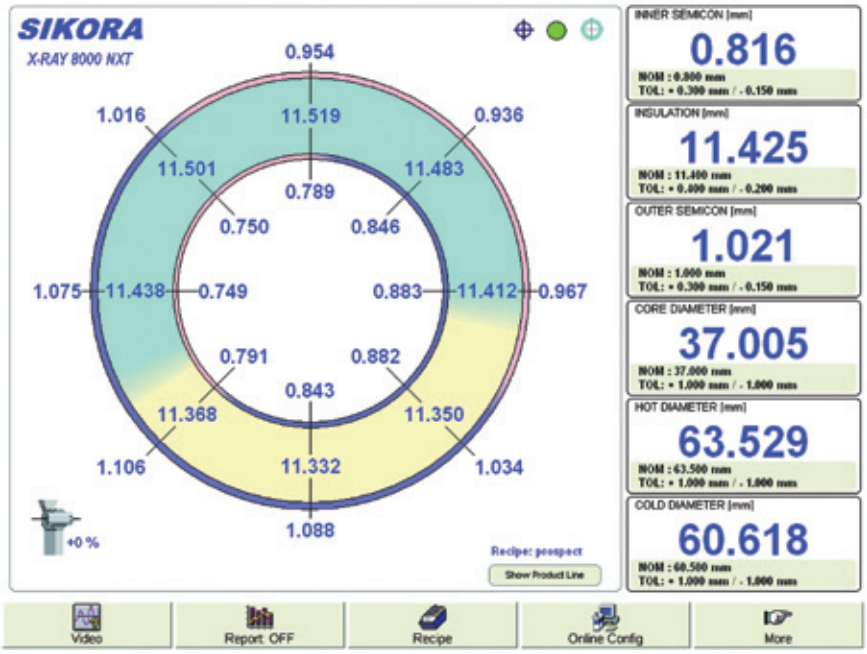
X-RAY 8000 NXT, Système révolutionnaire de contrôle de la qualité des câbles dans les lignes CV

Grâce au système de mesure innovant X-RAY 8000 NXT Sikora offre l'instrument approprié pour une conception efficace en termes de contrôle de la qualité, d'optimisation du produit et de réduction de la consommation des matériaux dans la production de câbles d'alimentation.

Le système X-RAY 8000 NXT est conçu pour effectuer un contrôle de la qualité constant durant la production de câbles de moyenne, haute et extra haute tension dans les lignes de type CCV, VCV et MDCV.

Sikora occupe une position importante en tant que précurseur dans le secteur de la production de câbles extra haute tension (EHV). Le système X-RAY 8000 NXT, spécialement conçu pour ce type d'applications, est idéal pour des diamètres de câble très larges arrivant jusqu'à 180mm pour les lignes CCV et jusqu'à 220mm pour les lignes VCV.

Le système X-RAY 8000 NXT est conçu pour mesurer l'épaisseur des parois, l'excentricité ainsi que les diamètres et l'ovalité avec une précision de mesure et une répétabilité incomparables. Un seul balayage suffit pour calculer la totalité des valeurs de mesure. Le système X-RAY 8000 NXT permet à l'opérateur d'effectuer un centrage rapide des instruments d'extrusion et un contrôle excellent de la ligne de production en mode automatique.



▲ *Image d'écran du système X-RAY 8000 NXT*

La variante haut de gamme du système X-RAY 8000 NXT comprend des détecteurs à semi-conducteurs multicapteurs intégrés. Cette technologie multicapteurs garantit la fiabilité de lecture également dans le cas de vibration du câble et offre quatre valeurs de mesure dans chaque procès de balayage pour une mesure exacte.

Un chef-d'œuvre d'ingénierie est représenté par l'intégration de fenêtres en céramique* et fenêtres NTX (rayons X non toxiques), qui séparent les scanners de la pression de la ligne CV. La surface des fenêtres ne réagit avec aucun sous-produit résultant du procès de réticulation et reste toujours propre. * Brevet en instance

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IWMA, nouveau président

Au mois de février, Stephen Wood a quitté son poste de président de IWMA, après trois ans, et il a été remplacé par le vice-président Colin Dawson de Whitelegg Machinery Ltd. Steve Rika, membre du directoire, a été nommé nouveau président et Terry Robinson été réélu trésorier honoraire.

Stephen Wood a été remercié pour le travail excellent réalisé en tant que président et IWMA est fière de sa permanence dans l'association comme membre du directoire où il pourra travailler à côté du nouveau président et du vice-président en offrant sa précieuse collaboration.

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▲ *Colin Dawson, nouveau président de IWMA*

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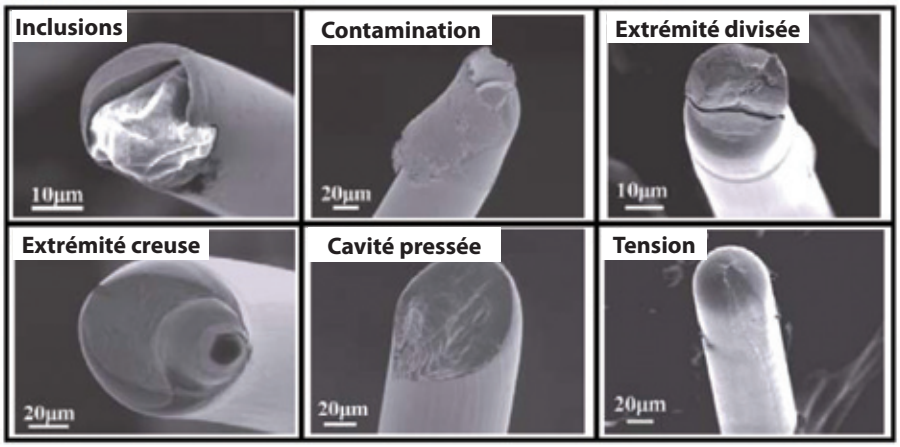
Analyse des défauts superficiels sur le fil étiré et ruptures du fil

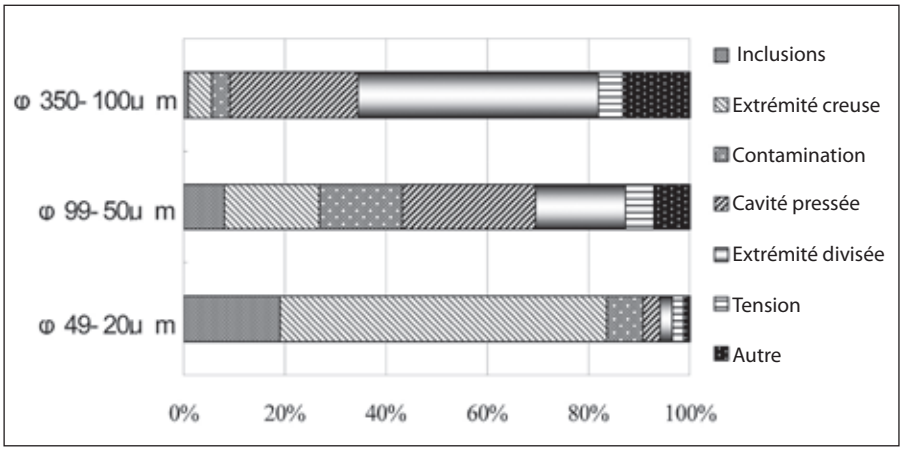
Par Kazunari Yoshida, Tetsuo Shinohara, Tsutomu Yamashita, et Atsuhiro Tanaka de l'Université de Tokai, Japon

Résumé

En effectuant des expériences et des analyses avec la méthode des éléments finis (FEM), le présent article analyse si les fissures superficielles présentes sur les fils machine se développent ou sont éliminées durant le tréfilage. On a étudié le comportement de déformation des fissures transversales en forme de V, concaves et en forme de U à la suite d'opérations de tréfilage répétées. Les auteurs ont clarifié les conditions auxquelles ces fissures transversales peuvent être éliminées afin de réaliser une condition de la surface similaire à celle de la zone sans fissures.



▲ **Figure 1**: *Type de rupture du fil*



▲ **Figure 2**: *Pourcentages de causes de rupture du fil durant le tréfilage de fils d'or extra-fins*

1 Introduction

Le diamètre des fils et des barres produits au moyen du tréfilage varie de 10μm à 100mm. Pour tout diamètre de fil, la rupture durant le tréfilage entraîne un effet direct sur la productivité. En outre, souvent les défauts sur la surface des fils causent des ruptures par fatigue, la détérioration des propriétés mécaniques et la perte de valeur du produit. C'est pourquoi les défauts superficiels représentent la cause la plus fréquente de plainte de la part des utilisateurs. En outre, récemment des fils plus minces et plus longs sont requis pour être utilisés en tant que fils de connexion de semi-conducteurs et pour des instruments médicaux. Par conséquent, la rupture et les défauts superficiels des fils sont des problèmes à résoudre.

Plusieurs chercheurs ont étudié la forme de filière optimale pour réduire la force de tréfilage, pour adopter des mesures pour la prévention de ruptures intérieures des fils (dues à la formation de défauts d'entailles centrales – central burst - ou emboutissage - cupping), le meilleur lubrifiant, des mesures pour la réduction des tensions résiduelles, etc. Des solutions utiles ont été trouvées, mais seulement quelques études ont été menées pour analyser les mesures pouvant être adoptées pour éviter la rupture du fil et les effets des inclusions et des défauts superficiels dans le tréfilage du fil[1,4].

Cette étude analyse les causes des ruptures du fil dans les fils étirés de différents diamètres. Des fils avec des défauts superficiels et des inclusions ont été analysés expérimentalement et avec la méthode des éléments finis (FEM) pour déterminer si les défauts superficiels et les inclusions causent des ruptures du fil ou restent sous forme de défauts superficiels lorsque le tréfilage est répété.

2 Types de rupture du fil causée par le tréfilage

Récemment, la rupture du fil durant le tréfilage a été considérablement réduite grâce à une mineure ségrégation des particules et à une quantité inférieure d'inclusions dans les barres et dans les fils obtenus au moyen d'un nettoyage efficace du matériau et à l'amélioration des conditions de tréfilage.

Toutefois, la fréquence de rupture durant le tréfilage augmente à mesure que le diamètre du fil diminue.

Les causes de rupture du fils sont multiples (*Figure 1*). Deux types de rupture du fil sont causés par les inclusions.

Une cause se produit en présence d'inclusions sur la surface de la fracture, et l'autre, appelée rupture de "l'extrémité creuse" se vérifie lorsqu'il y a des traces d'inclusions concaves, mais les inclusions ne sont pas trouvées.

Deux types de rupture sont causés par des matériaux étrangers introduits durant un processus différent par rapport au processus de coulée. Une est appelée rupture par «contamination», et a lieu en présence de matériaux étrangers sur la surface de la fracture, et l'autre est définie comme rupture de la "cavité pressée" en l'absence de matériaux étrangers.

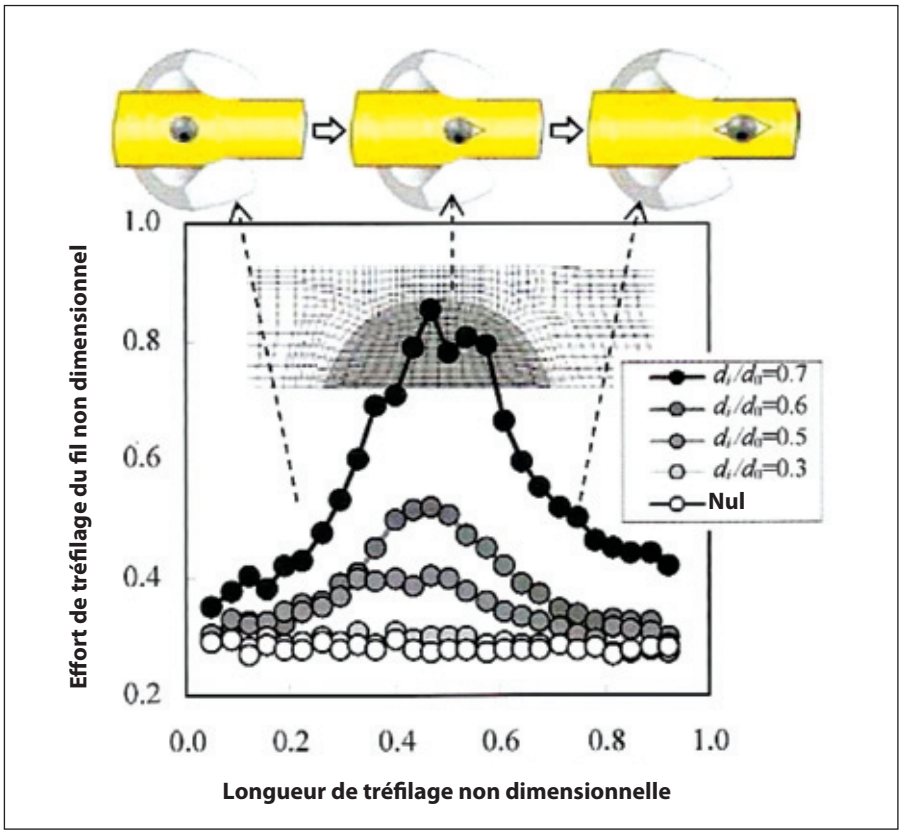
En outre, il est estimé que la rupture de l'extrémité divisée" est causée par des défauts superficiels et la rupture par "tension" est causée par un effort supérieur à la résistance du fil[5].

On a examiné les différents types de rupture qui ont lieu en cas de tréfilage de fils de connexion d'or.

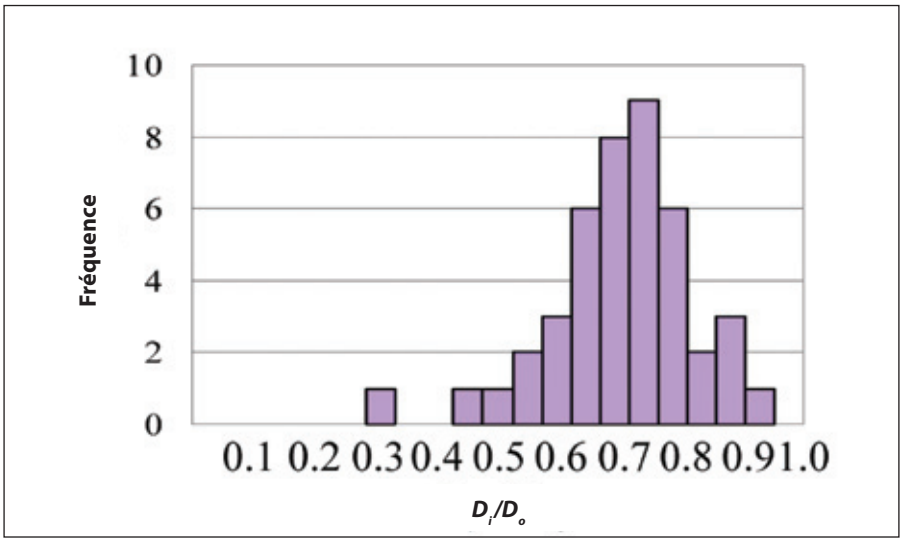
La *Figure 2* montre la fréquence à laquelle se vérifie chaque type de rupture, en divisant les diamètres des fils tréfilés en trois groupes, c'est-à-dire 100-350µm, 50-99µm et 20-49µm[4].

La *Figure 1* et la *Figure 2* montrent que les défauts superficiels, les matériaux étrangers et une tension excessive de tréfilage causée par grippage entraînent les ruptures du fil. Toutefois, on estime que les nombreuses ruptures de fil ayant un diamètre inférieur à 50µm sont dues à la présence d'inclusions à l'intérieur du fil générées durant la coulée[5].

En conclusion, l'on peut affirmer que la condition pour garantir des fils résistants à la rupture durant le tréfilage, est l'absence de défauts superficiels et les inclusions doivent être le plus possible réduites en nombre et dimensions.



▲ **Figure 3**: *Variation de l'effort de tréfilage lorsque l'inclusion passe à travers la filière (analysée au moyen de FEM (pourcentage de réduction R/P=10%))*



▲ **Figure 4**: *Fréquence de rupture du fil par rapport à D_i/D_o*

3 Analyse FEM du tréfilage d'un fil avec inclusions ou matériaux étrangers

3.1 Effets des inclusions à l'intérieur d'un fil

La majorité des inclusions dans les fils est représentée par des matériaux durs.

Les résultats des analyses des inclusions dans les surfaces avec des fractures de fils au moyen du spectromètre à dispersion de rayons d'énergie (EDS - Energy Dispersive Spectrometer) ont mis en évidence que nombreuses inclusions étaient de $A1_2O_3$ ou SiO_2, et la partie résiduelle consistait en des matériaux étrangers générés par abrasion de la filière et de l'équipement.

Par conséquent, vu qu'il y a des inclusions d'alumine et de matériaux étrangers à l'intérieur des fils, on a effectué une analyse FEM du tréfilage du fil.

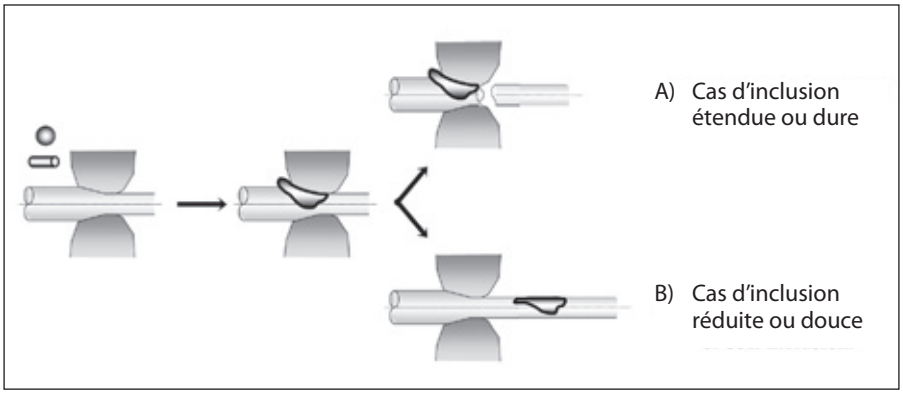
La relation entre la dimension des inclusions et le diamètre du fil, c'est-à-dire Di/Do, a été établie en tant que variable de 0,3 à 0,7.

Les constantes du matériau et la condition de tréfilage pour l'analyse FEM sont indiquées au *Tableau 1*.

Les variations des efforts de tréfilage dans la partie intérieure de la filière ont été examinées au moyen de l'analyse FEM, en utilisant des fils avec des inclusions de dimensions différentes.

Constantes mécaniques pour l'or	
Module de Young	80GPa
Coefficient de Poisson	0.44
Courbe de l'écrouissage	$\sigma=475\varepsilon^{0.07}$
Condition du matériau pour l'inclusion	
Matériau	$A1_2O_3$, SUS304
Module de Young	300, 194GPa
Coefficient de Poisson	0.23, 0.30
Limite d'élasticité	4.3, 0.205GPa
Demi-angle de la filière, réduction	$_{\alpha}$=7°, R/P=10%
Coefficient de frottement	0.05µm

▲ **Tableau 1**: *Conditions des matériaux et de tréfilage pur l'analyse FEM*



▲ **Figure 5**: *Schémas de la rupture d'un fil causée par un matériau étranger*

La *Figure 3* illustre les résultats. Il a été relevé que l'effort de tréfilage se déplace rapidement vers le haut lorsqu'une inclusion passe à travers la filière.

L'on peut remarquer que à mesure que la relation entre les dimensions de l'inclusion et le diamètre du fil augmente, c'est-à-dire Di/Do, l'effort de tréfilage augmente également.

Dans le cas d'un fil ave une inclusion pour laquelle Di/Do est égale à 0,7, l'effort de tréfilage atteint la résistance du fil.

Cela signifie qu'il a une probabilité élevée de rupture du fil. En considérant le facteur de sécurité, l'on suppose qu'il existe le risque que le fil se casse lorsque la valeur de Di/Do est supérieure à 0,4.

Les dimensions des inclusions sur la surface de la fracture ont été mesurées durant le tréfilage de fils d'or avec des diamètres allant de 20 à 50µm.

La *Figure 4* montre la fréquence plus élevée de rupture du fil pour différentes valeurs de Di/Do.

Cette figure indique que le fil peut se casser si Di/Do est égale à 0,3 ou supérieure et que la fréquence la plus élevée d'un fil a lieu lorsque la valeur Di/Do est égale à environ 0,7.

3.2 Effet des particules étrangères

Dans certains cas, les matériaux étrangers sont présents sur la surface du fil durant le tréfilage, ou bien ils peuvent entrer dans la filière à travers le lubrifiant.

Ces matériaux étrangers sont formés principalement par érosion du fil ou de la filière ou de l'équipement, ou bien ils peuvent naître de la poudre présente dans l'air. Suivant la forme et la dureté du matériau étranger, la rupture du fil peut se vérifier comme représenté à la *Figure 5*.

Par exemple, la *Figure 6* montre des images au microscope électronique à balayage (SEM - Scanning Electron Microscope) et des photos du spectromètre EDS d'un fil après le tréfilage avec des matériaux étrangers sur la surface du fil. Le matériau du fil est l'acier inoxydable austénitique.

L'analyse avec spectromètre EDS a relevé que le matériau étranger consiste en carbure de fer, incluant une petite composante de Ni.

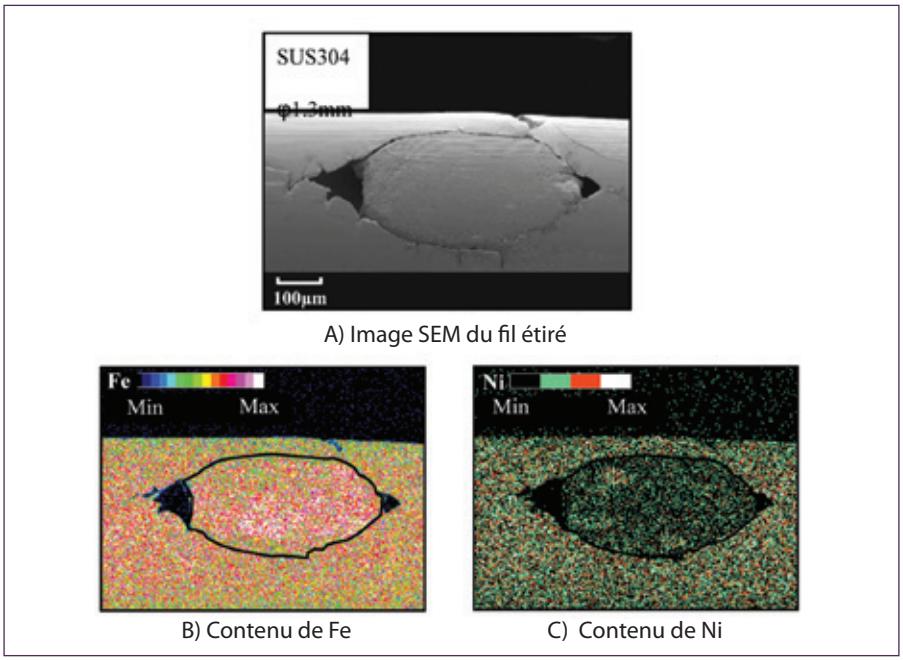
Les dimensions étaient 0,53x0,27mm, et la valeur Di/Do était égale à environ 0,2. L'on estime que la rupture du fil n'a pas été causée par la valeur réduite de Di/Do.

La *Figure 7* illustre les résultats, obtenus avec l'analyse FEM du tréfilage d'un fil avec un matériau étranger à proximité de la surface.

Le matériau étranger et le fil sont unis mécaniquement à l'interface correspondante. Après des opérations de tréfilage répétées, l'effort agit sur l'interface et entraîne la séparation de cette dernière, en générant un espace vide. Cette étude a utilisé le code FEM à trois dimensions MSC/Marc Mentat 2008r1.

Les résultats de l'analyse FEM sont cohérents avec les résultats expérimentaux. Indépendamment de la position du matériau étranger dans le fil (à l'intérieur ou sur la surface du fil), ce dernier ne subit aucune déformation du fait de sa dureté,

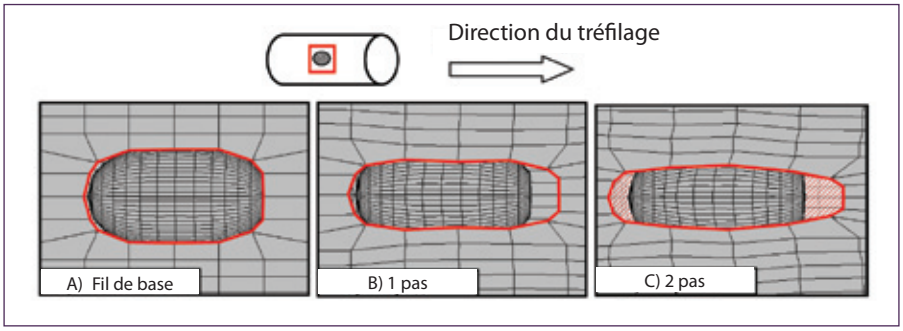
▼ **Figure 6**: *Image SEM et analyse componentielle avec matériau étranger*



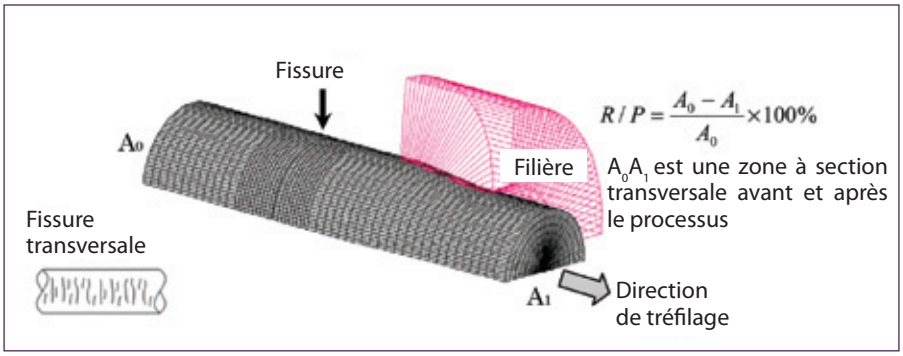
A) Image SEM du fil étiré

B) Contenu de Fe

C) Contenu de Ni



▲ **Figure 7**: *Déformation de la maille après des opérations répétées de tréfilage du fil avec matériau étranger sur la surface, examinée moyennant FEM*



▲ **Figure 8**: *Modèle de tréfilage du fil*

Aspect	Nom	Morphologie et caractéristiques
	Croûte	Empreinte à feuille; la barre est frottée jusqu'à obtenir une surface lisse
	Fissure transversale	Fissure perpendiculaire à la direction de laminage
	Bosse	Fissures en forme d'écailles sur la surface
	Éraflure	Fissure concave due à éraflure dans la direction de laminage
	Laminé dans le matériau	Entaille résultant de la pression exercée contre des substances étrangères telles que des fragments de métal
	Remplissage excessif	Défaut dû à un entaillage continu dans la direction de laminage

▲ **Tableau 2**: *Classification des fissures superficielles dans le fil* [7]

même dans le cas d'opérations de tréfilage répétées. Cela entraîne une valeur de Di/Do élevée, qui augmente l'effort et la probabilité de rupture du fil.

4. Analyse d'un fil tréfilé avec fissures superficielles

Les fissures superficielles se développent sur les barres ou sur les fils dan le cas d'opérations de coulée, de laminage à chaud, de tréfilage ou de transport effectuées de façon incorrecte, ou à cause de l'enroulement impropre des fils[6].

Les fissures superficielles qui se développent sur le fil machine durant le laminage vertical sont classées comme indiqué[7] au *Tableau 2*; toutefois il n'existe pas une solution claire pour ce problème. En effet il existe un petit nombre d'études concernant les fissures superficielles qui se sont produites durant le tréfilage. [8–11]

Dans cette étude, des fils machine qui ont développé des fissures circonférentielles durant la coulée continue et le laminage, ont été utilisés comme fil de base et tréfilés à plusieurs reprises.

L'augmentation et l'élimination de ces fissures ont été analysées dans les expériences et au moyen de l'analyse FEM.

Le fil machine d'acier inoxydable (SUS304) a été frotté mécaniquement dans la direction axiale en utilisant un tour et ensuite analysé au moyen d'expériences et de la méthode FEM.

On a utilisé les fils machine marqués mécaniquement de façon à obtenir des fissures en forme de V, concaves et en forme de U dans la direction circonférentielle.

Pour Cette étude, on a utilisé le logiciel FEM MSC/Marc Mentat 2008 R1. Les *Figures 8* et *9*, et le *Tableau 3* montrent respectivement le modèle utilisé dans l'analyse FEM, la constante du matériau et les paramètres de la fissure en forme de V.

Le coefficient de frottement (μ) a été fixé à 0,05. En outre, un modèle à axes symétriques a été adopté pour l'analyse FEM afin de réduire les temps de calcul.

4.1 Comparaison des résultats de l'expérience et de l'analyse FEM

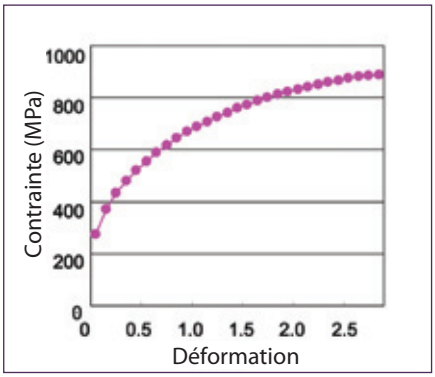
Une fissure a été réalisée d'une profondeur de h=0,8mm (8%) dans un fil de 8mm de diamètre et son changement de forme a été analysé du point de vue expérimental et analytique après chaque pas de tréfilage.

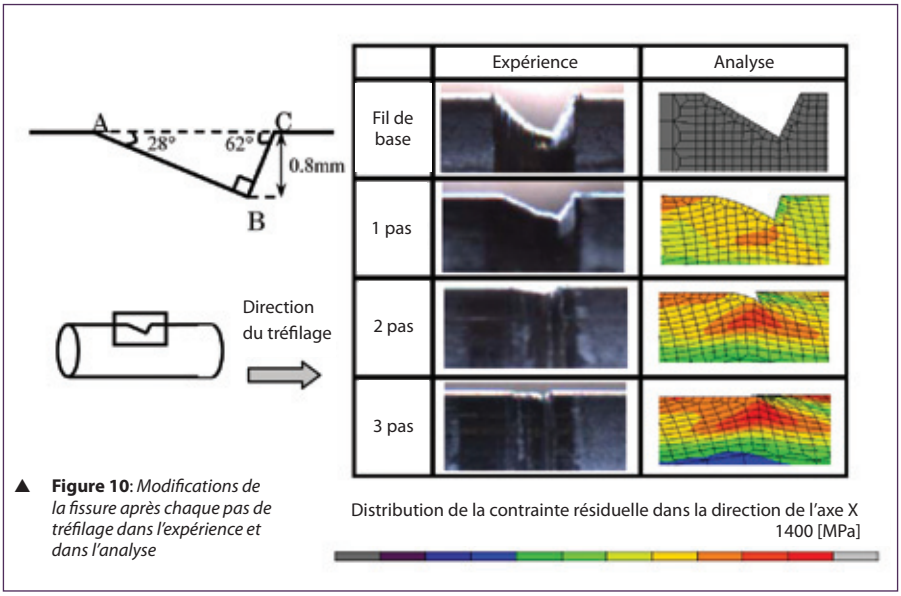
La fissure initiale dans le fil de base présentait une forme en V asymétrique.

La forme de la fissure initiale a été observée en utilisant un microscope, et un fil de base a été modelé avec une fissure de la même forme avec l'analyse FEM. Il est évident que le résultat de l'analyse FEM concorde avec le résultat expérimental.

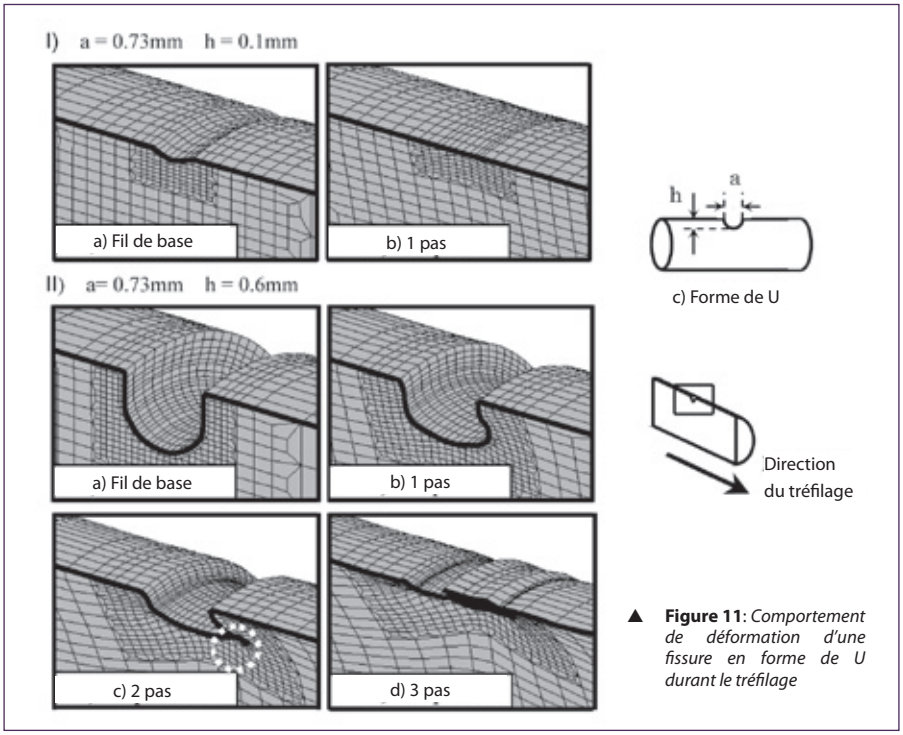
Comme illustré à la *Figura 10*, il semble que la fissure ait été éliminée puisque le côté AB est poussé vers le haut à l'intérieur du fil; toutefois, le côté BC de la fissure est incliné de façon à dépasser le côté AB, en formant une fissure superposée (défaut).

▼ **Figure 9**: *Diagramme d'écrouissage du fil d'acier inoxydable testé*





▲ **Figure 10**: *Modifications de la fissure après chaque pas de tréfilage dans l'expérience et dans l'analyse*



▲ **Figure 11**: *Comportement de déformation d'une fissure en forme de U durant le tréfilage*

▼ **Tableau 3**: *Paramètres de la fissure*

Paramètres de la fissure	
Paramètre de la forme	Fissures en forme de V, concaves et en forme de U
Profondeur (h)	0.10, 0.35, 0.60, 1.0mm
Ampleur (a)	0.73, 0.93, 1.15, 1.40mm
Angle (θ)	60°, 70°, 80°, 90°, 100°, 110°, 120°
Direction	Direction circonférentielle
Condition du matériau pour le fil	
Matériau	SUS304
Module de Young	206GPa
Diamètre	10mm, 8mm
Demi-angle de la filière, réduction	$_{a}$=6°, R/P=20%
Coefficient de frottement	0.05µm

Le tréfilage à trois pas d'un fil de base avec une fissure superficielle a été répété dans l'expérience et avec l'analyse FEM.

La *Figure 10* montre également le comportement de déformation de la fissure ainsi obtenu.

4.2 Analyse FEM du comportement de déformation de la fissure en forme de U durant un tréfilage répété

Ensuite, un fil avec une fissure en forme de U a été modelé et le processus de tréfilage a été également analysé au moyen de l'analyse des éléments finis (FEM).

La *Figure 11* illustre quelques exemples de comportement de déformation des fissures de fils de 10mm de diamètre avec une fissure d'une ampleur (a)=0,73mm et une profondeur (h)=0,10mm (1%), et avec une fissure a=0,73mm et h=0,60mm (6%) durant le tréfilage répété avec a=6° et R/P=20%.

Comme l'on peut remarquer à la *Figure 11*, dans la condition I, le fond de la fissure se lève durant le tréfilage répété, et donc la fissure superficielle est éliminée après le premier pas.

Par contre, dans la condition II, avec une plus grande profondeur, le côté droit de la fissure est incliné de façon à dépasser le côté gauche et former une fissure superposée (défaut), ce qui signifie que la fissure ne peut être éliminée par le tréfilage. En outre, une fissure profonde dans le fil se développe bien que de dimensions réduites.

En conclusion, le comportement de la fissure en forme de U durant le tréfilage dépend de la profondeur (h).

Les résultats des fissures concaves et en forme de U ont été comparés. La fissure concave présente un défaut résultant de la superposition de matériau, indépendamment de la profondeur (h), tandis que pour la fissure en forme de U, la profondeur (h) fait fonction de paramètre; c'est-à-dire la fissure peu profonde (h) est éliminée, mais la fissure reste dans le fil lorsque la valeur (h) est supérieure.

On estime que la forme de deux côtés de la fissure influence de façon significative son élimination dans la condition I illustrée à la *Figure 11*.

5 Conclusions

La rupture du fil a été étudiée au moyen d'expériences et de l'analyse des éléments finis (FEM). L'étude portait sur la rupture des fils causée par la présence de substances à l'intérieur ou sur la surface du

fil, ou causée par des fissures transversales se développant sur la surface du fil à cause de fatigue, d'inclusions ou de défauts superficiels.

Les résultats obtenus sont illustrés ci-après.

1) Les défauts superficiels, les matériaux étrangers et un effort excessif de tréfilage généré par le grippage sont les causes de rupture des fils. Toutefois, il est supposé que de nombreuses ruptures dans des fils d'un diamètre de 50µm ou inférieurs sont causées par la présence d'inclusions se formant durant la coulée
2) Il est estimé que le fil peut se rompre lorsque la valeur Di/Do est égale à 0,3 ou supérieure, et que la fréquence la plus élevée de ruptures du fil a lieu lorsque la valeur de Di/Do est environ de 0,7. Il a été vérifié que cela se produit puisque l'effort de tréfilage se déplace rapidement vers le haut lorsqu'une inclusion passe à travers la filière
3) Les résultats de l'analyse FEM coïncident avec les résultats expérimentaux; par conséquent il est possible d'évaluer le comportement de déformation des fissures au moyen de l'analyse FEM pour prévoir l'état après le tréfilage
4) Le mécanisme existant à la base de l'élimination d'une fissure dans un fil machine est le levage du fond de la fissure durant le tréfilage
5) Le comportement d'une fissure en forme de U durant le tréfilage dépend de la profondeur (h)
6) Toutefois, avec une profondeur supérieure, le côté droit de la fissure est incliné de façon à dépasser le côté gauche et former une fissure superposée (défaut), ce qui signifie que la fissure ne peut être éliminée à travers le tréfilage. En outre, on développe une fissure profonde dans le fil, bien qu'elle semble avoir des dimensions réduites

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Record di vendite per circa 3 miliardi di euro

Leoni, azienda leader nella fornitura di cavi e sistemi di cavi per il settore automobilistico e altre industrie, secondo stime indicative nell'anno fiscale 2010 ha realizzato una vendita record pari a circa 2960 milioni di euro (2160 milioni di euro l'anno precedente).

A parte un ulteriore aumento del prezzo del rame, la cifra prevista di circa 2800 milioni di Euro è stata notevolmente superata anche grazie a una tendenza dinamica al rialzo della domanda nel settore dell'automobile e in altri mercati affini fino alla fine dell'anno.

Il forte incremento delle vendite di cablaggi e sistemi di cablaggio per veicoli nei paesi BRIC (Brasile, Russia, India e Cina) e negli Stati Uniti merita una menzione speciale.

Analogamente, in termini di benefici di risultato operativo (EBIT) Leoni ha conseguito un gran successo registrando un volume di vendite di circa 131 milioni di euro (perdita di 116 milioni di euro l'anno precedente), superando decisamente il suo ultimo obiettivo di 120 milioni di euro.

Gli ulteriori costi di ristrutturazione sostenuti nel quarto trimestre sono stati già assorbiti in questo risultato.

La società Leoni è riuscita a superare notevolmente il proprio obiettivo di raggiungere almeno un flusso di cassa neutro.

Di conseguenza, secondo le stime preliminari il debito netto potrebbe essere ridotto di circa 50 milioni di euro, restando nuovamente al di sotto del patrimonio netto alla fine dell'anno per la prima volta dall'inizio della crisi economica.

Leoni conferma nuovamente la propria previsione di vendite di oltre 3100 milioni di euro per l'esercizio del 2011.

La società confida di poter continuare ad ottenere utili in netto aumento. Il recente danno sofferto dalla produzione e dalla logistica negli stabilimenti della Tunisia e dell'Egitto non darà luogo, per come si presenta oggi, ad alcun onere finanziario materiale.

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Disponibile nuova gamma

Daetwyler Cables ha presentato una gamma, recentemente sviluppata, di cornici di distribuzione ottica (ODF) ad alta densità da 19" per l'utilizzo in reti di distribuzione e infrastrutture FTTH durante la Conferenza sui cavi a fibre ottiche destinati all'utenza residenziale (FTTH) tenutasi a Milano.

Le cornici di distribuzione ottica, con fino a 6624 connettori LC da 47 unità di rack (formato 47U), offrono la maggiore densità di porte sul mercato attuale. Nonostante le elevate densità di impaccamento, le ODF offrono una chiara gestione dei cavi di connessione e uno spazio sufficiente per assemblaggio, giunzione e connessione agevoli.

La versione standard della cornice di distribuzione ottica è costituita da un rack di 19" da 42U e 47U, rispettivamente con altezze da 2000mm e 2200mm, entrambe con 1200mm di ampiezza e 800mm di profondità. Alle porte LC possono essere collegate fino a 2880 fibre ottiche nel modello standard con 42U e fino a 5760 fibre nella versione back-to-back. Il modello 47U ha spazio per 3312 e 6624 connettori LC. Daetwyler Cables può inoltre fornire cornici di distribuzione ottica di altre dimensioni, ad esempio di 400mm o 600mm di profondità, o in altezze individuali.

Le cornici di distribuzione ottica formano un sofisticato sistema di disposizione dei cavi di connessione che consente di organizzare facilmente i cavi di connessione in direzione verticale e orizzontale e offrono lo spazio necessario per instradare e alloggiare le lunghezze in eccesso.

Oltre allo spazio di alloggiamento per i conduttori di riserva, le cornici presentano una muffola di derivazione integrata per i cavi che può essere anch'essa montata in una cavità ricavata nel suolo, sul tetto o sulla parete laterale secondo necessità, dispositivi di controllo del raggio di curvatura circolare e semicircolare in tutte le guide per fibre per evitare raggi di curvatura eccessivamente stretti e pannelli di giunzione precaricati con filo connettore a spirale.

L'equipaggiamento di base dispone inoltre di ingressi per cavi sia nella parte alta che bassa, una sbarra di terra nella parte frontale, piedini regolabili preassemblati e profili di montaggio variabili in profondità.

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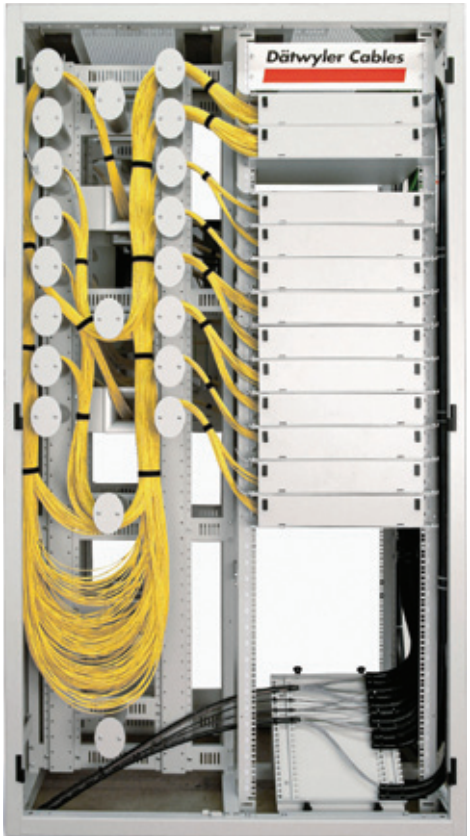


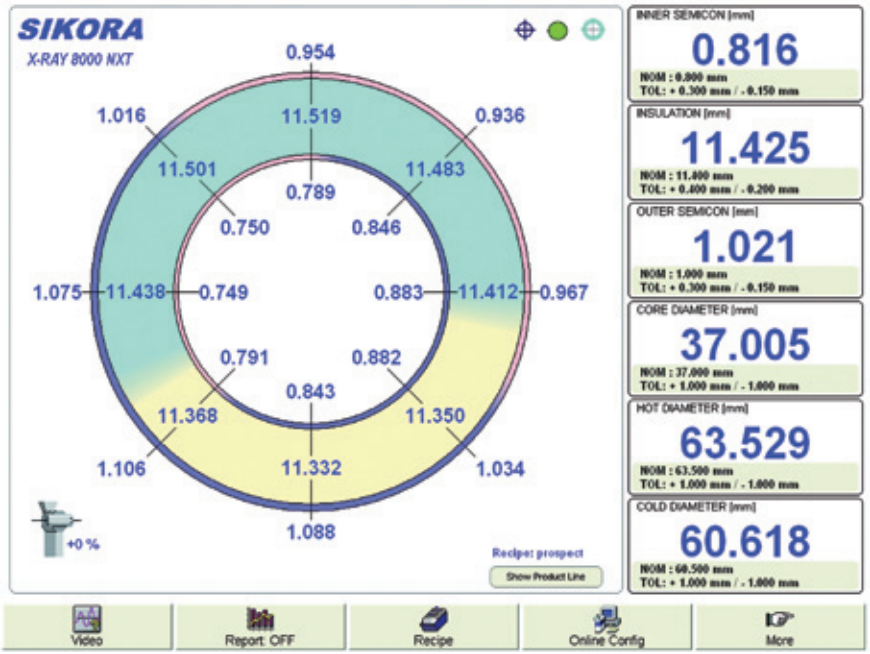
▲ *Parte della nuova gamma di Daetwyler*

X-RAY 8000 NXT, Rivoluzionario sistema di controllo della qualità in linee CV

Grazie all'innovativo sistema di misurazione X-RAY 8000 NXT Sikora offre lo strumento giusto per una progettazione efficiente in termini di controllo della qualità, ottimizzazione della produzione e riduzione del consumo di materiali nella produzione di cavi di potenza.

Il sistema X-RAY 8000 NXT è progettato per effettuare un controllo di qualità costante durante la produzione di cavi di media, alta ed extra alta tensione in linee del tipo CCV, VCV e MDCV. Sikora occupa una posizione di rilievo come precursore nel settore della produzione di cavi di extra alta tensione (EHV). Il sistema X-RAY 8000 NXT, specificamente progettato per questo tipo di applicazioni, è ideale per diametri di cavo molto grandi fino a 180mm per linee CCV e 220mm per linee VCV.

Il sistema X-RAY 8000 NXT è progettato per misurare spessori di pareti, eccentricità nonché diametri e ovalità con una precisione di misurazione e ripetibilità incomparabili. É sufficiente una sola scansione per calcolare tutti i valori di misurazione. Il sistema X-RAY 8000 NXT consente all'operatore di effettuare un rapido centraggio degli strumenti di estrusione ed un eccellente controllo della linea di produzione in modalità automatica.



▲ *Immagine del monitor del sistema X-RAY 8000 NXT*

Nella variante di alta gamma del sistema X-RAY 8000 NXT sono integrati rivelatori a semiconduttori multisensore. Questa tecnologia a multisensore garantisce l'affidabilità di lettura anche in caso di vibrazione del cavo e offre quattro valori di misurazione in ciascun processo di scansione per una misurazione esatta.

Un capolavoro di ingegneria è rappresentato dall'integrazione di finestre in ceramica* e finestre NTX (raggi X non tossici), che tengono separati gli scanner dalla pressione della linea CV.

La superficie delle finestre non reagisce con alcun sottoprodotto del processo di reticolazione mantenendosi sempre pulita. * Brevetto in corso di registrazione

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IWMA, nuovo presidente

Mentre Stephen Wood lasciava dopo tre anni l'incarico di presidente di IWMA nel mese di febbraio, e fu sostituito dal vice-presidente Colin Dawson, di Whitelegg Machinery Ltd., Steve Rika, membro del comitato esecutivo fu nominato nuovo vice presidente e Terry Robinson fu rieletto tesoriere onorario.

Stephen Wood è stato onorato per l'eccellente lavoro svolto in qualità di presidente ed è una soddisfazione per IWMA che egli resti nell'associazione come membro del comitato esecutivo ove potrà affiancare il nuovo presidente ed il vice-presidente offrendo la sua preziosa collaborazione. Per conoscere tutti i dettagli dei direttivi e dei membri del comitato per l'anno 2011/2012, consultare la pagina web IWMA www.iwma.org

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▲ *Colin Dawson, nuovo presidente di IWMA*

Chemetall acquisisce Artech Technologies

Chemetall (Australasia) Pty Ltd ha acquisito l'attività di Artech Technologies Pty Ltd, una società specializzata in prodotti chimici con stabilimento a Geelong, nello stato australiano di Victoria.

Artech Technologies è un'impresa specializzata in fluidi di alta qualità per la lavorazione dei metalli e per il trattamento di superfici. L'impresa, fondata nel 2002 come società a capitale privato, conta su una clientela prevalentemente localizzata in Australia e Nuova Zelanda.

Con questa nuova acquisizione, Chemetall consolida ulteriormente la propria posizione sul mercato dell'Australasia e del Sud-Est Asiatico.

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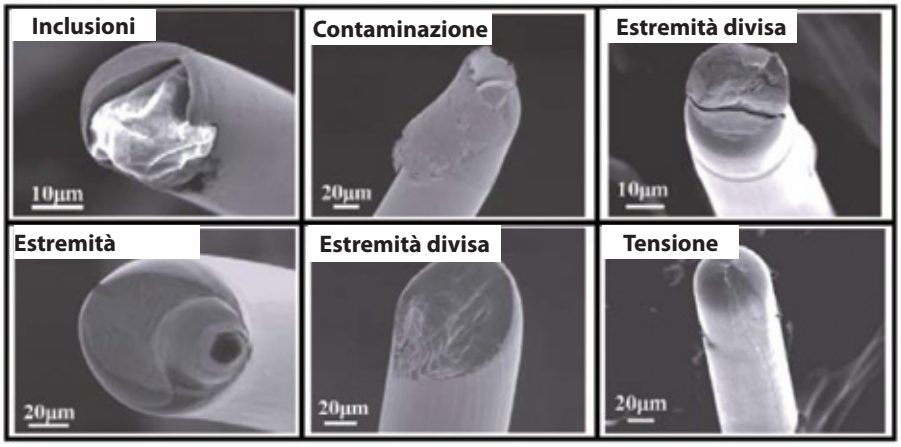
Analisi dei difetti superficiali su filo trafilato e rotture del filo

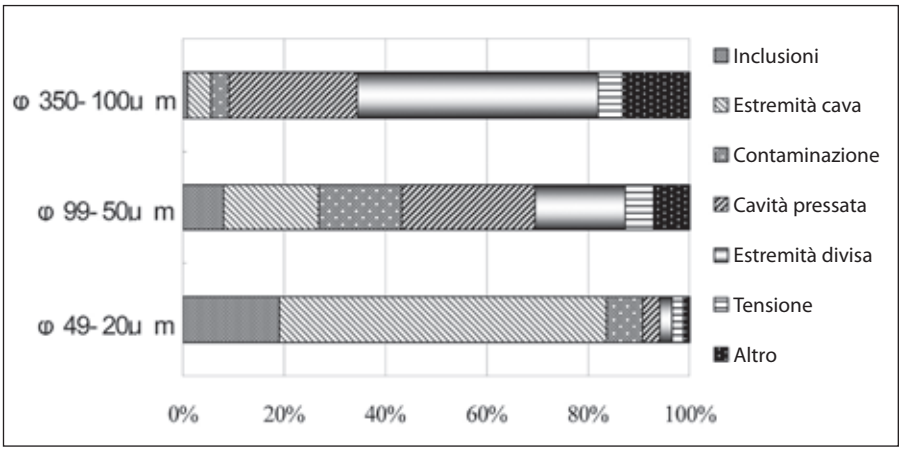
A cura di Kazunari Yoshida, Tetsuo Shinohara, Tsutomu Yamashita, e Atsuhiro Tanaka dell'Università di Tokai, Giappone

Riassunto

Tramite esperimenti e mediante l'analisi effettuata con il metodo degli elementi finiti (FEM - Finite Element Method), il presente articolo analizza se le crepe superficiali presenti sulle vergelle si sviluppano o si eliminano durante la trafilatura. É stato studiato il comportamento di deformazione di crepe trasversali a forma di V, concave e a forma di U in seguito a ripetute operazioni di trafilatura. Gli autori hanno chiarito le condizioni alle quali si eliminano tali crepe trasversali per ottenere una condizione della superficie simile a quella dell'area priva di crepe.



▲ **Figura 1**: *Tipi di rotture del filo*



▲ **Figura 2**: *Percentuali di cause di rottura del filo durante la trafilatura di fili d'oro ultrafini*

1 Introduzione

Il diametro dei fili e delle barre prodotti mediante trafilatura varia da 10μm a 100mm. Per qualsiasi diametro di filo, la rottura durante la trafilatura determina un effetto diretto sulla produttività. Inoltre, i difetti sulla superficie dei fili spesso causano rotture per fatica, il deterioramento delle proprietà meccaniche e la perdita di valore del prodotto.

Questa è la ragione per la quale i difetti superficiali rappresentano la causa più frequente di lamentela fra gli utilizzatori. Inoltre, recentemente sono stati richiesti fili più sottili e più lunghi per essere utilizzati come fili di connessione di semiconduttori e per strumenti medicali. Pertanto, la rottura ed i difetti superficiali dei fili sono problemi che devono essere risolti. Molti ricercatori hanno studiato la forma di filiera ottimale per ridurre la forza di trafilatura, adottare misure per prevenire la formazione di rotture interne dei fili (dovute alla formazione di difetti di rottura centrali – central burst - o a imbutitura - cupping), il migliore lubrificante, e delle misure per la riduzione delle tensioni residue e così via.

Sono state individuate soluzioni utili, ma sono stati effettuati solo pochi studi che analizzano le misure da adottare per evitare la rottura del filo e gli effetti delle inclusioni e dei difetti superficiali sulla trafilatura del filo[1, 4]. Nel presente studio, si esaminano le cause delle rotture del filo in fili trafilati di diametri diversi.

Sono stati analizzati fili con difetti superficiali e inclusioni sia sperimentalmente sia con il metodo degli elementi finiti (FEM) per determinare se i difetti superficiali e le inclusioni causano le rotture del filo o restano sotto forma di difetti superficiali quando si ripete la trafilatura.

2 Tipi di rottura del filo causata dalla trafilatura

Recentemente, la rottura del filo durante la trafilatura è stata notevolmente ridotta grazie ad una minore segregazione delle particelle e ad una quantità inferiore di inclusioni nelle barre e nei fili ottenute mediante un'efficace pulizia del materiale e al miglioramento delle condizioni di trafilatura.

Tuttavia, la frequenza con la quale si verificano le rotture durante la trafilatura aumenta al diminuire del diametro del filo. Esistono diverse cause di rottura del filo (*Figura 1*). Due tipi di rottura del filo sono causati dalle inclusioni.

Una si verifica quando le inclusioni si incontrano sulla superficie della frattura; l'altra, chiamata rottura dell'"estremità cava" si verifica quando vi sono tracce di inclusioni concave, ma le inclusioni non si riscontrano.

Due tipi di rotture sono causati da materiali estranei introdotti durante un processo diverso rispetto al processo di colata. Una è definita rottura per "contaminazione", e si verifica quando si incontrano materiali estranei sulla superficie della frattura; l'altra è definita rottura della "cavità pressata" quando non si incontrano materiali estranei.

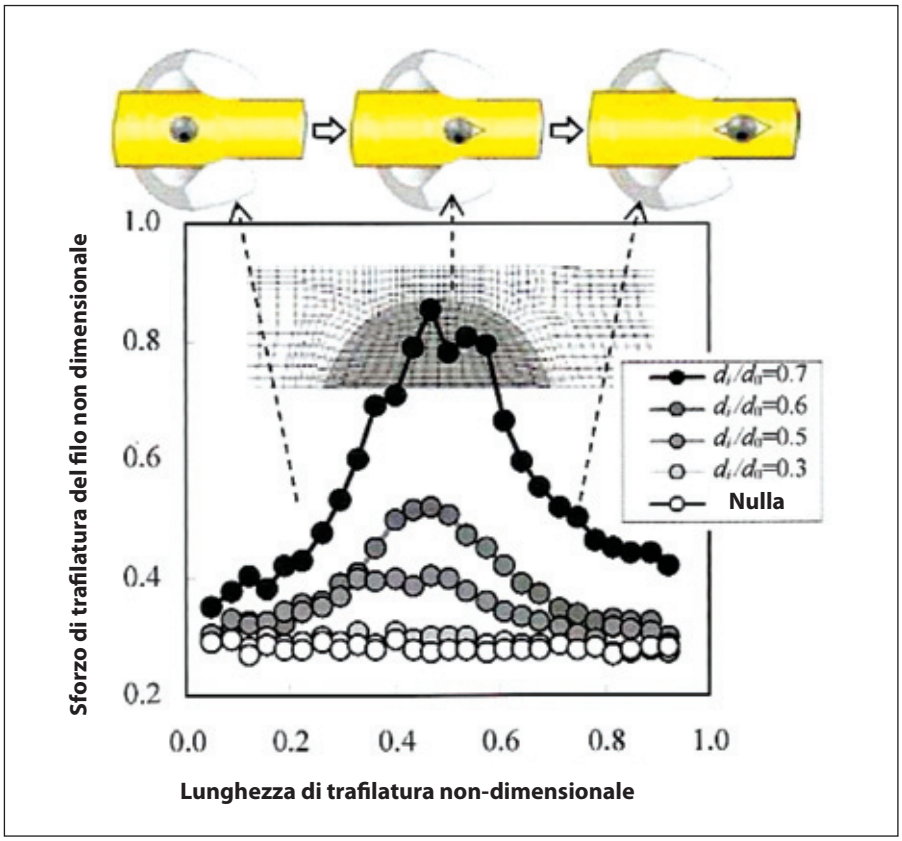
Inoltre, la rottura dell'"estremità divisa" si considera causata da difetti superficiali mentre la rottura da "tensione" è provocata dall'applicazione di una sollecitazione superiore alla resistenza del filo[5].

Sono stati esaminati i tipi di rottura che si verificano quando vengono trafilati fili di connessione d'oro.

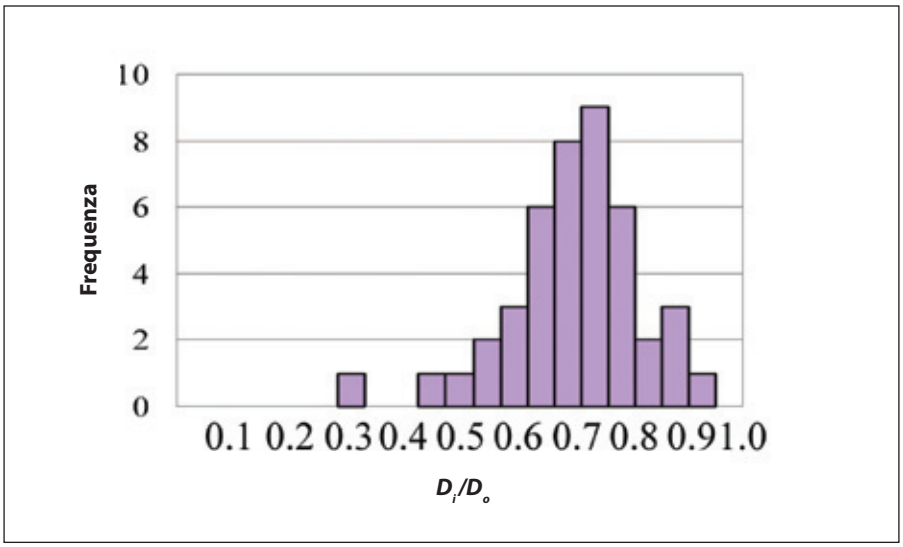
La *Figura 2* mostra la frequenza con la quale si verifica ciascun tipo di rottura del filo, con i diametri dei fili trafilati divisi in tre gruppi: 100-350µm, 50-99µm e 20-49µm[4].

La *Figura 1* e la *Figura 2* mostrano che i difetti superficiali, i materiali estranei e una tensione eccessiva di trafilatura provocata da grippaggio sono le cause della rottura del filo. Tuttavia, si suppone che numerose rotture di fili con diametro inferiore a 50µm siano dovute alla presenza di inclusioni all'interno del filo che si formano durante la colata[5].

Pertanto, possiamo concludere che affinché i fili resistano alla rottura durante la trafilatura, non devono esserci difetti superficiali e le inclusioni devono essere il più possibile ridotte di numero e dimensioni.



▲ **Figura 3**: *Variazione dello sforzo di trafilatura quando l'inclusione passa attraverso la filiera (analizzata mediante FEM (percentuale di riduzione R/P=10%))*



▲ **Figura 4**: *Frequenza di rottura del filo rispetto a D/D_o*

3 Analisi FEM della trafilatura di un filo con inclusioni o materiali estranei

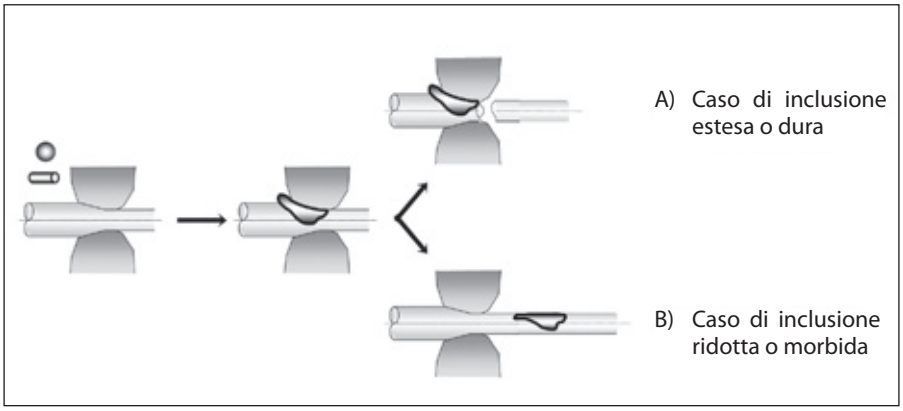
3.1 Effetti delle inclusioni all'interno di un filo

La maggior parte delle inclusioni nei fili è costituita da materiali duri. I risultati delle analisi delle inclusioni effettuate nelle superfici con fratture di fili mediante spettrometro a dispersione di raggi di energia (EDS - Energy Dispersive Spectrometer) hanno evidenziato che molte inclusioni erano di $A1_2O_3$ o SiO_2, e il resto era costituito da materiali estranei formatisi da abrasione della filiera e dell'equipaggiamento.

Pertanto, dal momento che vi sono inclusioni di allumina e materiali estranei nei fili, è stata effettuata un'analisi FEM della trafilatura del filo. Il rapporto fra la dimensione delle inclusioni e il diametro del filo, ossia Di/Do, è stato

Costanti meccaniche per l'oro	
Modulo di Young	80GPa
Rapporto di Poisson	0.44
Curva dell'incrudimento	$\sigma=475\varepsilon^{0.07}$
Condizione del materiale per l'inclusione	
Materiale	$A1_2O_3$, SUS304
Modulo di Young	300, 194GPa
Rapporto di Poisson	0.23, 0.30
Limite di snervamento	4.3, 0.205GPa
Semiangolo della filiera, riduzione	$_{\alpha}$=7°, R/P=10%
Coefficiente d'attrito	0.05µm

▲ **Tabella 1**: *Condizioni dei materiali e di trafilatura per l'analisi FEM*



▲ **Figura 5**: *Schema della rottura di un filo causata da materiale estraneo*

stabilito come variabile da 0,3 a 0,7. Le costanti del materiale e la condizione di trafilatura per l'analisi FEM sono indicate nella *Tabella 1*.

Sono state esaminate le variazioni dello sforzo di trafilatura nel lato interno della filiera mediante l'analisi FEM, utilizzando fili con inclusioni di varie dimensioni.

La *Figura 3* illustra i risultati. É stato riscontrato che lo sforzo di trafilatura si sposta rapidamente verso l'alto quando un'inclusione passa attraverso la filiera.

Si può notare che all'aumentare della relazione fra le dimensioni dell'inclusione e il diametro del filo, cioè Di/Do, aumenta anche lo sforzo di trafilatura. Nel caso di un filo con un'inclusione per la quale Di/Do è pari a 0,7, lo sforzo di trafilatura raggiunge la resistenza del filo.

Ciò significa che vi è un'elevata probabilità che il filo si rompa. Prendendo in considerazione il fattore di sicurezza, si suppone che esiste il rischio che il filo si rompa quando Di/Do è superiore a 0,4.

Sono state misurate le dimensioni delle inclusioni sulla superficie della frattura durante la trafilatura di fili d'oro con diametri tra 20 e 50µm.

La *Figura 4* mostra la frequenza di rottura del filo per diversi valori di Di/Do. Questa figura indica che il filo può rompersi se Di/Do è pari a 0,3 o maggiore e che la frequenza più elevata di rottura di un filo si ha quando Di/Do è approssimativamente pari a 0,7.

3.2 Effetto delle particelle estranee

In alcuni casi i materiali estranei sono presenti sulla superficie del filo durante la trafilatura, oppure possono entrare nella filiera attraverso il lubrificante.

Questi materiali estranei si formano principalmente per erosione del filo o della filiera o dell'equipaggiamento, oppure possono originarsi dalla polvere presente nell'aria. Secondo la forma e la durezza del materiale estraneo, la rottura del filo può verificarsi come illustrato nella *Figura 5*.

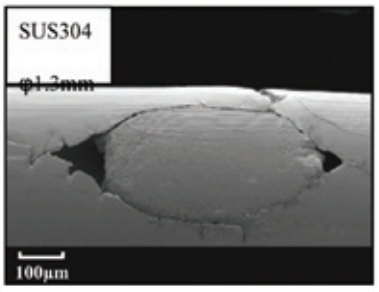
Come esempio, la *Figura 6* mostra immagini del microscopio a scansione elettronica (SEM - Scanning Electron Microscope) e fotografie dello spettrometro EDS di un filo dopo la trafilatura con materiali estranei sulla superficie del filo. Il materiale del filo è acciaio inossidabile austenitico.

L'analisi con spettrometro EDS ha evidenziato che il materiale estraneo consiste in carburo di ferro, che includeva una piccola componente di Ni. Le dimensioni erano 0,53x0,27mm, e Di/Do era approssimativamente pari a 0,2. Si suppone che la rottura del filo non è stata causata dal basso valore di Di/Do.

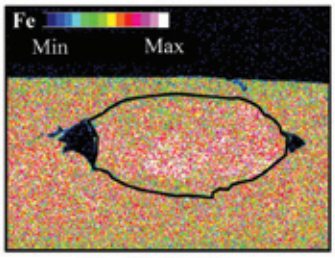
La *Figura 7* illustra i risultati, ottenuti con l'analisi FEM, della trafilatura di un filo con materiale estraneo vicino alla superficie.

Il materiale estraneo e il filo sono uniti meccanicamente all'interfaccia corrispondente. Dopo ripetute operazioni di trafilatura, lo sforzo agisce sull'interfaccia e causa la separazione nella medesima, generando uno spazio vuoto. Nel presente studio è stato utilizzato il codice FEM a tre dimensioni MSC/Marc Mentat 2008r1.

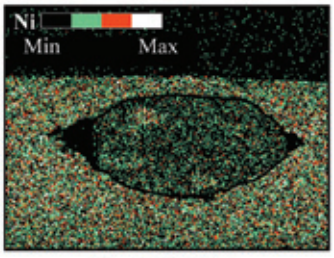
▼ **Figura 6**: *Immagine SEM e analisi componenziale del filo con materiale estraneo*



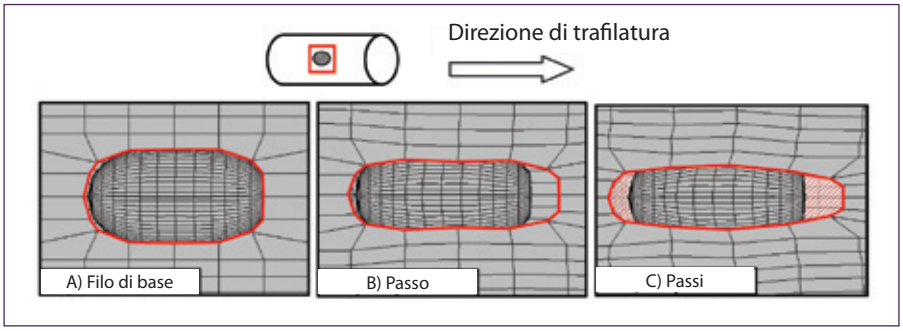
A) Immagine SEM del filo trafilato



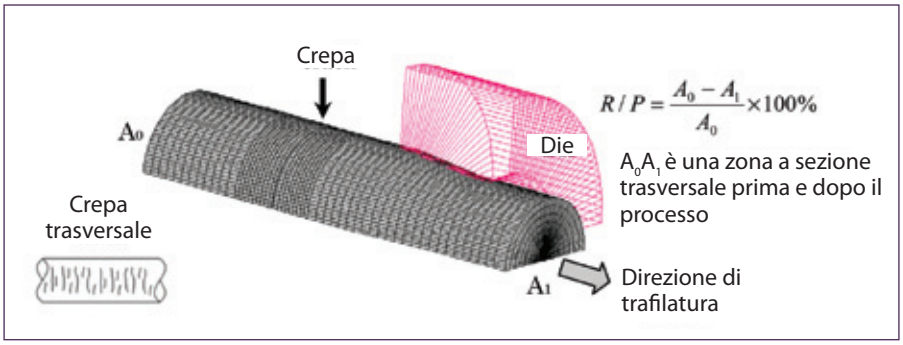
B) Contenuto di Fe



C) Contenuto di Ni



▲ **Figura 7**: *Deformazione della maglia dopo ripetute operazioni di trafilatura di filo con materiale estraneo sulla superficie, esaminata mediante FEM*



▲ **Figura 8**: *Modello di trafilatura del filo*

Aspetto	Nome	Morfologia e caratteristiche
	Incrostazione	Impronta a forma di foglia; la superficie della barra è sfregata fino a diventare liscia
	Crepa trasversale	Crepa perpendicolare alla direzione di laminazione
	Ammaccatura	Crepe a forma di scaglie sulla superficie
	Raschiatura	Crepa concava dovuta a raschiatura nella direzione di laminazione
	Laminato nel materiale	Intaglio risultante da pressione contro sostanze estranee come frammenti di metallo
	Sovrariempimento	Difetto dovuto ad una continua intagliatura nella direzione di laminazione

▲ **Tabella 2**: *Classificazione delle crepe superficiali nel filo*[7]

I risultati dell'analisi FEM sono coerenti con i risultati sperimentali. Indipendentemente dalla posizione del materiale estraneo nel filo (all'interno o sulla superficie del filo), esso non si deforma a causa della sua durezza, anche nel caso di ripetute operazioni di trafilatura. Ciò comporta un elevato valore di Di/Do, che aumenta lo sforzo e la probabilità di rottura del filo.

4 Analisi di un filo trafilato con crepe superficiali

Le crepe superficiali si sviluppano sulle barre o sui fili durante operazioni di colata, di laminazione a caldo, di trafilatura o di trasporto effettuate in modo scorretto, o a causa di un avvolgimento inappropriato dei fili[6]. Le crepe superficiali che si sviluppano sulla vergella durante la laminazione ascendente sono classificate come indicato[7] nella *Tabella 2*; tuttavia, non esiste una soluzione chiara per questo problema. Infatti, esiste una scarsa letteratura che tratta di crepe superficiali formatesi durante la trafilatura.[8–11]

Nel presente studio, delle vergelle in cui si sono formate crepe circonferenziali durante la colata e la laminazione, sono state utilizzate come filo di base e ripetutamente trafilate.

Sono stati analizzati l'aumento e l'eliminazione di queste crepe negli esperimenti e mediante l'analisi FEM.

La vergella d'acciaio inossidabile (SUS304) è stata grattata meccanicamente nella direzione assiale utilizzando un tornio e quindi analizza mediante esperimenti e il metodo FEM.

Sono state utilizzate come campioni le vergelle marcate meccanicamente in modo tale da ottenere delle crepe a forma di V, concave e a forma di U in direzione circonferenziale.

Per il presente studio è stato utilizzato il software FEM MSC/Marc Mentat 2008 R1.

Le *Figure 8* e *9* e la *Tabella 3* mostrano rispettivamente il modello utilizzato nell'analisi FEM, la costante del materiale ed i parametri della crepa a forma di V.

Il coefficiente di attrito (μ) è stato fissato a 0,05. Inoltre, è stato adottato un modello di assi simmetrici per l'analisi FEM per ridurre i tempi di calcolo.

4.1 Comparazione dei risultati dell'esperimento e dell'analisi FEM

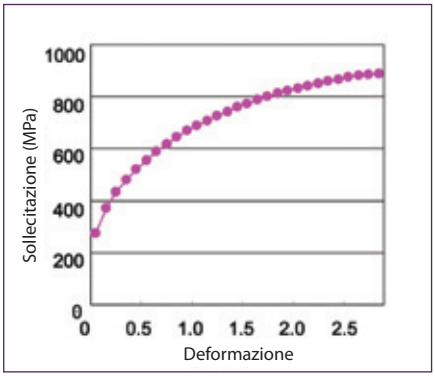
È stata tagliata una crepa della profondità di h=0,8mm (8%) in un filo da 8mm di diametro ed è stato esaminato il suo cambiamento di forma sia dal punto di vista sperimentale che analitico dopo ciascun passo di trafilatura. La crepa iniziale nel filo di base presentava una forma a V asimmetrica.

La forma della crepa iniziale è stata osservata utilizzando un microscopio, ed è stato modellato un filo di base con una crepa della stessa forma con l'analisi FEM. Appare evidente che il risultato dell'analisi FEM concorda con il risultato sperimentale.

Come illustrato nella *Figura 10*, la crepa sembra essere eliminata poiché il lato AB viene spinto verso l'alto all'interno del filo; tuttavia, il lato BC della crepa viene inclinato in modo da sporgere sul lato AB, formando una crepa sovrapposta (difetto).

La trafilatura a tre passi di un filo di base con una crepa superficiale è stata ripetuta nell'esperimento e con l'analisi FEM.

▼ **Figura 9**: *Diagramma di incrudimento del filo d'acciaio inossidabile testato*



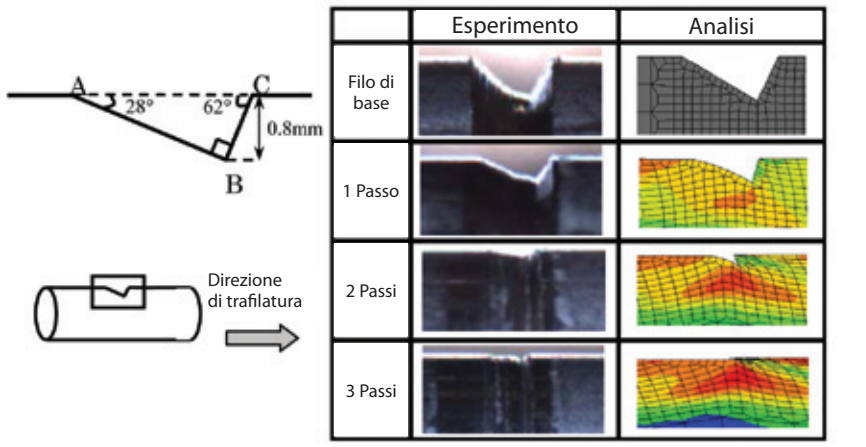


Figura 10: *Modifiche della crepa dopo ciascun passo di trafilatura nell'esperimento e nell'analisi*

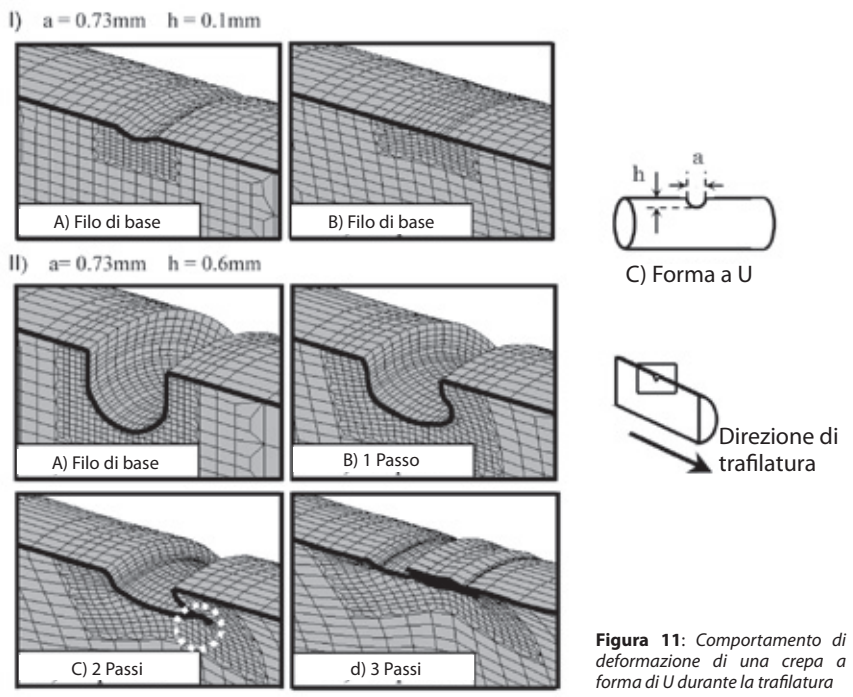


Figura 11: *Comportamento di deformazione di una crepa a forma di U durante la trafilatura*

▼ **Tabella 3**: *Parametri della crepa*

Parametri della crepa	
Parametro della forma	Crepe a forma di V, concave e a forma di U
Profondità (h)	0.10, 0.35, 0.60, 1.0mm
Ampiezza (a)	0.73, 0.93, 1.15, 1.40mm
Angolo (θ)	60°, 70°, 80°, 90°, 100°, 110°, 120°
Direzione	Direzione circonferenziale
Condizione del materiale per il filo	
Materiale	SUS304
Modulo di Young	206GPa
Diametro	10mm, 8mm
Semiangolo della filiera, riduzione	$_{\alpha}$=6°, R/P=20%
Coefficiente di attrito	0.05µm

La *Figura 10* mostra inoltre il comportamento di deformazione della crepa ottenuto.

4.2 Analisi FEM del comportamento di deformazione della crepa a forma di U durante una trafilatura ripetuta

Successivamente, è stato modellato un filo con una crepa a forma di U ed è stato analogamente analizzato il processo di trafilatura mediante l'analisi degli elementi finiti (FEM).

La *Figura 11* illustra alcuni esempi di comportamento di deformazione delle crepe di fili da 10mm di diametro con una crepa di ampiezza (a)=0,73mm e profondità (h)=0,10mm (1%), e con una crepa a=0,73mm e h=0,60mm (6%) durante trafilatura ripetuta con a=6° e R/P=20%.

Come si può notare nella *Figura 11*, nella condizione I, il fondo della crepa si alza durante la trafilatura ripetuta, e pertanto la crepa superficiale viene eliminata dopo il primo passo.

Per contro, nella condizione II, con una profondità maggiore, il lato destro della crepa viene inclinato in modo da sporgere sopra il lato sinistro e formare una crepa sovrapposta (difetto), il che indica che la crepa non può essere eliminata dalla trafilatura.

Inoltre, si sviluppa una crepa profonda nel filo nonostante sembri essere di dimensioni ridotte. In conclusione, il comportamento della crepa a forma di U durante la trafilatura dipende dalla profondità (h).

Sono stati comparati i risultati delle crepe concave e a forma di U. Dalla crepa concava si sviluppa un difetto da sovrapposizione di materiale, indipendentemente dalla profondità (h), mentre per la crepa a forma di U la profondità (h) funge da parametro; cioè la crepa poco profonda (h) è eliminata, ma la crepa rimane nel filo quando (h) è maggiore.

Si suppone che la forma di entrambi i lati della crepa influenzi in modo significativo la sua eliminazione nella condizione I illustrata nella *Figura 11*.

5 Conclusioni

È stata studiata la rottura del filo mediante esperimenti e l'analisi di elementi finiti (FEM). L'obiettivo era studiare la rottura del filo causata dalla presenza di sostanze presenti all'interno o sulla superficie del filo, o causata da crepe trasversali che si sviluppano sulla superficie del filo a causa di fatica, inclusioni o difetti superficiali.

I risultati ottenuti sono illustrati qui di seguito.

1) I difetti superficiali, i materiali estranei ed un eccessivo sforzo di trafilatura generato da grippaggio sono le cause della rottura del filo. Tuttavia, numerose rotture in fili del diametro di 50µm o inferiori si ritengono presumibilmente causate dalla presenza di inclusioni che si formano durante la colata
2) Si suppone che il filo possa rompersi quando il valore Di/Do è pari a 0,3 o superiore, e che la frequenza più elevata di rotture del filo si verifica quando il valore Di/Do è approssimativamente pari a 0,7. É stato verificato che ciò accade poiché lo sforzo di trafilatura si muove rapidamente verso l'alto quando un'inclusione passa attraverso la filiera
3) I risultati dell'analisi FEM coincidono con i risultati sperimentali; pertanto, è possibile valutare il comportamento di deformazione delle crepe mediante l'analisi FEM per prevedere lo stato dopo la trafilatura
4) Il meccanismo che sta alla base dell'eliminazione di una crepa in una vergella è l'innalzamento del fondo della crepa durante la trafilatura
5) Il comportamento di una crepa a forma di U durante la trafilatura dipende dalla profondità (h)
6) Tuttavia, con una profondità maggiore, il lato destro della crepa viene inclinato in modo da sporgere sul lato sinistro e formare una crepa sovrapposta (difetto), il che indica che la crepa non può essere eliminata attraverso la trafilatura. Inoltre, nel filo si sviluppa una crepa profonda, nonostante sembri essere di dimensioni ridotte

Il presente articolo è stato presentato a Istanbul Cable & Wire '09 ed è stato qui riprodotto con l'autorizzazione di IWMA e WAI.

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Volumen de ventas récord en torno a los 3000 millones de Euros

Leoni, líder en el suministro de cables y sistemas de cables para el sector automovilístico y otras industrias, registró un volumen de ventas récord de aproximadamente 2960 millones de Euros (2160 millones de Euros el año anterior) en el año fiscal 2010, según cifras indicativas.

A parte de un nuevo encarecimiento del cobre, la cifra prevista de unos 2800 millones de Euros fue superada considerablemente gracias a una tendencia dinámica creciente de la demanda en el sector del automóvil y otros mercados relacionados hasta finales de año.

El acentuado incremento de las ventas de cableados y sistemas de cableado para vehículos en los países BRIC (Brasil, Rusia, India y China) y en Estados Unidos merece una mención especial.

Asimismo, en términos de beneficios antes de intereses e impuestos (EBIT) Leoni cosechó gran éxito registrando un volumen de ventas aproximado de 131 millones de Euros (pérdida de 116 millones de Euros el año anterior), superando claramente su último objetivo de 120 millones de Euros. Los gastos de reestructuración realizados en el cuarto trimestre ya han sido tenidos en cuenta en este resultado.

Leoni consiguió superar significativamente su objetivo de llegar al menos a un flujo de efectivo neutro. Por consiguiente, la deuda neta pudo ser reducida en unos 50 millones de Euros según cifras indicativas, quedando de nuevo por debajo de sus recursos propios a fin de año por primera vez desde el inicio de la crisis económica.

Leoni reafirma su previsión de ventas de más de 3100 millones de Euros para el ejercicio de 2011. La compañía cree que superará significativamente estas cifras. El reciente daño sufrido por la producción y logística de las plantas de Túnez y Egipto no dará lugar, tal como se presenta hoy, a gravámenes financieros materiales.

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Disponible nueva gama

Daetwyler Cables presentó una gama recién desarrollada de bastidor de distribución óptica de alta densidad de 19" para uso en redes de distribución e infraestructura FTTH durante la Conferencia sobre FTTH celebrada en Milán, en Italia.

Los bastidores de distribución óptica, con hasta 6624 conectores LC de 47 unidades de rack (formato 47U) ofrecen la mayor densidad de puertos del mercado actual. A pesar de las altas concentraciones de elementos, los bastidores de distribución óptica ofrecen una gestión ordenada de los cables de conexión y bastante espacio para un cómodo ensamblaje, empalme y conexión.

La versión estándar del bastidor de distribución óptica está constituida por un bastidor de 19" de 42U y 47U, de 2000mm y 2200mm de altura, respectivamente, ambos de 1200mm de ancho y 800mm de profundidad. Los puertos LC pueden ser conectados hasta a 2880 fibras ópticas en el modelo estándar de 42U y a 5760 fibras en la versión back-to-back.

El modelo de 47U tiene cabida para 3312 y 6624 conectores LC. Daetwyler Cables también puede suministrar bastidores de distribución óptica de otras dimensiones, por ejemplo de 400mm ó 600mm de profundidad, o de distintos formatos.

Los bastidores constituyen un sofisticado sistema de disposición de los cables de conexión que permite organizar los cables de conexión fácilmente en vertical y horizontal y ofrece el espacio necesario para enrutar y almacenar longitudes de más.

Además del espacio de almacenamiento para los conductores de reserva, tienen una caja de derivación integrada para los cables que puede ser montada también en el hueco que queda en el suelo, en el techo o en la pared según la necesidad, dispositivos de control de radio de curvatura circular y semicircular en todas las guías para fibras a fin de evitar radios de curvatura excesivamente cerrados y paneles de empalme precargados con rabillos.

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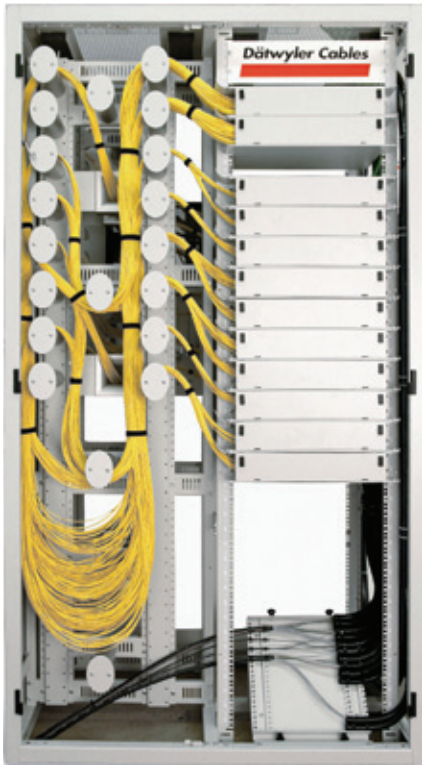


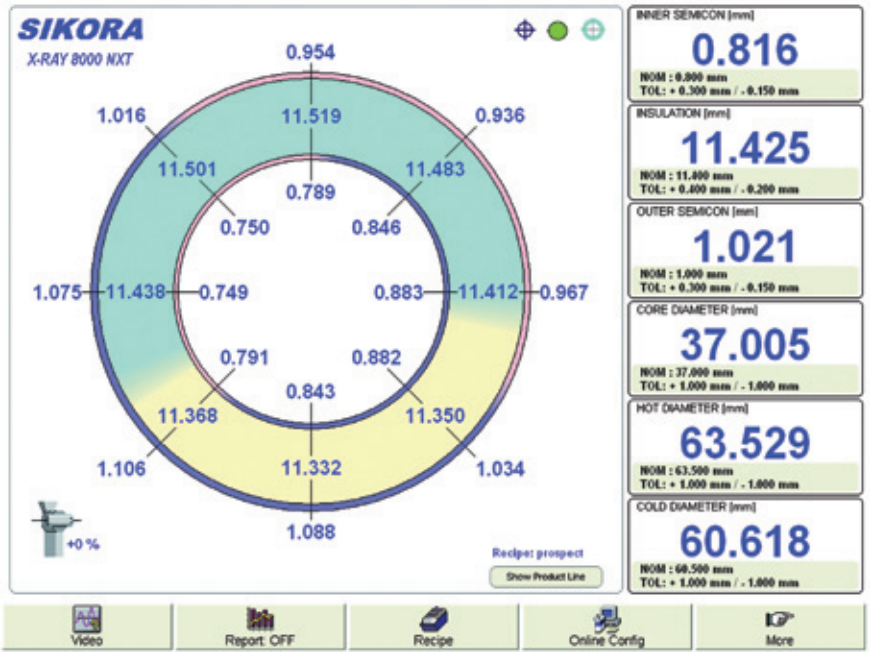
▲ *Parte de la nueva gama de Daetwyler*

X-RAY 8000 NXT, revolucionario sistema de control de calidad de cables

Con el innovador sistema de medida X-RAY 8000 NXT Sikora propone el instrumento necesario para un diseño eficiente en términos de control de calidad, optimización productiva y reducción del consumo de materiales en la producción de cables de suministro energético.

El sistema X-RAY 8000 NXT está diseñado para efectuar un control de calidad constante durante la producción de cables de media, alta y extra alta tensión en líneas de tipo CCV, VCV y MDCV. Sikora ocupa una distinguida posición como precursor en el campo de la producción de cables de extra alta tensión (EHV). El sistema X-RAY 8000 NXT, diseñado específicamente para este tipo de aplicaciones, resulta ideal para diámetros de cable muy grandes de hasta 180mm para líneas CCV y 220mm para líneas VCV.

El sistema X-RAY 8000 NXT sirve para medir espesor de pared, excentricidad, diámetro y ovalidad de cables con una precisión de medida y repetibilidad incomparables. Un solo escáner es suficiente para calcular todas las medidas. El X-RAY 8000 NXT permite al operador centrar rápidamente las herramientas de extrusión y efectuar un excelente control de la línea de producción en modo automático.



▲ *Imagen del monitor del X-RAY 8000 NXT*

La variante de gama alta del X-RAY 8000 NXT lleva integrados detectores multisensor semiconductores. Esta tecnología multisensor garantiza la fiabilidad de lectura incluso cuando el cable vibra y ofrece cuatro medidas en cada escaneado para dar una medida exacta.
La integración de ventanas* cerámicas y ventanas NTX (rayos no tóxicos), que tienen separados los escáneres de la presión de la línea catenaria, constituye una verdadera obra maestra en el campo de la ingeniería.

La superficie de las ventanas no reacciona con ningún subproducto del proceso de reticulado y se mantiene limpia en todo momento. * Pendiente de Patente

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IWMA nombra nuevo presidente

Stephen Wood abandonó su cargo de presidente de la IWMA en febrero, al término de su mandato trienal, cuando le sucedió el vice presidente Colin Dawson, de Whitelegg Machinery Ltd. Steve Rika, miembro del consejo ejecutivo, fue nombrado nuevo vice presidente y Terry Robinson fue reelegido tesorero honorario.

Stephen Wood fue homenajeado por el excelente trabajo realizado como presidente y es una satisfacción para la IWMA que siga en la asociación como miembro del consejo ejecutivo, donde podrá seguir ofreciendo su inestimable colaboración asesorando al nuevo presidente y vice presidente.

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▲ *Colin Dawson, nuevo presidente de IWMA*

Chemetall compra Artech Technologies

Chemetall (Australasia) Pty Ltd ha adquirido los bienes de Artech Technologies Pty Ltd, empresa de productos químicos para aplicaciones especiales con oficina central en Geelong, en el estado australiano de Victoria.

Artech Technologies es una empresa especializada en el suministro de tecnologías para el tratamiento superficial y fluidos para el mecanizado de metales de alta calidad. La empresa, fundada en 2002 como empresa de propiedad privada, cuenta con una clientela situada básicamente en Australia y Nueva Zelanda.

Con la nueva adquisición, Chemetall consolida aún más su posición en el mercado de Australasia y del sureste asiático.

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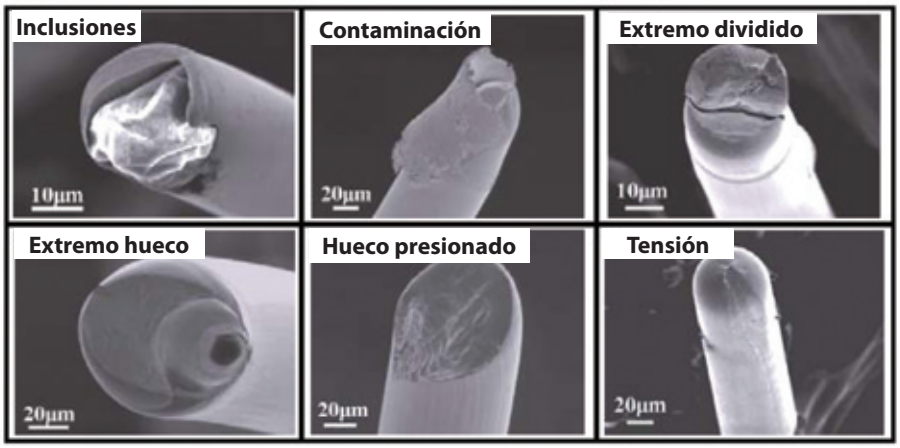
Análisis de defectos superficiales en alambre trefilado y de roturas de alambre

Por Kazunari Yoshida, Tetsuo Shinohara, Tsutomu Yamashita, y Atsuhiro Tanaka de la Universidad de Tokai, Japón

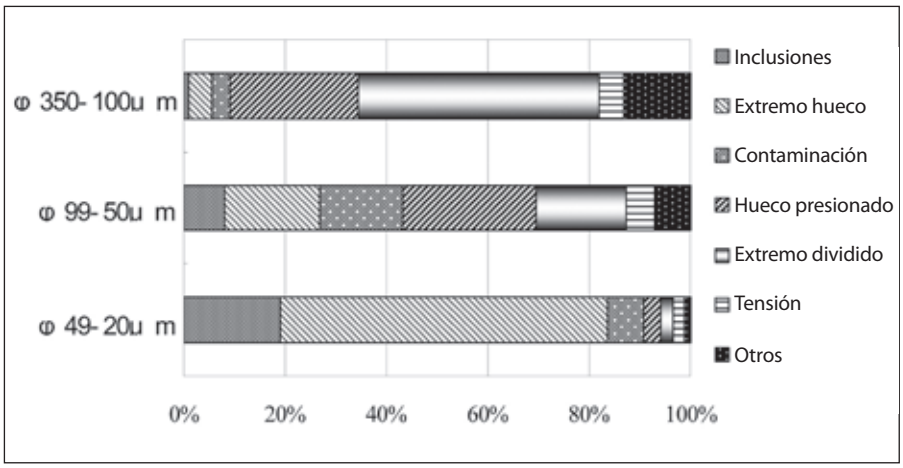
Resumen

Mediante la realización de experimentos y análisis aplicando el método de los elementos finitos (*FEM - Finite Element Method*), este artículo examina si las grietas superficiales en el alambrón aumentan o desaparecen durante el trefilado.

Se ha observado el comportamiento de deformación de las grietas transversales en forma de V, cóncavas y en forma de U durante varios trefilados. Los autores especifican cuáles son las condiciones que permiten eliminar dichas grietas transversales para obtener una superficie semejante a una sin grietas.



▲ **Figura 1**: *Tipos de roturas del alambre*



▲ **Figura 2**: *Porcentajes de causas de rotura del alambre durante el trefilado de alambres de oro superfinos*

1 Introducción

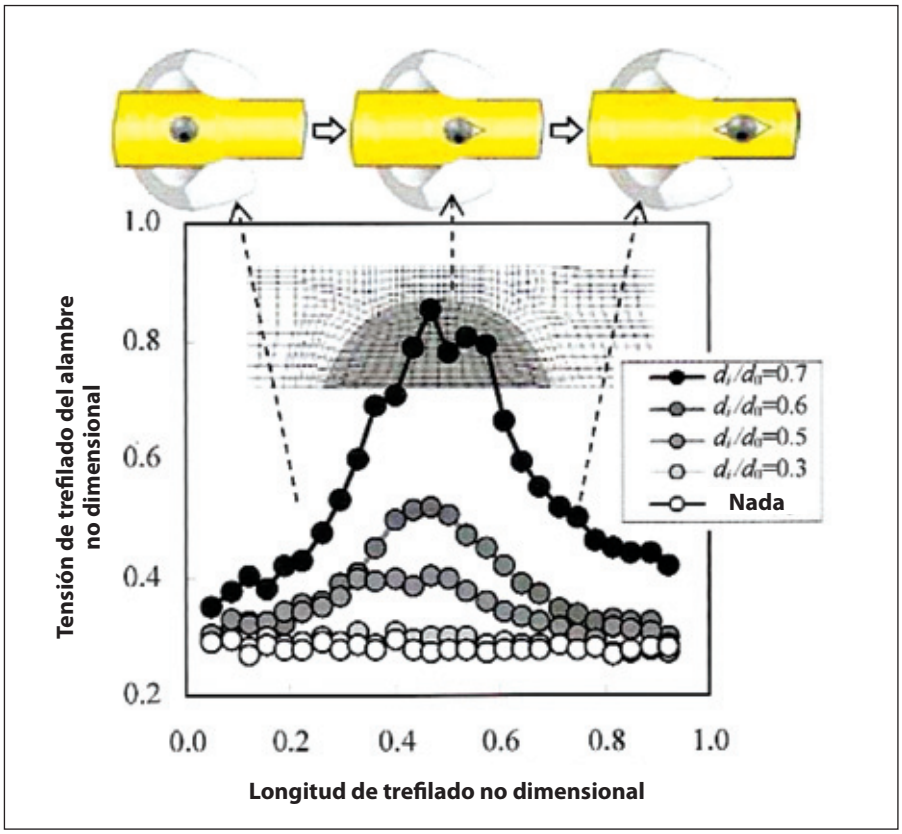
El diámetro de los alambres y de las barras producidas mediante trefilado varía de 10µm a 100mm. Con cualquier diámetro de alambre, la rotura durante el trefilado afecta directamente a la productividad. Además, los defectos superficiales de los alambres causan a menudo roturas por fatiga, deterioro de las propiedades mecánicas y pérdida del valor del producto.

Por esto los defectos superficiales son el motivo de queja más frecuente entre los usuarios. Además, recientemente se requieren alambres más finos y más largos para usarlos como alambres de conexión de semiconductores y para instrumental médico. Por lo tanto, la rotura y los defectos superficiales de los alambres son problemas que hay que resolver.

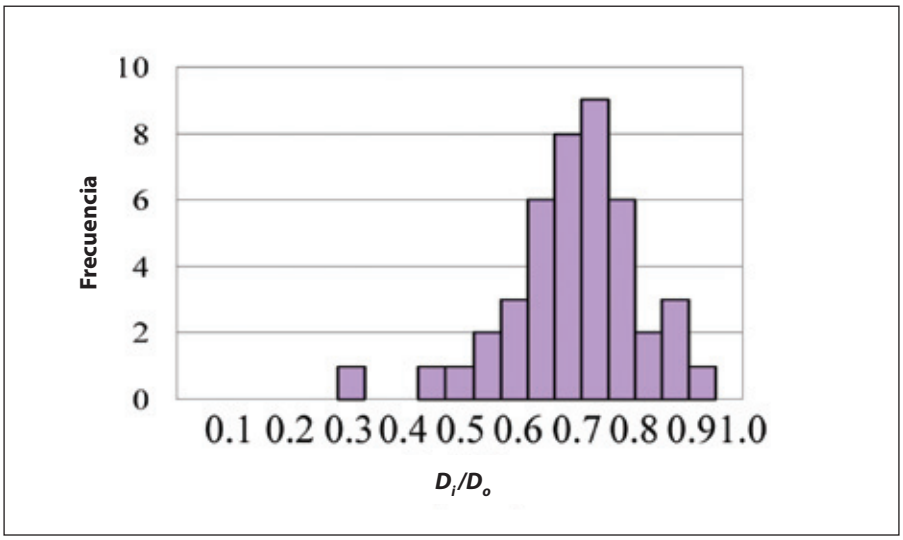
Muchos investigadores han buscado la forma de hilera ideal para reducir la fuerza de trefilado, medidas para evitar el agrietamiento interior de los alambres debido a fenómenos de embutición (*central burst*) o acopamiento (*cupping*), el lubricante ideal, medidas para reducir las tensiones residuales y demás.

Se han conseguido soluciones útiles, pero hay pocos estudios que consideren las medidas como factor para evitar la rotura del alambre y los efectos de las inclusiones y de los defectos superficiales en el trefilado de alambre[1, 4].

En este estudio se examinan las causas de rotura en alambres trefilados de varios diámetros. Se han analizado alambres con defectos superficiales e inclusiones experimentalmente y con el método de los elementos finitos (FEM) para determinar si los defectos superficiales y las inclusiones causan la rotura del alambre o quedan como defectos superficiales cuando se repite el trefilado



▲ **Figura 3**: *Variación de la tensión de trefilado cuando la inclusión pasa a través de la hilera (examinada por medio de FEM - porcentaje de reducción R/P=10%)*



▲ **Figura 4**: *Frecuencia de rotura del alambre frente a D_i/D_o*

2 Tipos de rotura de alambre causada por el trefilado

Recientemente, la rotura del alambre durante el trefilado se ha reducido considerablemente gracias a una menor segregación de las partículas y a una cantidad inferior de inclusiones en las barras y alambres obtenida con una buena limpieza del material y con la mejora de las condiciones de trefilado.

Sin embargo, la frecuencia con que ocurren las roturas durante el trefilado aumenta al disminuir el diámetro del alambre.

Hay varias causas de rotura del alambre (*Figura 1*). Dos tipos de rotura son causados por las inclusiones. Una se produce cuando las inclusiones se encuentran en la superficie de la fractura, y la otra, llamada rotura de "extremo hueco" se verifica cuando hay señales de inclusiones cóncavas pero no se localizan dichas inclusiones.

Dos tipos de roturas son causadas por materiales extraños introducidos durante un proceso distinto del proceso de colada.

Una es llamada rotura por "contaminación", y ocurre cuando se encuentran materiales extraños en la superficie de la fractura, y la otra es llamada rotura de "hueco presionado", cuando no se encuentran materiales extraños.

Además, la rotura de "extremo dividido" se considera causada por defectos superficiales y la rotura de "tensión" es causada por una tensión superior a la resistencia del alambre[5].

Se han examinado los tipos de rotura que se producen cuando se trefila alambres de conexión de oro.

La *Figura 2* muestra la frecuencia con la cual ocurre cada tipo de rotura de alambre, dividiendo los diámetros de los alambres trefilados en tres grupos de 100-350µm, 50-99µm y 20-49µm[4].

La *Figura 1* y la *Figura 2* muestran que los defectos superficiales, los materiales extraños y una tensión de trefilado excesiva causada por agarrotamiento son las causas de la rotura del alambre.

Sin embargo, se supone que muchas de las causas de la rotura de alambres con diámetro inferior a 50µm es la presencia de inclusiones que se forman durante la colada[5].

Por lo tanto, se puede concluir que, para que los alambres resistan a la rotura durante el trefilado, no deben tener defectos superficiales y las inclusiones deben ser lo más pequeñas y escasas posible.

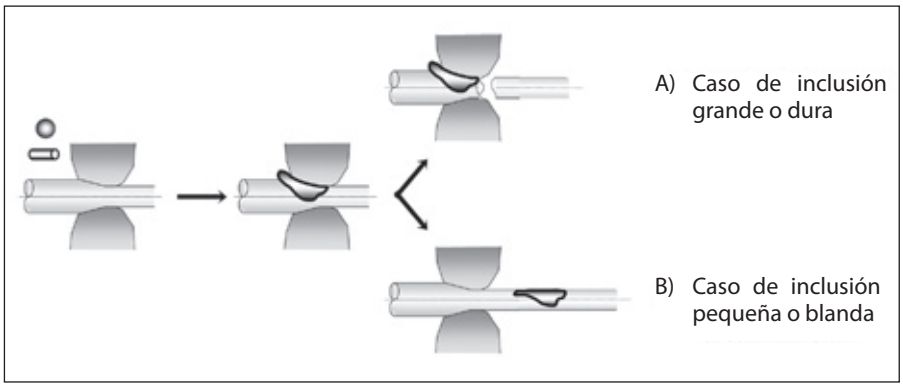
3 Análisis FEM del trefilado de un alambre con inclusiones o materiales extraños

3.1 Efectos de las inclusiones en un alambre

La mayor parte de las inclusiones en los alambres son materiales duros. Los resultados del análisis de las inclusiones en las superficies de alambres con fracturas por medio del espectrómetro de energía dispersiva (*EDS - Energy Dispersive Spectrometer*) han mostrado que muchas inclusiones eran de $A1_2O_3$ o SiO_2, y las demás eran materiales extraños resultado de la abrasión de la hilera y del equipo.

Constantes mecánicas para el oro	
Módulo de Young	80GPa
Relación de Poisson	0.44
Curva del endurecimiento mecánico	$\sigma=475\varepsilon^{0.07}$
Condición del material para la inclusión	
Material	$A1_2O_3$, SUS304
Módulo de Young	300, 194GPa
Relación de Poisson	0.23, 0.30
Límite elástico	4.3, 0.205GPa
Ángulo mitad de la hilera, reducción	$_{\alpha}$=7º, R/P=10%
Coeficiente de rozamiento	0.05µm

▲ **Tabla 1**: *Condiciones de los materiales y del trefilado para el análisis FEM*



▲ **Figura 5**: *Esquema de la rotura de un alambre causada por material extraño*

Por lo tanto, dado que hay inclusiones de alúmina y materiales extraños en los alambres, se ha efectuado el análisis FEM del trefilado de alambre. Se ha establecido una relación entre el tamaño de las inclusiones y el diámetro del alambre (Di/Do) de 0,3 a 0,7.

Las constantes del material y las condiciones de trefilado para el análisis FEM se indican en la *Tabla 1*.

Se han examinado las variaciones de la tensión de trefilado en el lado interno de la hilera mediante el análisis FEM, usando alambres con inclusiones de varios tamaños.

La *Figura 3* muestra los resultados. Se ha verificado que la tensión de trefilado se mueve rápidamente hacia arriba cuando una inclusión pasa a través de la hilera. Se puede ver que al aumentar la relación entre tamaño de la inclusión y diámetro del alambre (Di/Do) aumenta también la tensión de trefilado.

En el caso de un alambre con una inclusión con relación Di/Do igual a 0,7, la tensión de trefilado llega al valor de resistencia del alambre. Esto significa que hay alta probabilidad de que el alambre se rompa.

Considerando el factor de seguridad, existe el riesgo de que el alambre se rompa cuando la relación Di/Do sea superior a 0,4. Se ha medido el tamaño de las inclusiones en la superficie de la fractura durante el trefilado de alambres de oro de 20-50µm.

La *Figura 4* muestra la frecuencia de rotura del alambre para varios valores de Di/Do. Este valor indica que el alambre se puede romper si la relación Di/Do es igual o mayor de 0,3 y que la frecuencia más alta de rotura de un alambre es cuando Di/Do es aproximadamente 0,7.

3.2 Efecto de partículas extrañas

En algunos casos hay materiales extraños sobre la superficie del alambre durante el trefilado, o que pueden entrar en la hilera con el lubricante.

Estos materiales extraños se forman principalmente por desgaste del alambre o de la hilera o del equipo, o pueden formarse a partir del polvo del aire. Según la forma y dureza del material extraño, la rotura del alambre puede ocurrir como se ilustra en la *Figura 5*.

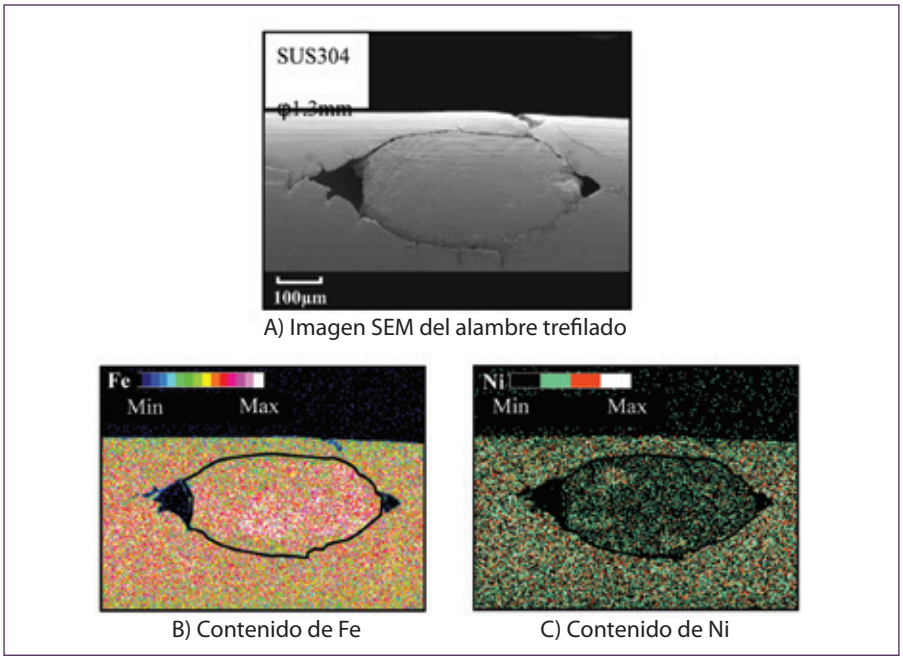
Como ejemplo, la *Figura 6* muestra imágenes del microscopio electrónico de barrido (*SEM - Scanning Electron Microscope*) y fotografías del espectrómetro EDS de un alambre después del trefilado con materiales extraños en la superficie del alambre. El material del alambre es acero inoxidable austenítico.

El análisis con espectrómetro EDS muestra que el material extraño estaba compuesto por carburo de hierro, que incluía una pequeña cantidad de Ni.

Las partículas medían 0,53x0,27mm y tenían una relación Di/Do de aproximadamente 0,2. Se supone que el alambre no se ha roto debido al bajo valor de Di/Do.

La *Figura 7* muestra los resultados, obtenidos con el análisis FEM, del trefilado de un alambre con material extraño cerca de la superficie.

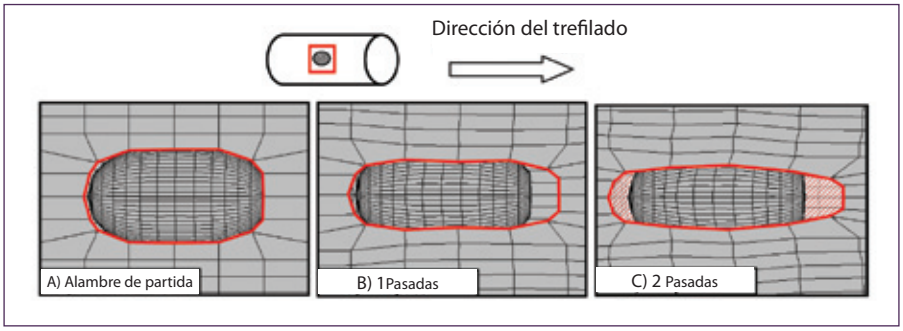
▼ **Figura 6**: *Imagen SEM y análisis componencial del alambre con material extraño*



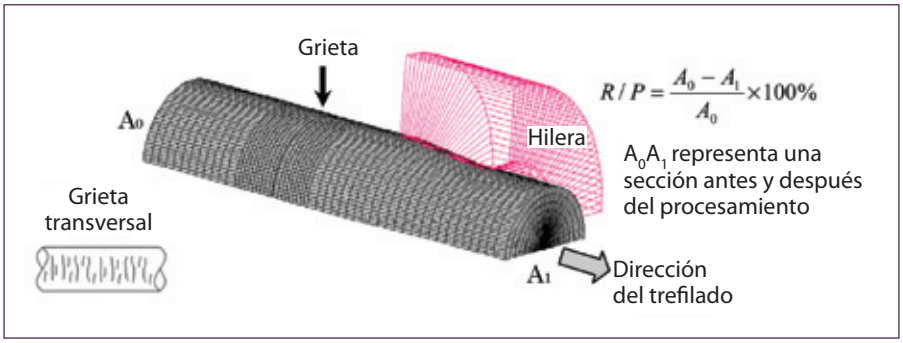
A) Imagen SEM del alambre trefilado

B) Contenido de Fe

C) Contenido de Ni



▲ **Figura 7**: *Deformación de la malla después de varios trefilados del alambre con material extraño en la superficie, examinada mediante FEM*



▲ **Figura 8**: *Modelo de trefilado del alambre*

Aspecto	Nombre	Morfología y características
	Costra	Marca foliada; la superficie de la barra es frotada hasta eliminarla
	Grieta transversal	Grieta perpendicular a la dirección de laminación
	Abolladura	Grietas en forma de escamas en la superficie
	Rayas	Grieta cóncava debida al rayado en la dirección de laminación
	Laminada en el material	Mella debida a presión contra sustancias extrañas como fragmentos de metal
	Sobrellenado	Defectos debidos al mellado continuo en la dirección de laminación

▲ **Tabla 2**: *Clasificación de las grietas superficiales en el alambrón*[7]

El material extraño y el alambre están unidos mecánicamente en la zona interfacial. Después de varias operaciones de trefilado, la tensión actúa en la zona interfacial y hace que la partícula se despegue en esa zona, generando un espacio vacío. En este estudio se ha usado el código FEM en tres dimensiones MSC/Marc Mentat 2008r1. Los resultados del análisis FEM son coherentes con los resultados experimentales.

Dejando a un lado la posición del material extraño en el alambre (dentro o en la superficie), éste no se deforma debido a su dureza, incluso después de varias operaciones de trefilado.

Esto da lugar a un valor de Di/Do alto, que causa un aumento de la tensión y de la probabilidad de rotura del alambre.

4 Análisis de un alambre trefilado con grietas superficiales

Las grietas superficiales se forman en las barras o alambres durante las operaciones de colada, laminación en caliente o trefilado realizadas de manera incorrecta, durante el transporte, o bien a causa del enrollado incorrecto de los alambres [6].

Las grietas superficiales que se forman en el alambrón durante la laminación ascendente son clasificadas como se indica[7] en la *Tabla 2*; sin embargo, no hay una solución clara para este problema. En este caso concreto, hay pocos estudios que hablen de las grietas superficiales que se forman durante el trefilado. [8–11]

Para este estudio se han usado barras de alambrón que han desarrollado grietas circunferenciales durante la colada y la laminación como alambre de partida para las múltiples operaciones de trefilado.

Se han examinado el crecimiento y la eliminación de estas grietas mediante la realización de experimentos y de análisis FEM.

Las barras de alambrón de acero inoxidable (SUS304) han sido rayadas mecánicamente en dirección axial usando un torno, y luego, han sido analizadas mediante experimentos y el método FEM.

Se ha usado como muestras las barras de alambrón rayadas mecánicamente para obtener grietas en forma de V, cóncavas y en forma de U en dirección circunferencial. Para este estudio se ha usado el software FEM MSC/Marc Mentat 2008 R1.

Las *Figuras 8* y *9*, y la *Tabla 3* muestran respectivamente el modelo usado en el análisis FEM, su constante del material y los parámetros de la grieta en forma de V. Se ha determinado el coeficiente de rozamiento (μ) en 0,05.

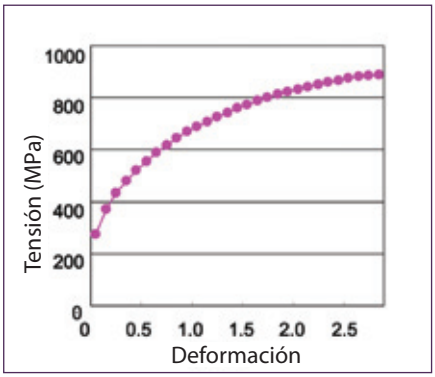
Además, se ha adoptado un modelo de ejes simétricos para el análisis FEM para acortar los tiempos de cálculo.

4.1 Comparación de los resultados del experimento y del análisis FEM

Se ha cortado una grieta con una profundidad h=0,8mm (8%) en un alambre de 8mm de diámetro y se ha examinado su cambio de forma de manera experimental y mediante análisis después de cada pasada de trefilado. La grieta inicial en el alambre de partida tenía forma de V asimétrica.

Se ha observado la forma de la grieta inicial con un microscopio, y en el análisis FEM se ha modelado un alambre de partida con una grieta de la misma

▼ **Figura 9**: *Diagrama del endurecimiento mecánico del alambre de acero inoxidable probado*



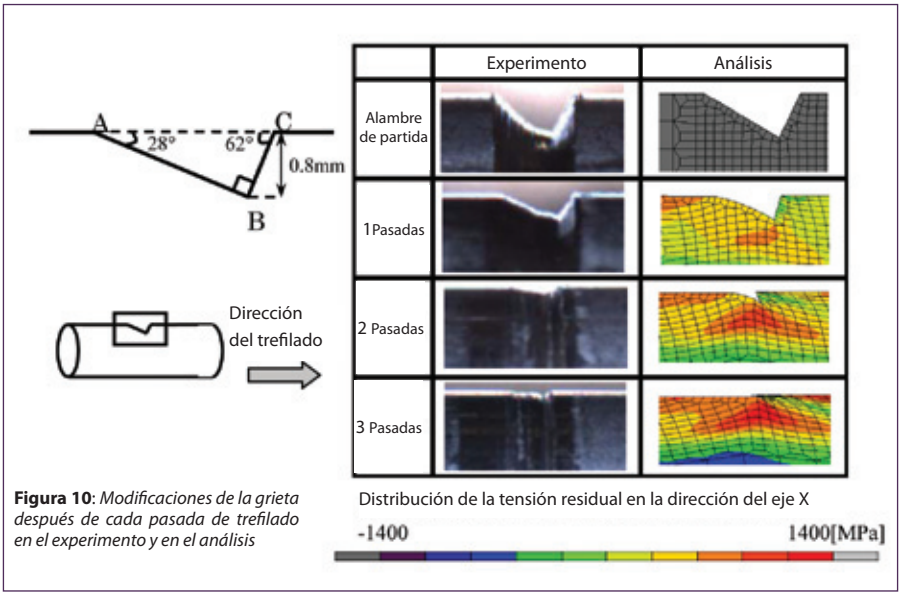
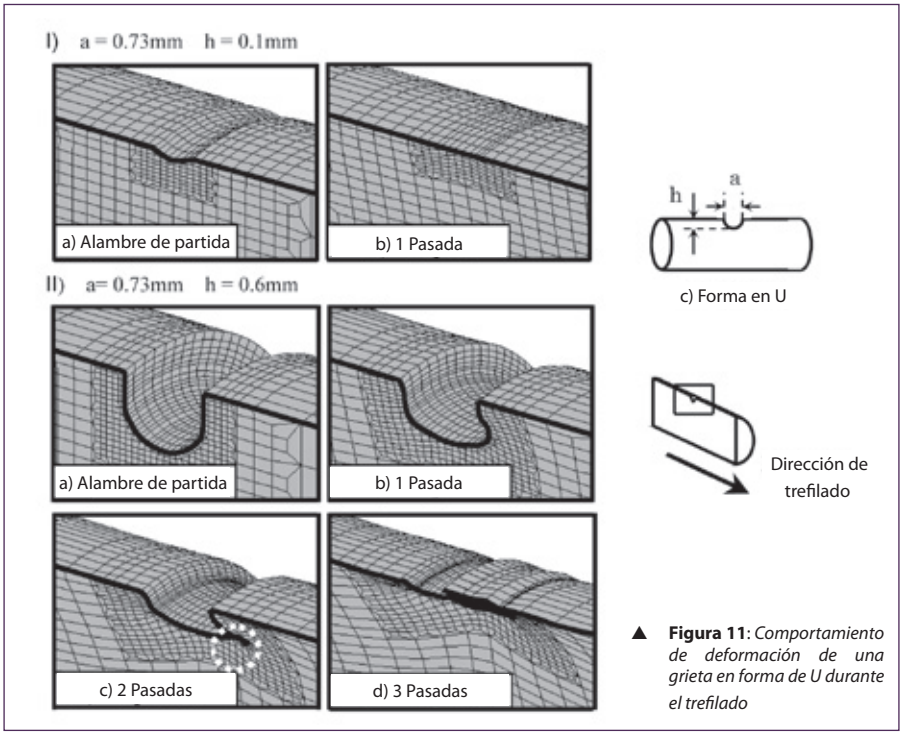


Figura 10: *Modificaciones de la grieta después de cada pasada de trefilado en el experimento y en el análisis*



▲ **Figura 11**: *Comportamiento de deformación de una grieta en forma de U durante el trefilado*

▼ **Tabla 3**: *Parámetros de la grieta*

Parámetros de la grieta	
Parámetro de la forma	Grietas en forma de V, cóncavas y en forma de U
Profundidad (h)	0.10, 0.35, 0.60, 1.0mm
Anchura (a)	0.73, 0.93, 1.15, 1.40mm
Ángulo (θ)	60º, 70º, 80º, 90º, 100º, 110º, 120º
Dirección	Dirección circunferencial
Condiciones del material para el alambre	
Material	SUS304
Módulo de Young	206GPa
Diámetro	10mm, 8mm
Ángulo mitad de la hilera, reducción	$_{\alpha}$=6º, R/P=20%
Coeficiente de rozamiento	0.05µm

forma. Queda claro que el resultado del análisis FEM concuerda con el resultado experimental.

Como se puede ver en la *Figura 10*, la grieta ha sido eliminada porque el lado AB está empujado hacia arriba en el alambre; sin embargo, el lado BC de la grieta está inclinado de manera que sobresale por encima del lado AB, formando una grieta por superposición de material (defecto).

Se ha repetido el trefilado en tres pasadas de un alambre de partida con una grieta superficial en el experimento y en el análisis FEM. La *Figura 10* muestra el comportamiento de deformación de la grieta observado.

4.2 Análisis FEM del comportamiento de deformación de la grieta en forma de U durante varios trefilados

Sucesivamente, se ha modelado un alambre con una grieta en forma U y se ha analizado de la misma manera el proceso de trefilado mediante el análisis por elementos finitos (FEM).

La *Figura 11* muestra algunos ejemplos del comportamiento de deformación de la grietas de alambres de 10mm de diámetro con una grieta de anchura (a)=0,73mm y profundidad (h)=0,10mm (1%), y con una grieta de a=0,73mm y h=0,60mm (6%) durante varios trefilados con a=6° y R/P=20%.

Como se puede ver en la *Figura 11*, en la situación I, el fondo de la grieta sube durante el trefilado repetido y, por lo tanto, la grieta superficial es eliminada después de la primera pasada.

En cambio, en la situación II, con una profundidad mayor, el lado derecho de la grieta es inclinado de manera que sobresale por encima del lado izquierdo y forma una grieta por superposición de material (defecto), lo que indica que la grieta no puede ser eliminada mediante trefilado.

Además, en el alambre se desarrolla una grieta profunda, pero parece pequeña. En conclusión, el comportamiento de la grieta en forma de U durante el trefilado depende de la profundidad (h).

Se han comparado los resultados de grietas cóncavas y en forma de U. A partir de la grieta cóncava se forma un defecto por superposición de material donde la profundidad (h) no es un factor determinante.

En cambio, en el caso de la grieta en forma de U la profundidad (h) sí lo es; es decir, que una grieta poco profunda (h) puede ser eliminada, pero una grieta con profundidad (h) mayor no desaparece.

Se considera que la forma de los dos lados de la grieta determina de manera significativa su eliminación en la situación I ilustrada en la *Figura 11*.

5 Conclusiones

Se ha estudiado la rotura de alambre mediante la realización de experimentos y análisis aplicando el método de los elementos finitos. El objetivo era estudiar la rotura de alambre causada por sustancias extrañas contenidas dentro o depositadas en la superficie del alambre, o causada por grietas transversales que se forman en la superficie del alambre debido a fatiga, inclusiones o defectos superficiales.

Se ilustran a continuación los resultados obtenidos.

1) Los defectos superficiales, los materiales extraños y una tensión de trefilado excesiva causada por agarrotamiento son las causas que determinan la rotura del alambre. Sin embargo, muchas de las causas de la rotura de alambres con diámetro igual o inferior a 50µm son la presencia de inclusiones que se forman durante la colada
2) Se cree que el alambre se puede romper cuando la relación Di/Do es igual o mayor de 0,3, y que las roturas del alambre son más frecuentes cuando Di/Do es aproximadamente 0,7. Se ha observado que esto sucede porque la tensión de trefilado se mueve rápidamente hacia arriba cuando una inclusión pasa a través de la hilera
3) Los resultados del análisis FEM coinciden con los resultados experimentales; por lo tanto, es posible evaluar el comportamiento de deformación de las grietas mediante análisis FEM para predecir el estado después del trefilado
4) El mecanismo de fondo que determina la eliminación de una grieta en una barra de alambrón es la subida del fondo de la grieta durante el trefilado.
5) El comportamiento de una grieta en forma de U durante el trefilado depende de la profundidad (h)
6) Sin embargo, con una profundidad mayor, el lado derecho de la grieta es inclinado de manera que sobresale por encima del lado izquierdo y forma una grieta por superposición de material (defecto), lo que indica que la grieta no puede ser eliminada mediante trefilado. Además, en el alambre se desarrolla una grieta profunda, pero parece pequeña

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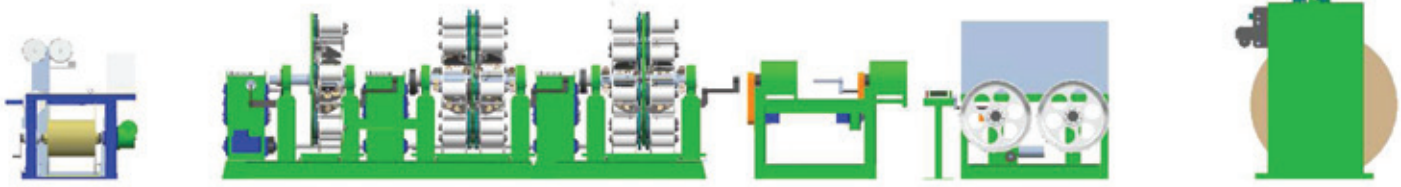

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