

NF Wire Forum

Aurubis
Metals for Progress

BALLOFFET

BECHEM
LUBRICATION
TECHNOLOGY

Cu Deutsches Kupferinstitut
Copper Alliance

NIEHOFF
GRUPPE

NF Wire Forum

The NF WIRE FORUM ONLINE EVENT will start soon.

We will use the interactive software Mentimeter during the event.

If you want to take part in our polls or interact with the speakers you can already open www.menti.com on your smartphone or any other device and enter the events code **92 62 15 3.**

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Tanja Winter
Aurubis AG

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BECHEM LUBRICATION TECHNOLOGY

Harry Hofmann
Carl Bechem GmbH

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.....what`s that ?



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…this surely is a waste of time…

..what will be the costs ?

…impressive name, but…



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...what could they teach me I do not yet know ?

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.....what`s that ?



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It is a platform !

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The **NF Wireforum** is the platform for companies working in the wire producing industry

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NF Wire Forum

- **everything started in 1997…..with the first BECHEM Wiredrawing Meeting**
  - **app 40 participants**
  - **Arrival at day 1 – come together**
  - **Official meeting including presentation at day 2**


Bechem

- Arrival at day 1 – come together

- Day 2 is the official meeting including presentation

- already from the very beginning we received a strong support from

  - NIEHOFF group
  - Norddeutsche Affinerie (now Aurubis)
  - Deutsches Kupfer Institut (Copper Alliance)
  - Societe des filieres Balloffet

  - but also many others

- these meetings were held every two years
- 11 times in a row
- and were always supported by presentation from our partners

NE Drahtforum

1st edition November 11. – 12. 2019

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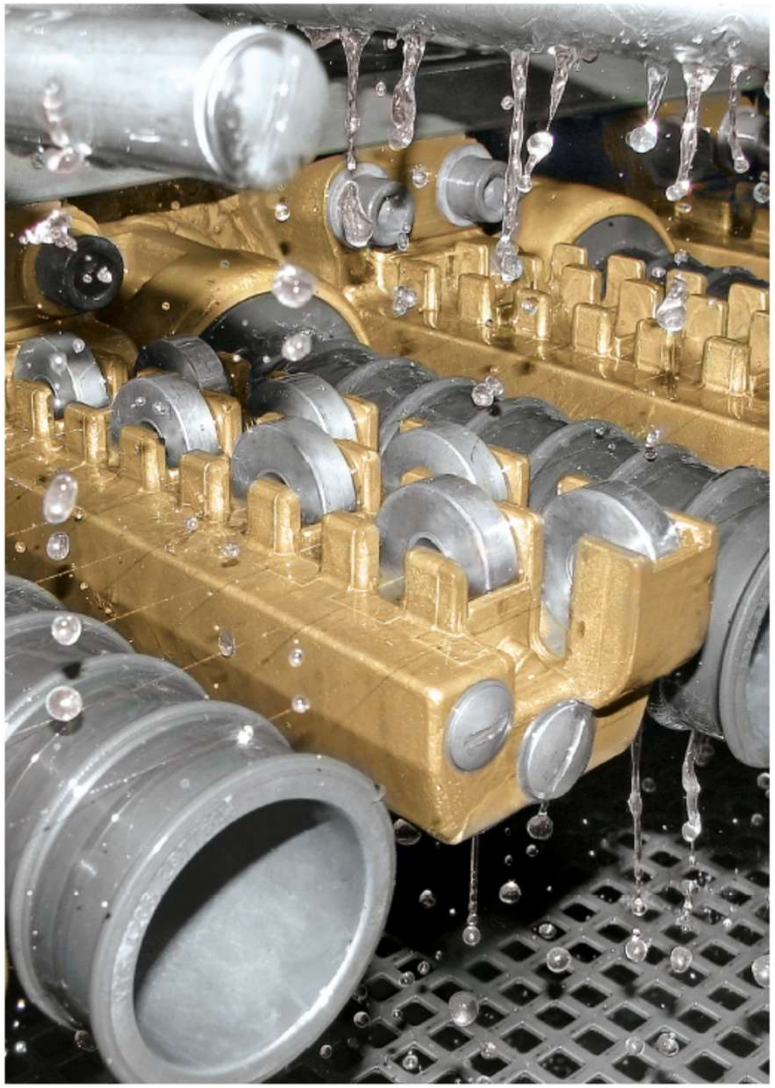
BECHEM LUBRICATION TECHNOLOGY

Cu Deutsches Kupferinstitut Copper Alliance

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Programm

Agenda	Von	Bis	Referent
Begrüßung, neues Format, Marktaussicht	09:00	09:20	Harry Hofmann (CARL BECHEM GMBH), Bernd Lohmüller (Maschinenfabrik NIEHOFF GmbH & Co. KG)
Elektromobilität	09:20	09:50	Markus Thoma (LEONI AG)
Wärmebehandlung und Glühen	09:50	10:20	Dr. Rainer Menge (Herborner Drahtbüro)
Die Kupfer-Feindraht-Produktion - Eine Einführung	10:20	10:35	Michael Sander (Deutsches Kupferinstitut Berufsverband e.V.)
Kaffeepause	10:35	11:05	
Kupfergieß(walz)draht	11:05	11:30	Dr. Cornel Abratis (Aurubis AG)
Ziehmaschinen + Ziehprozess	11:30	12:05	Stephan Gorgels (Maschinenfabrik NIEHOFF GmbH & Co. KG)
Mittagessen	12:05	13:20	
Ziehsteine	13:20	13:45	Michael Biller (Balloffet GmbH)
Emulsion	13:45	14:10	Christopher Folland (CARL BECHEM GMBH)
Drahtbrüche	14:10	14:35	Dr. Cornel Abratis (Aurubis AG)
Kaffeepause	14:35	15:05	
Werkstofftechnische Prozessentwicklungen in der Flachdrahtherstellung	15:05	15:30	Dr. Benjamin Hertweck (Hugo Kern und Liebers GmbH & Co. KG)
Schwingfestigkeit von Kupferdrähten – Werkstoffprüfung versus Bauteilprüfung-	15:30	15:55	Dr. Philipp Skoda (Deutsches Kupferinstitut Berufsverband e.V.)
Abschluss + Ausblick	15:55		Tanja Winter (Aurubis AG)



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NE Drahtforum

11. - 12. November 2019

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BECHEM –
The Brand for Special Lubricants.

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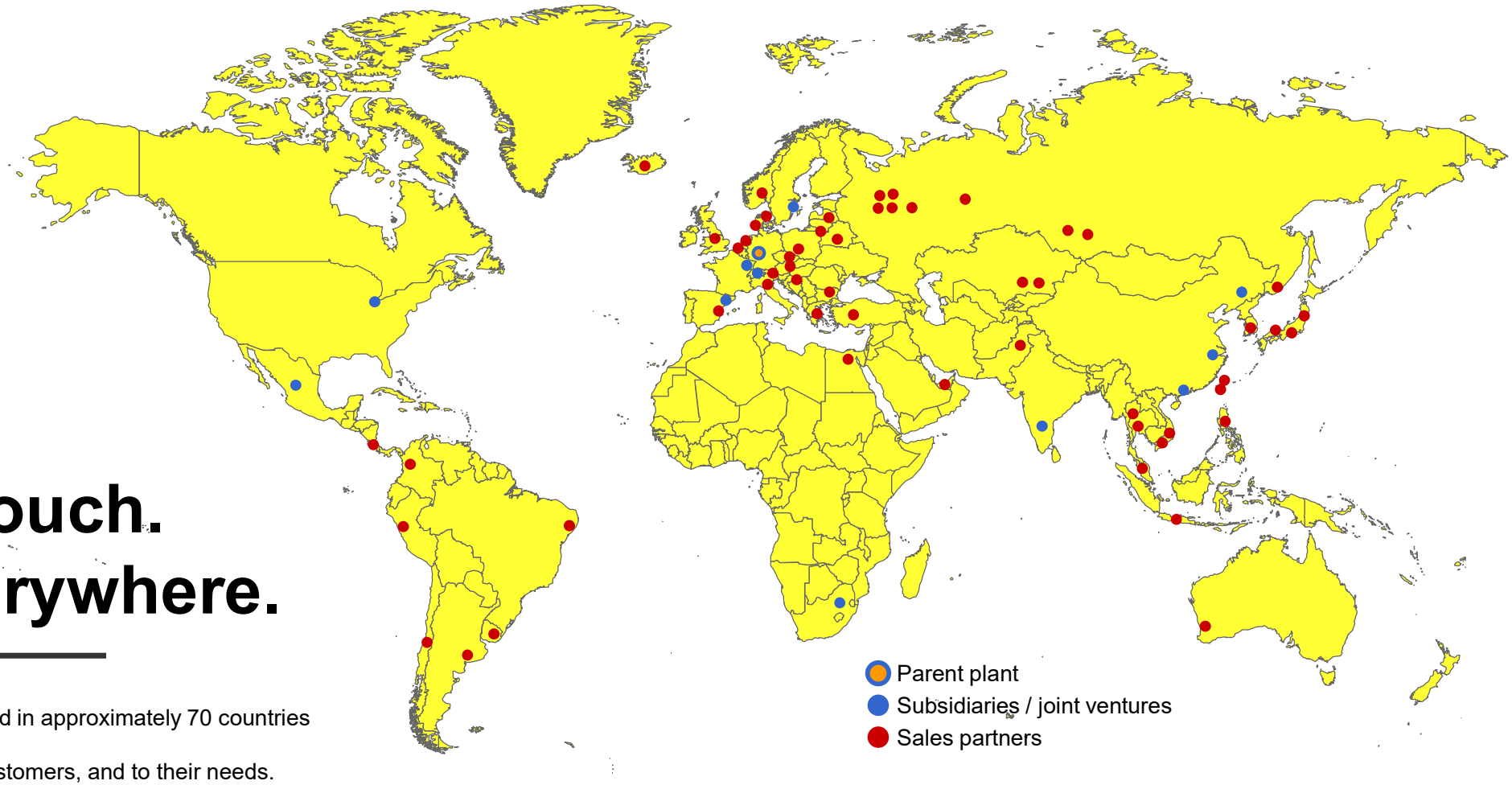


Over 180 years of lubricant history

In 1834, In Hagen, Carl Bechem founded the first German oil factory. In doing so he became the first German manufacturer of industrial lubricants.

BECHEM LUBRICATION TECHNOLOGY

In touch.
Everywhere.



Represented in approximately 70 countries worldwide.
Close to customers, and to their needs.

BECHEM LUBRICATION TECHNOLOGY

BECHEM – an overview.



Approximately 600 employees worldwide, of which 350 are in Germany.
Certified in accordance with IATF 16949, and DIN EN ISO 9001

Plants in Germany:
Hagen | Mieste | Kierspe

Plants worldwide:
China | India | USA

BECHEM LUBRICATION TECHNOLOGY

900 heroes.

900 products offer convincing performances in the most demanding industrial applications.

Lubricating greases and oils

Metal removal and forming lubricants

Anti-friction coatings

Corrosion protection and cleaners



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Specialist.

BECHEM is lubrication specialists for the most demanding industry applications.

**Automotive | Railway | Mining | Chemical industry | Electrical engineering/electronics | Conveyor technology |
Wood processing and wood working |
Plastics | Food products | Mechanical engineering |
Metal production and metal processing |
Pharmaceutical industry | HVAC | Industrial fittings |
Shipbuilding | Textile industry | Environmental technology | Cement**





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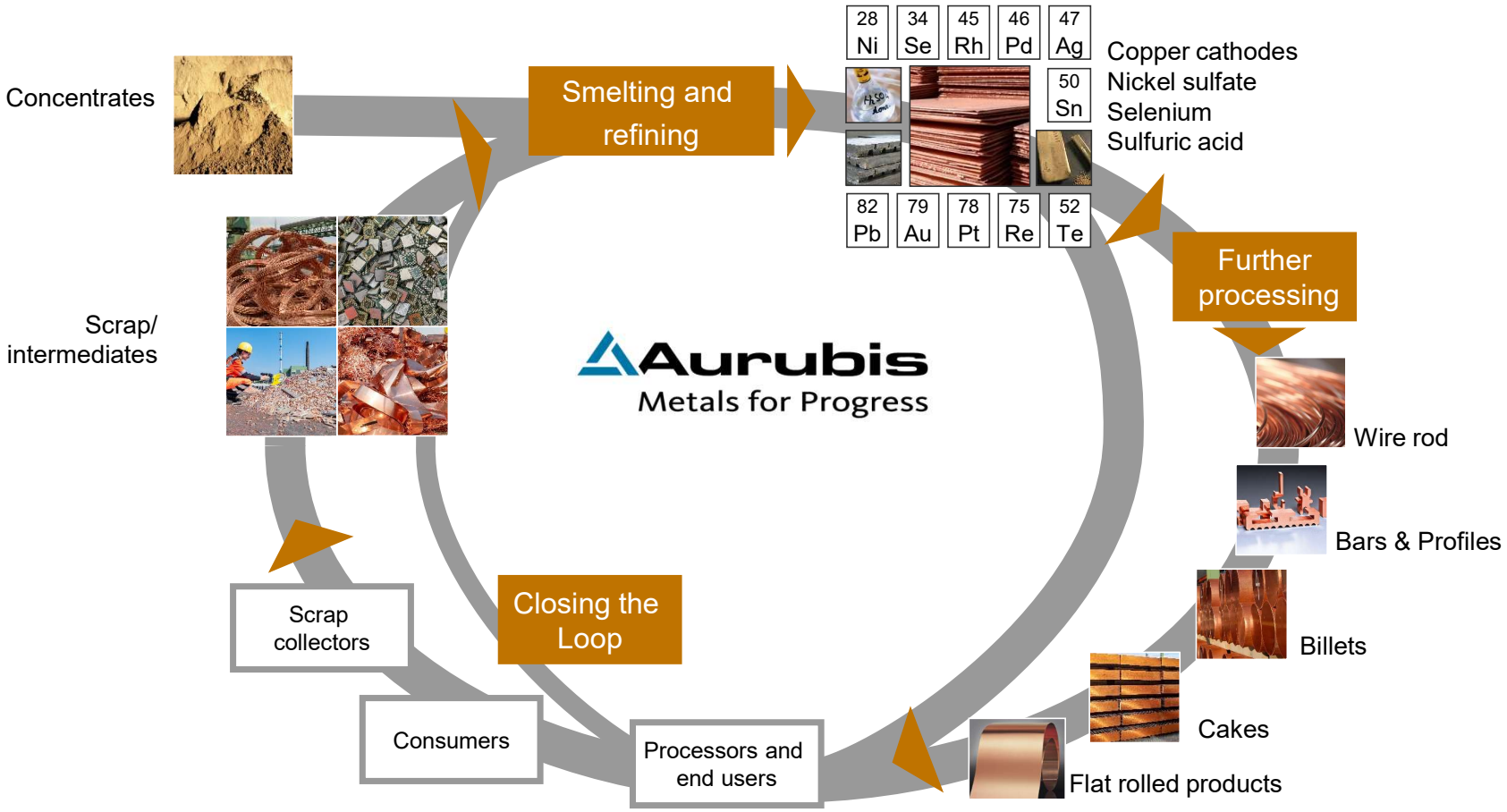
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Dr. Cornel Abratis
Aurubis AG

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Aurubis' strengths include productivity, efficiency, environmental protection, and processing expertise



Production volumes and metal portfolio

	FY 2018/19	Position
Concentrate processing*	2,225,000 t	No. 4 worldwide
Copper scrap input	291,000 t	No. 1 worldwide
Cathode output*	**1,075,000 t**	**No. 5 worldwide**
Continuous cast wire rod output	**804,000 t**	**No. 3 worldwide**
Copper shapes output	174,000 t	No. 1 in Europe
Flat rolled products + specialty wire output	210,000 t	No. 1 worldwide
Sulfuric acid output	2,101,000 t	

	FY 2018/19
Gold	51 t
Silver	861 t
Lead	19,038 t
Nickel	3,067 t
Tin	1,631 t
Minor metals	943 t
Platinum group metals (PGMs)	9,771 kg

* Custom smelter production

Production network – Cathode and Copper Wire Rod at Aurubis



Cathode & Rod – fully integrated plants:

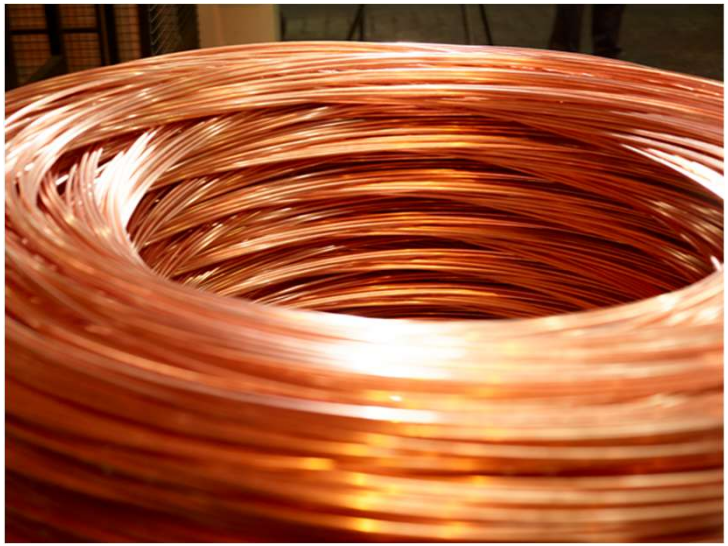
- Hamburg DE
- Olen BE

Rod:

- Avellino IT
- Emmerich DE

Cathode:

- Pirdop BG
- Lünen DE



Copper as part of responsible sourcing – sector demands & solutions

Aurubis
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THE COPPER MARK™ | RESPONSIBLY PRODUCED COPPER





- Launched for **copper producers** in March 2020
- Basis: UN SDGs & Risk Readiness Assessment
- Independent assessment every **3 years**
- Regular review of criteria (evolving system)
- **Chain of Custody** later
- Focus on steady improvement of the sector
- **Partners** are listed on the website

- OECD requirements for all base metals and LME brands
- Coming requirements:
  Red Flag Assessment, ISO 14001 and OHSAS 18001/ISO 45001
- Cooperation with the Copper Mark – development of a Joint Due Diligence Standard for Cu, Pb, Ni and Zn

The copper value chain demonstrates responsibility to mutually improve and develop.

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Michael Biller
BALLOFFET GmbH

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Balloffet France

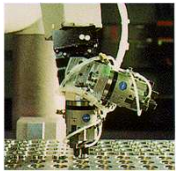
Family owned company specialized since 150 years in drawing tool & Dies for the drawing applications

R&D and permanent innovation to optimize tool and dies for Non ferrous high performance drawing for a fully integrated known how & expertise

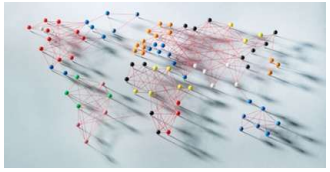
Production in France of diamond drawing dies, diamond tools & wear parts and die repair equipment

100 % European Production + worldwide local services

Latest integrated technology & automated process for the best quality

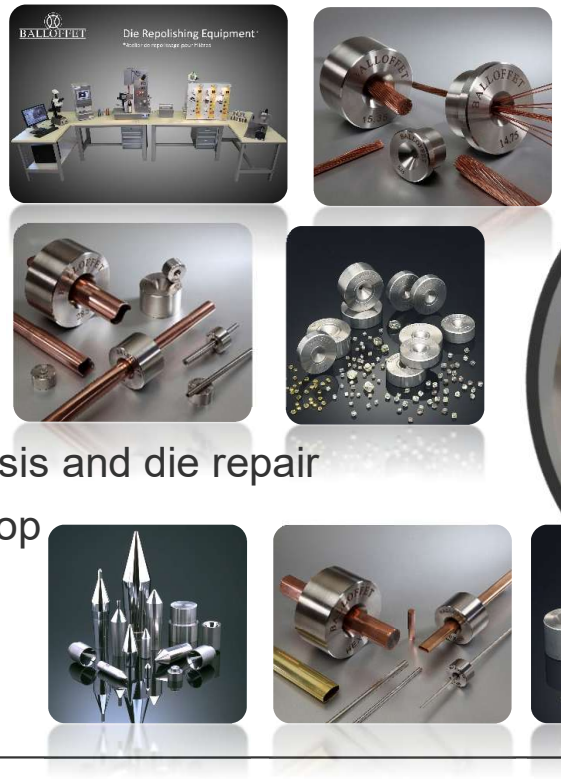




Balloffet Product Description

- Drawing dies
- Extrusion tools
- Compacting dies
- Stranding dies
- Shaped dies
- Enameling guides
- Repolishing service
- Training on die analysis and die repair
- Equipment for die shop



Balloffet produce diamond tools from 5 µm up to 40,00 mm



Balloffet France

- Sales manager
- Austria
- Germany
- Liechtenstein
- Since 12 years on board

Michael Biller













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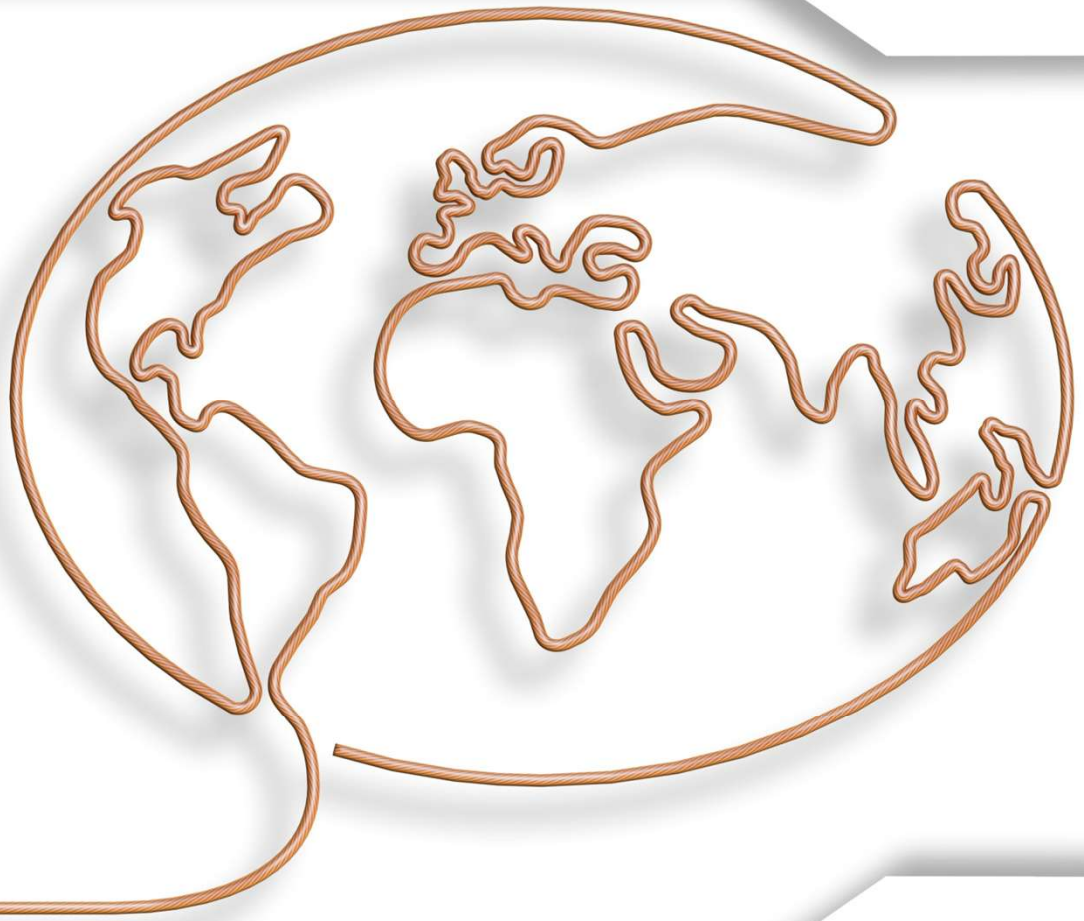
Stephan Gorgels

Maschinenfabrik NIEHOFF GmbH&Co.KG

With Our Customer Drive We Establish Trust

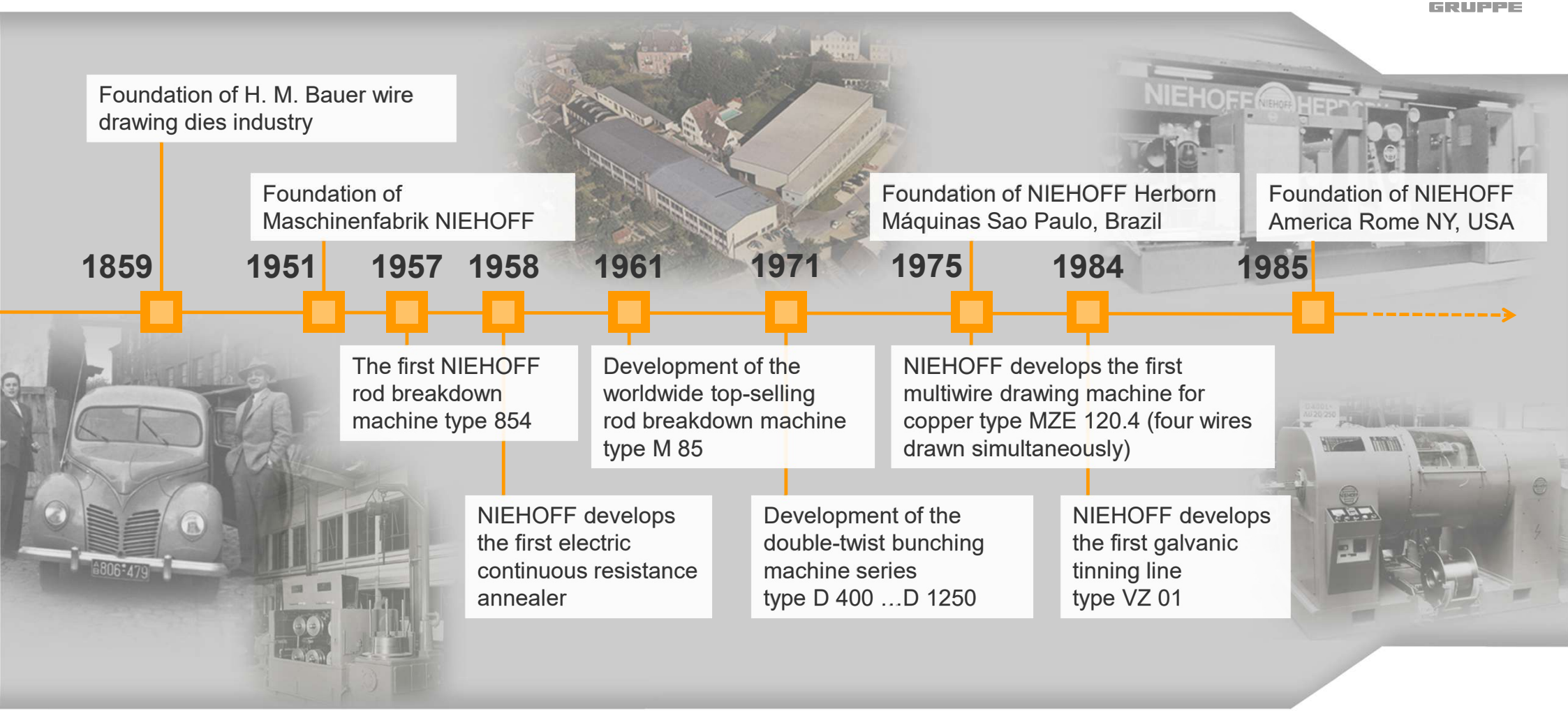
Company presentation of

NIEHOFF





Product Milestones and Acquisitions – Our History



1859 Foundation of H. M. Bauer wire drawing dies industry

1951 Foundation of Maschinenfabrik NIEHOFF

1957 The first NIEHOFF rod breakdown machine type 854

1958 NIEHOFF develops the first electric continuous resistance annealer

1961 Development of the worldwide top-selling rod breakdown machine type M 85

1971 Development of the double-twist bunching machine series type D 400 …D 1250

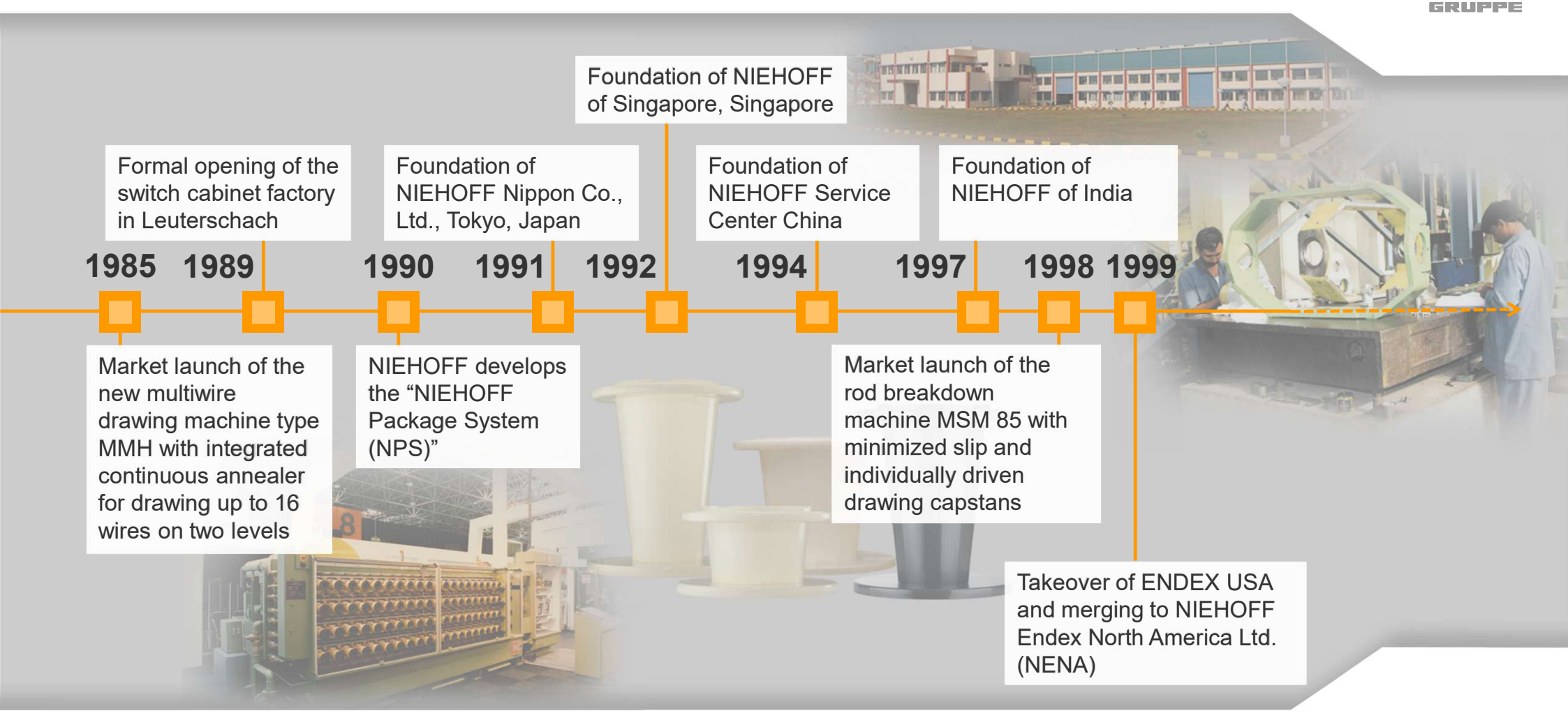
1975 Foundation of NIEHOFF Herborn Máquinas Sao Paulo, Brazil

1975 NIEHOFF develops the first multiwire drawing machine for copper type MZE 120.4 (four wires drawn simultaneously)

1984 NIEHOFF develops the first galvanic tinning line type VZ 01

1985 Foundation of NIEHOFF America Rome NY, USA

Product Milestones and Acquisitions – Our History



1985 – Market launch of the new multiwire drawing machine type MMH with integrated continuous annealer for drawing up to 16 wires on two levels

1989 – Formal opening of the switch cabinet factory in Leuterschach

1990 – NIEHOFF develops the “NIEHOFF Package System (NPS)”

1991 – Foundation of NIEHOFF Nippon Co., Ltd., Tokyo, Japan

1992 – Foundation of NIEHOFF of Singapore, Singapore

1994 – Foundation of NIEHOFF Service Center China

1997 – Market launch of the rod breakdown machine MSM 85 with minimized slip and individually driven drawing capstans

1998 – Foundation of NIEHOFF of India

1999 – Takeover of ENDEX USA and merging to NIEHOFF Endex North America Ltd. (NENA)

Product Milestones and Acquisitions – Our History



2002 Expansion of the product range by data cable stranding lines type DSI and braiding machines type BMV

2004 Diversification of the product range by bobbin winders (System Hacoba)

2005 Foundation of NIEHOFF of Russia, Moscow

2008 Adding induction annealer to the production portfolio

2011 Foundation of NIEHOFF Machinery Changzhou Co., Ltd., China

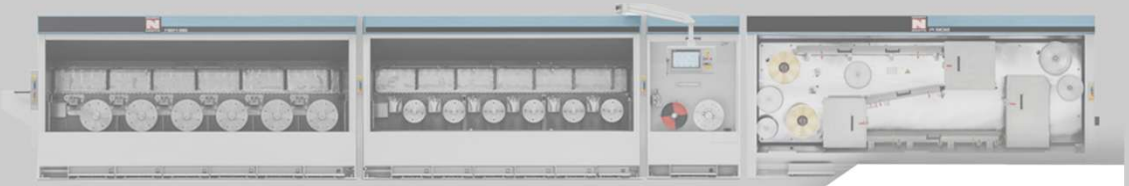
2013 NIEHOFF acquires shares in H. Folke Sandelin AB (HFSAB), Sweden (lead extruders)

2014 Rod breakdown machine type MSM 86 with continuous resistance annealer type R 502

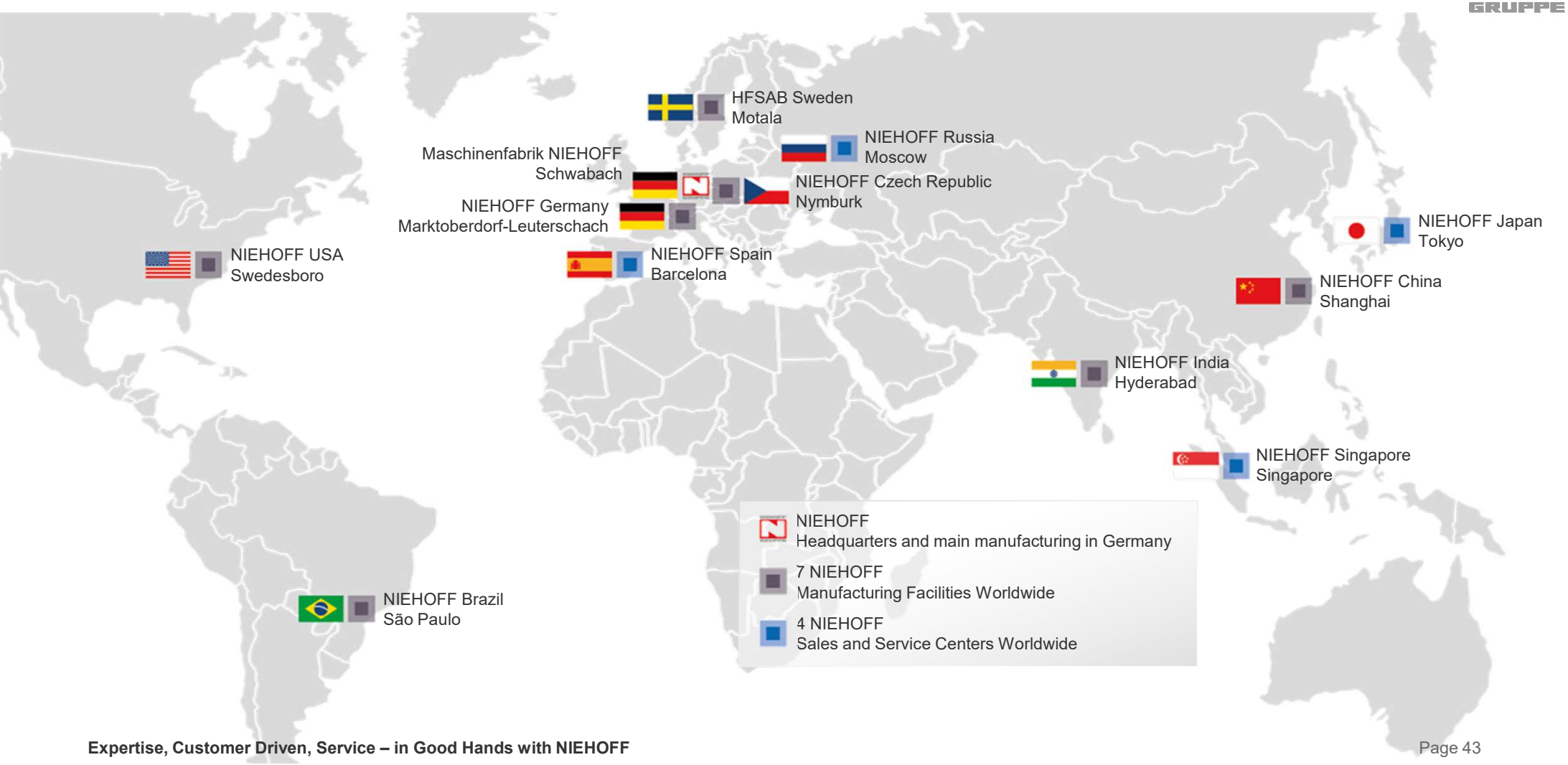
2015 Completion of the new factory NIEHOFF Schwabach

2017 Foundation of NIEHOFF Stranding Technology in Barcelona, Spain

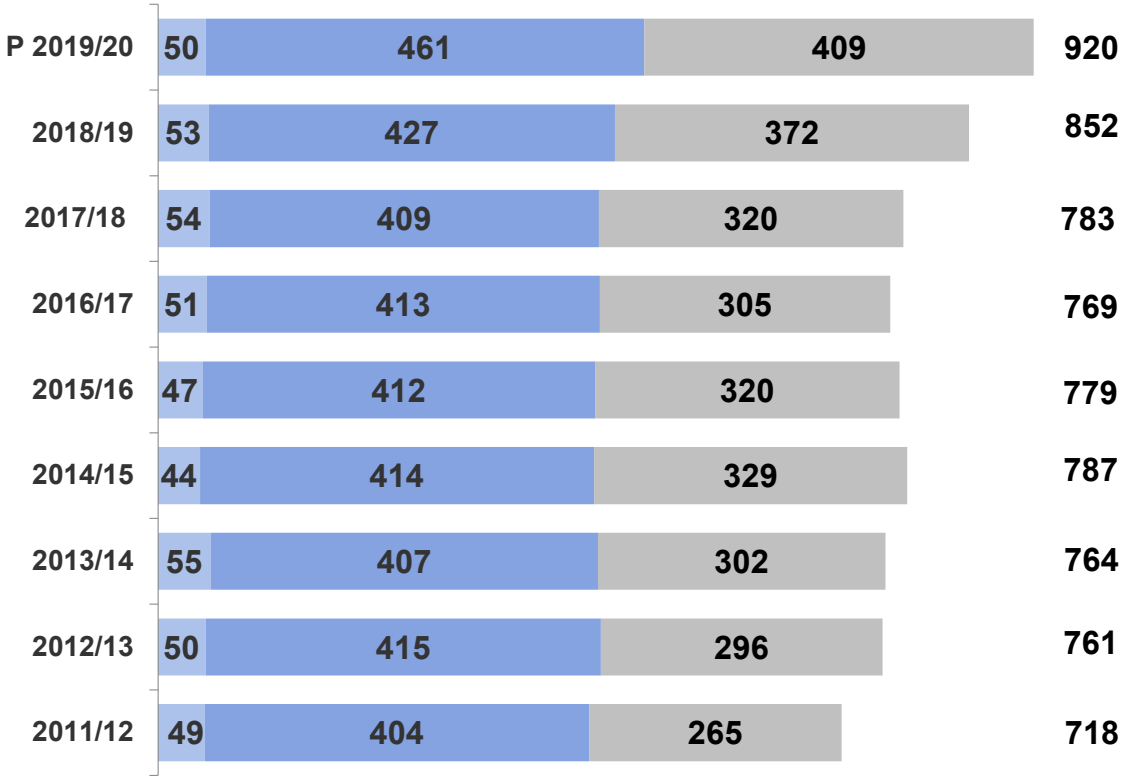


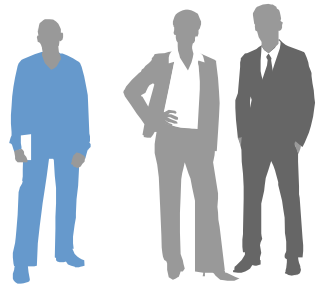


Locations Worldwide



Number of Employees in Germany and Worldwide (FTE)





Trainees

NIEHOFF Headquarters

NIEHOFF Group

Core Products

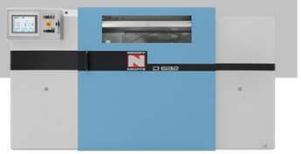
932
Rod Breakdown Lines



1,494
Multiwire Drawing Lines



4,502
Bunchers

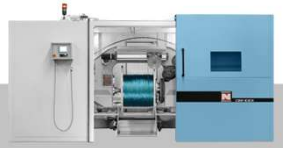


1,245
Braiders





463
NPS Cable Spoolers



134
Stranding Lines



114
Galvanic Plating Lines



104
Inductive Annealers

Total number of machines delivered since 1951:

62,400

Challenges of Today and Tomorrow …



… and How to Face These Challenges



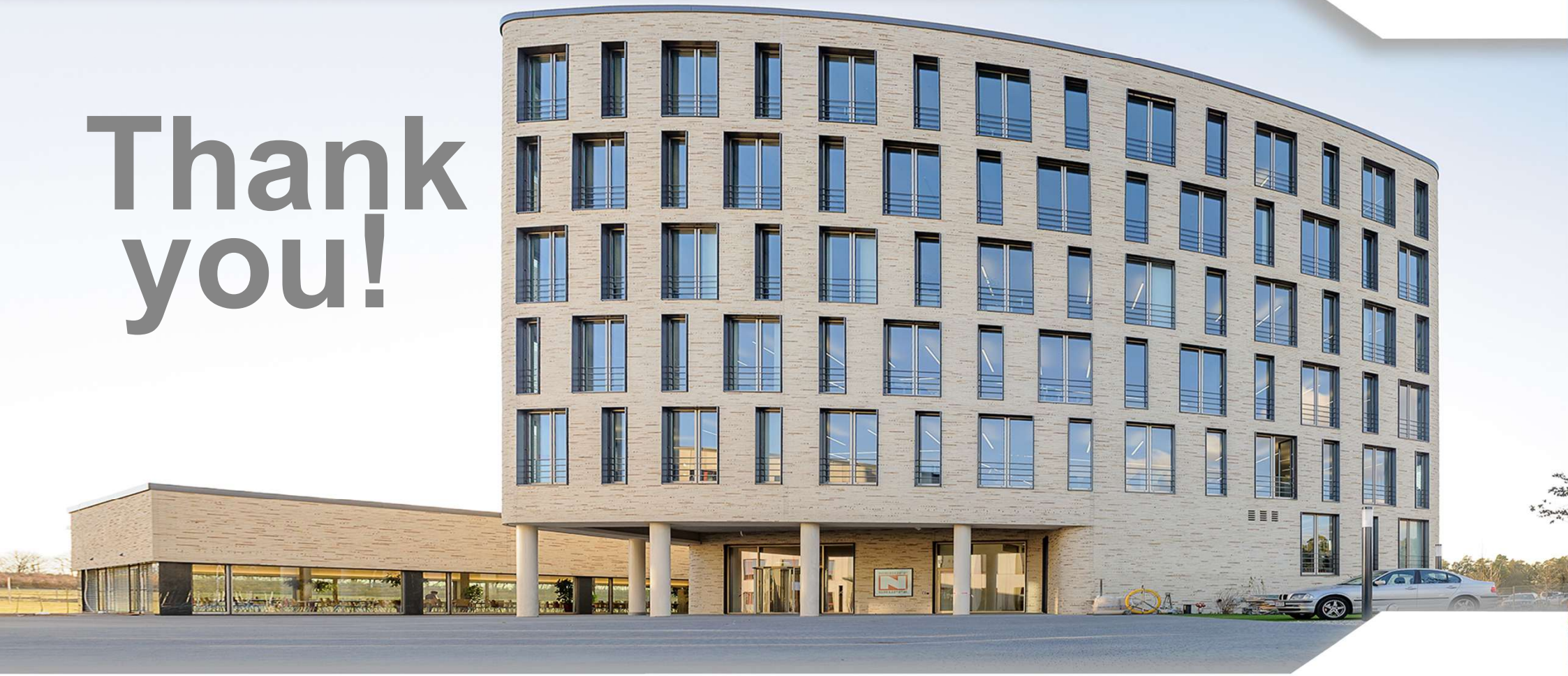
Geothermal Cooling and Heating

- Heating and cooling is realized utilizing geothermal energy from 162 earth probes in a depth of 85 m
- Cooling is integrated in the heating process without additional costs
- Heat recovery from cooling lubricant and cooling water facilities
- Utilization of heat from server rooms, air compressors, switchboard cabinets and exhaust air systems

we only use electrical energy
that has been generated from hydropower



Thank you!





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Copper Alliance

Michael Sander

Deutsches Kupferinstitut Berufsverband e. V.

Deutsches Kupferinstitut – Our Added Value (1)

Deutsches Kupferinstitut
Copper Alliance

The Copper Institute represents the interests of the copper processing industry as a technical and scientific association with a high reputation. For more than 90 years it has been disseminating general copper knowledge and thus promoting the acceptance, production, use and distribution of copper products.

neutral - competent - interdisciplinary

- ✓ **Consulting**
- ✓ **Knowledge transfer**
- ✓ **Laboratory services**
- ✓ **Research**

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Deutsches Kupferinstitut – Our Added Value (2)

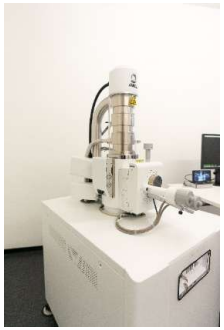
Deutsches Kupferinstitut
Copper Alliance

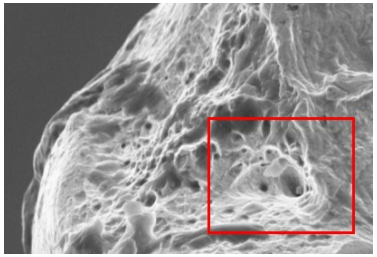
- ✓ **Consulting** on materials, applications and processing
- ✓ **Knowledge transfer** through publications, lectures, training, networks
- ✓ **Laboratory services** within the scope of engineering analyses
- ✓ **Research** on pre-competitive issues in cooperation with industry and universities









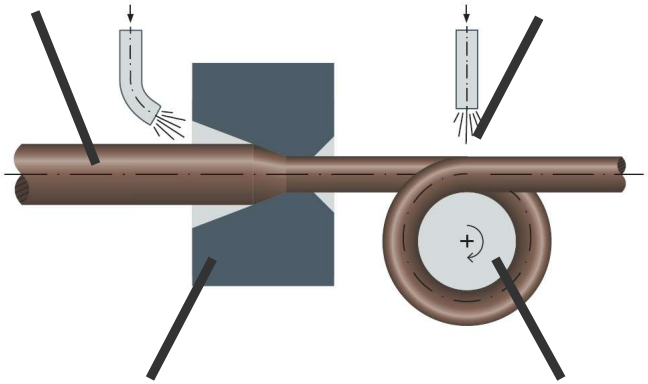


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The Drawing Process –
A simple system with four elements?



Pre-
material



Lubricant





Drawing
die

Drawing
machine



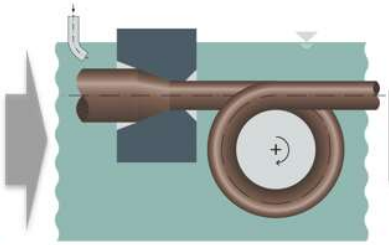
Chaining of drawing processes and influences

e.g. 2-3 drawing machines with 11-25 drawing steps

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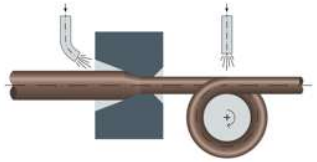
Pre-Processes:

- Melting
- Rolling
- Transport
- Storage
- Wire drawing
- Anealing



Chained Processes / In-between-Processes:

- Wire drawing
- Anealing
- Transport
- Storage
- (Coating)



Post-Processes:

- Wire drawing
- Anealing
- Transport
- Storage
- Winding
- Rolling





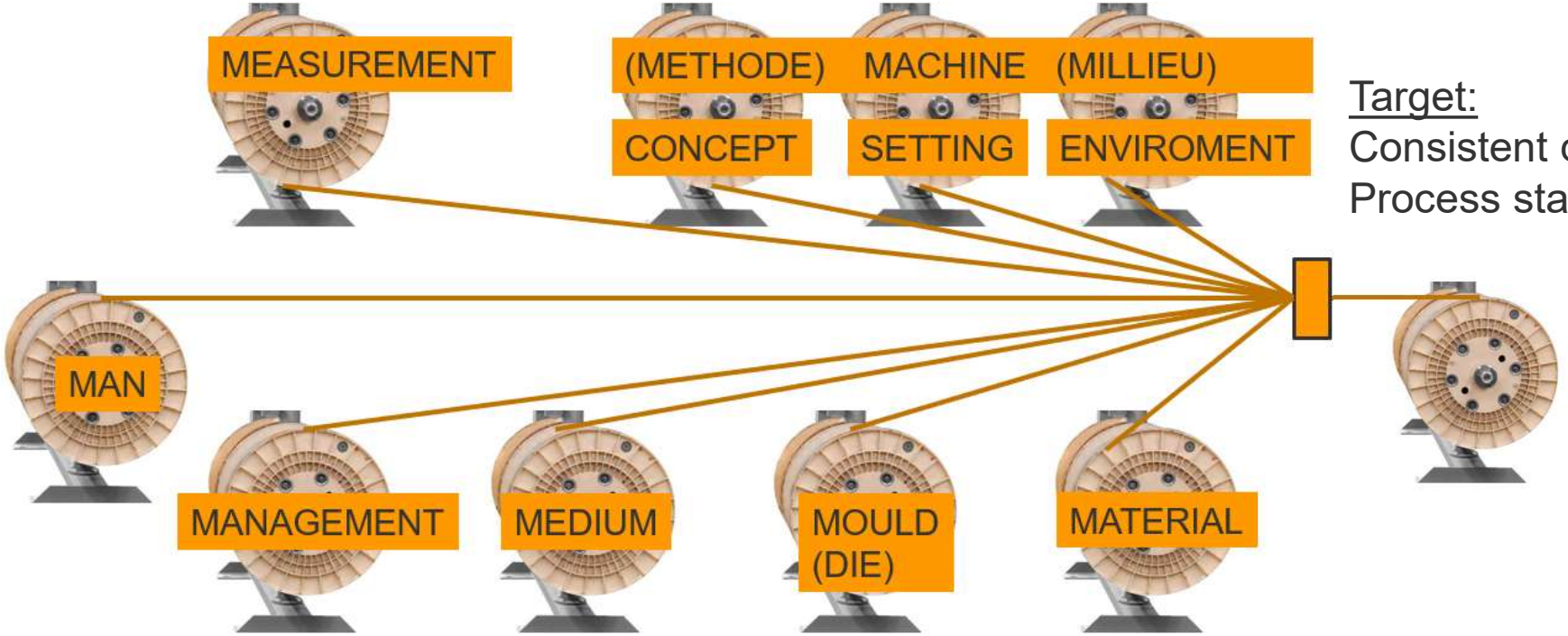






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7 M (influencing factors) of the drawing process



Target:
Consistent quality
Process stability



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Copper Wire Rod – Wire Break Types

NF WIRE FORUM ONLINE EVENT

October 20th, 2020

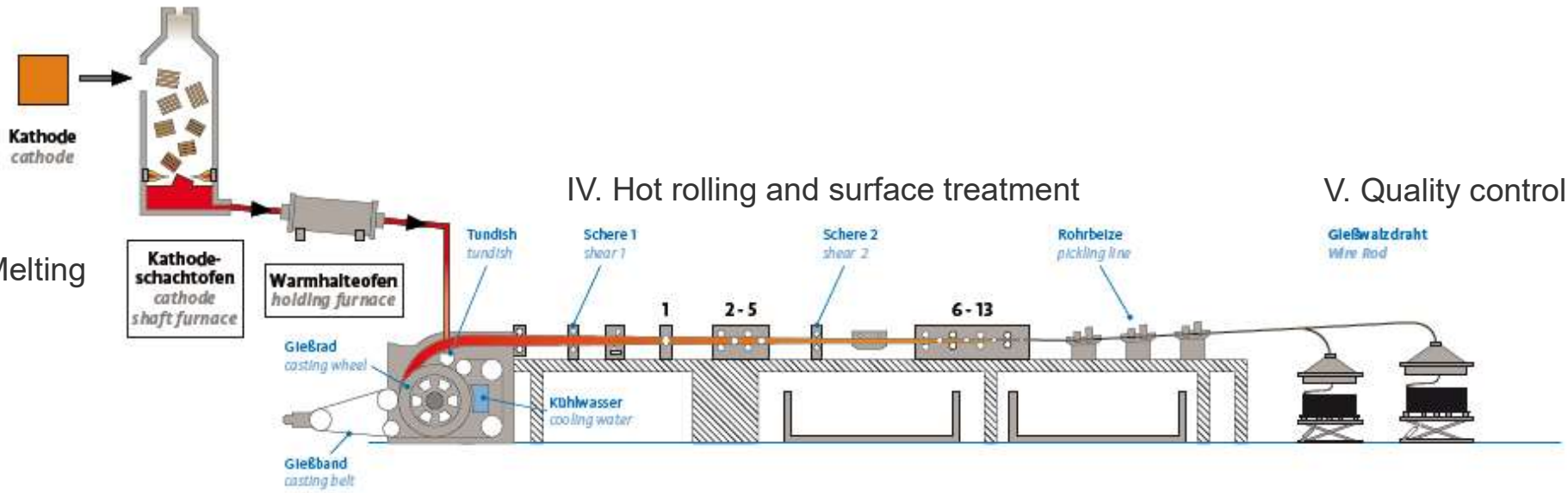
Aurubis AG, Dr. Cornel Abratis

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Influencing factors on good drawability of Copper Wire Rod

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I. Feed mix



II. Melting

III. Casting and Solidification

IV. Hot rolling and surface treatment

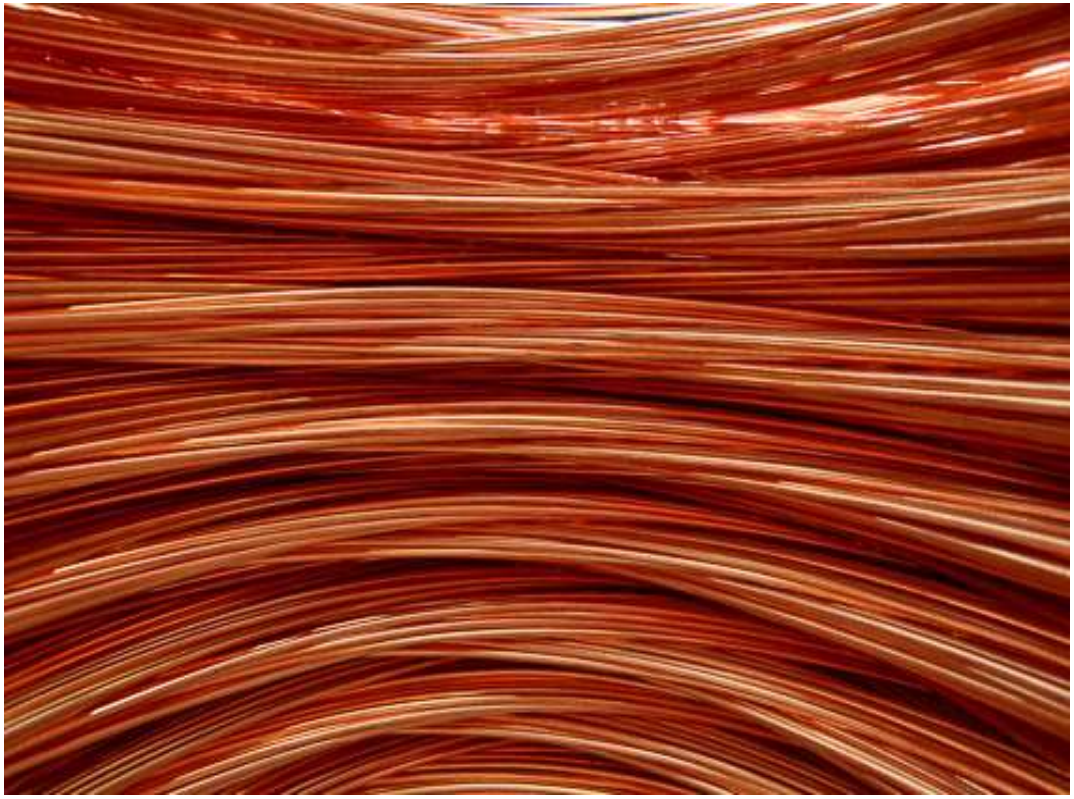
V. Quality control

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Selection criteria for good drawability copper wire rod

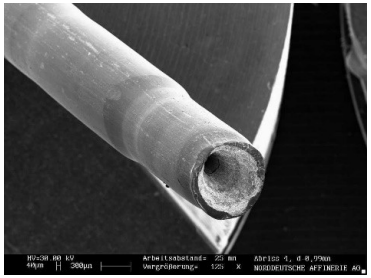
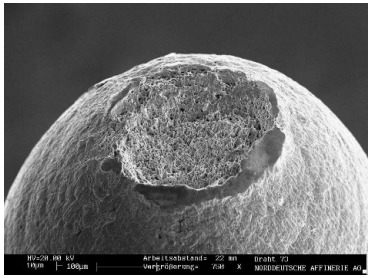
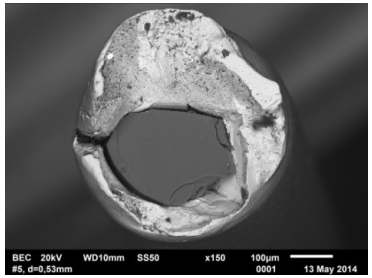
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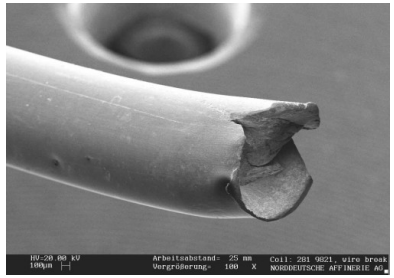
- “best” feed mix with grade A cathodes
- Oxygen content < 250 ppm
- Δ temperature $T_{Copper\ melt} > T_{Copper\ solidus}$
- Cooling water
- Rolling current at rolling stands
- Low defectomat and ferromat signals
- Good twist test result
- Low residual oxide layer



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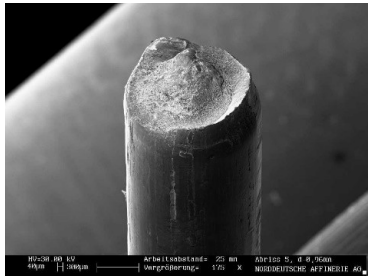
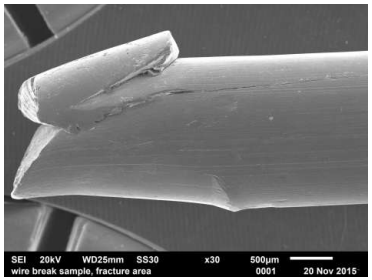
Introduction

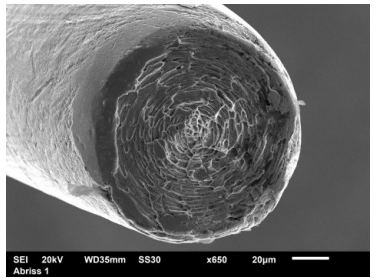




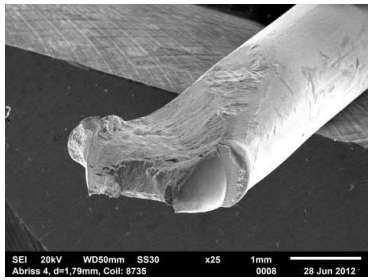


Wire Breaks

… are the undesired result of unfavorable interactions of adjacent forces, tensions and metallic/physical processes in the material exceeding beyond the material's stress limit.

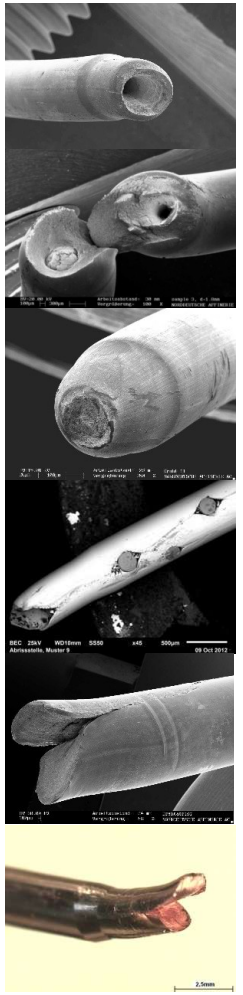







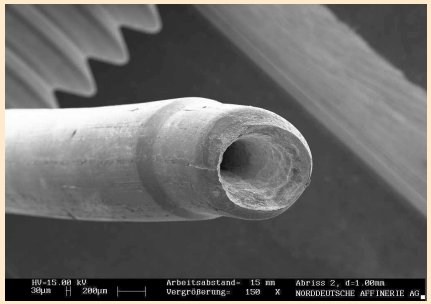
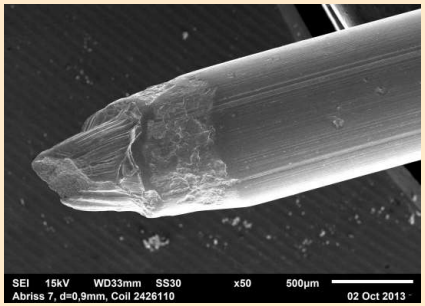
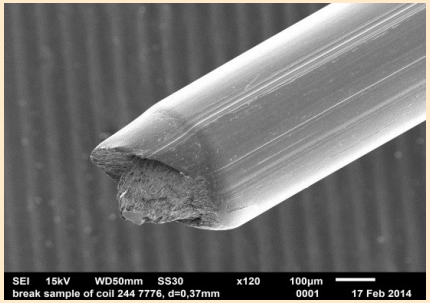
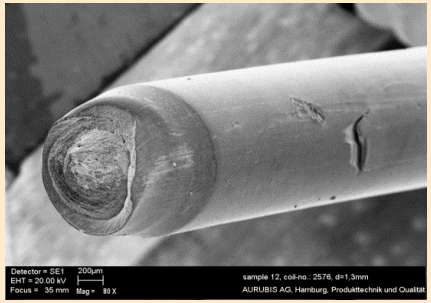
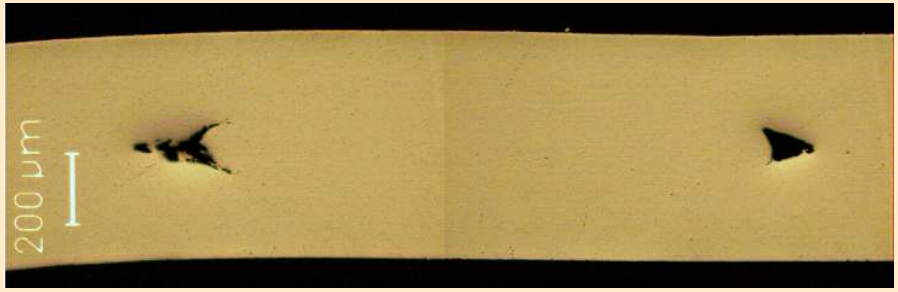
Typical Wire Breaks

- Cup- and Cone break I (drawing conditions)
- Cup- and Cone break II (Cuprous enrichments)
- Ductile force break / strain break
- Inclusion break
- Force break by rolled-in or pressed-in chip / mech. surface damage (surface break)
- Weld break
- Annealing break



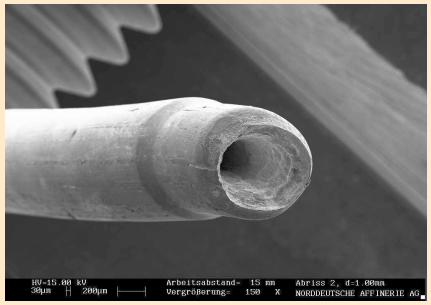
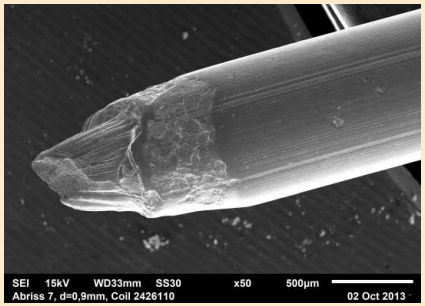
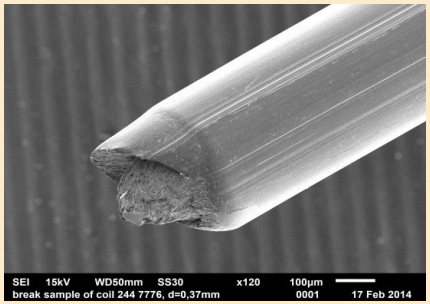
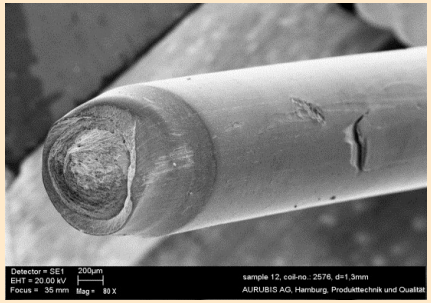
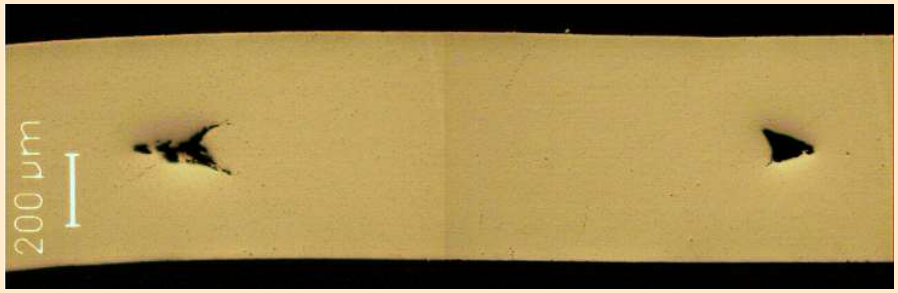
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Break type	Cup- and Cone-break I (drawing conditions)
Examples	    
Features	- Cup side with a deep whole in the middle of the wire or - Cone side with a symmetrical necking and a tip - surface defects (draw marks, etc.) aside of the breakage area - Inner cracks so called “craw feet” in longitudinal cross sections - no impurity phase agglomeration in the copper wire matrix

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Break type	Cup- and Cone-break I (drawing conditions)
Examples	    
Damage mechanism	- high shear stresses between wire surface and neutral line induce local material failures where the max. material stress level is exceeded (inner cracks “craw feet”) - the tip of the “craw feet” is orientated in drawing direction - with additional strain, these cracks grow and reduce the load-bearing cross-section of the wire until the material fails or breaks



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Drawing process

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What can Balloffet do to reduce wire breakage





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Wire breaks – the view from the die producer

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1. Wrong diameter
2. Geometry not respected
3. Rough polishing
4. Dies are not cleaned
5. Mishandling on dies (wrong in die holder)
6. Imperfect technical matching – drawing machine parameter / die sequence
7. Dies are in the wrong position
8. Elongation problems and/or unsuitable slip
9. Lack of die maintenance, extreme die wear, deep drawing ring,
10. irregular die wear

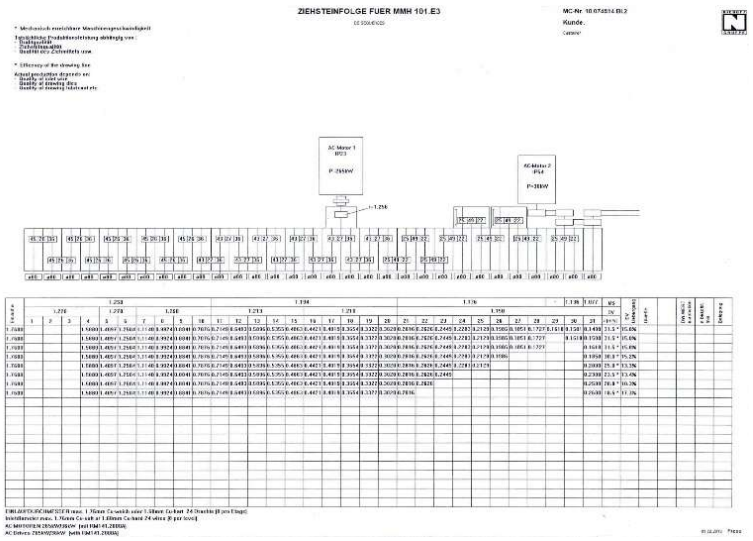
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Balloffet technical check list on drawing die parameters to reduce risks of wire breakages.

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Potential root causes analysis :

1. Imperfect technical matching:
   - machine parameter ./. die sequence



Balloffet Check list of possible actions :

1. Complete die sequence calculation
   - sizes
   - Elongation
   - slip

Die set control		
Ø	κ	Elong %
0.2	Final die	
0.2129	1.07233443	14.99%
0.2283	1.07271134	15.07%
0.2449	1.0722744	14.98%
0.2626	1.07235339	14.99%
0.2816	1.07244318	15.01%
0.302	1.1	21.00%
0.3322	1.0999398	20.99%
0.3654	1.09989053	20.98%
0.4019	1.10002488	21.01%
0.4421	1.09997738	21.00%
0.4863	1.10117212	21.26%
0.5355	1.10102708	21.23%
0.5896	1.10125509	21.28%
0.6493	0	-100.00%

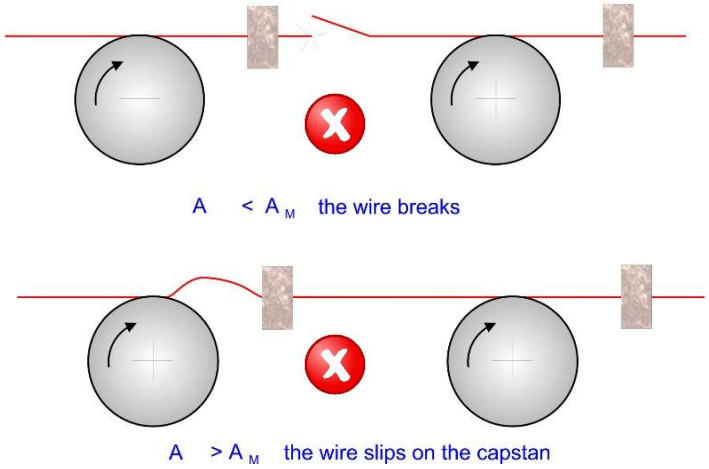
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Balloffet technical check list:

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Potential root cause analysis :

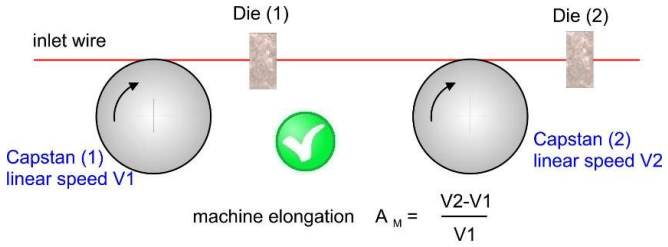
2. Elongation problems and/or wrong slip.



Balloffet Check list of possible actions :

2. Controle by Balloffet of :

- Die set elongation in accordance the machine specification.
- Difference between die elongation and machine elongation = theoretical slip depending on type and size of drawn material .



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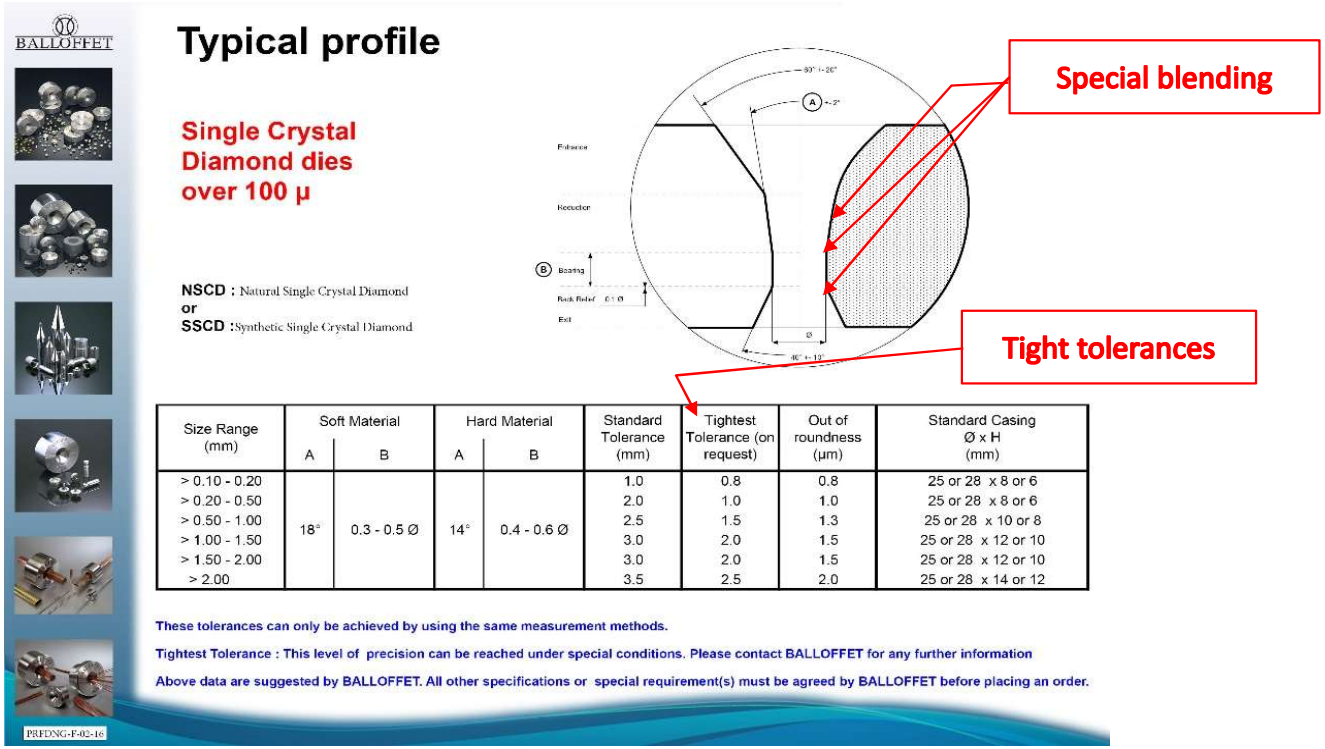
Balloffet technical check list:

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Potential root cause analysis :

3. Die issues
   - wrong Diameter
   - unsuitable geometry
   - rough polishing
   - wrong tolerances

Balloffet Check list of possible actions :



Size Range (mm)	Soft Material A	Soft Material B	Hard Material A	Hard Material B	Standard Tolerance (mm)	Tightest Tolerance (on request)	Out of roundness (µm)	Standard Casing Ø x H (mm)
> 0.10 - 0.20	18°	0.3 - 0.5 Ø	14°	0.4 - 0.6 Ø	1.0	0.8	0.8	25 or 28 x 8 or 6
> 0.20 - 0.50					2.0	1.0	1.0	25 or 28 x 8 or 6
> 0.50 - 1.00					2.5	1.5	1.3	25 or 28 x 10 or 8
> 1.00 - 1.50					3.0	2.0	1.5	25 or 28 x 12 or 10
> 1.50 - 2.00					3.0	2.0	1.5	25 or 28 x 12 or 10
> 2.00					3.5	2.5	2.0	25 or 28 x 14 or 12

These tolerances can only be achieved by using the same measurement methods.

Tightest Tolerance : This level of precision can be reached under special conditions. Please contact BALLOFFET for any further information

Above data are suggested by BALLOFFET. All other specifications or special requirement(s) must be agreed by BALLOFFET before placing an order.

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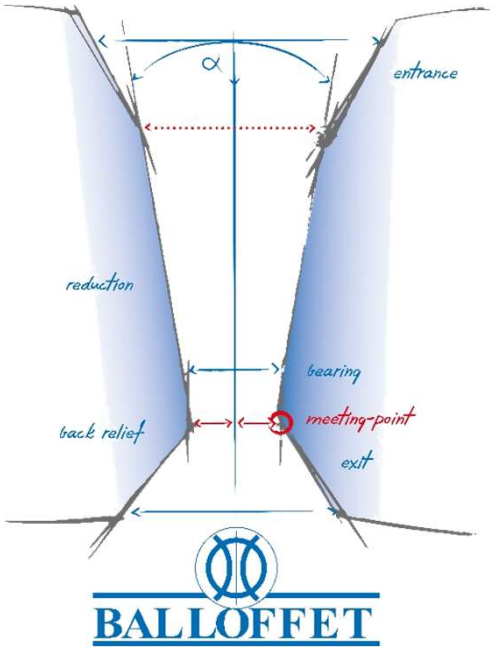
Balloffet technical check list:

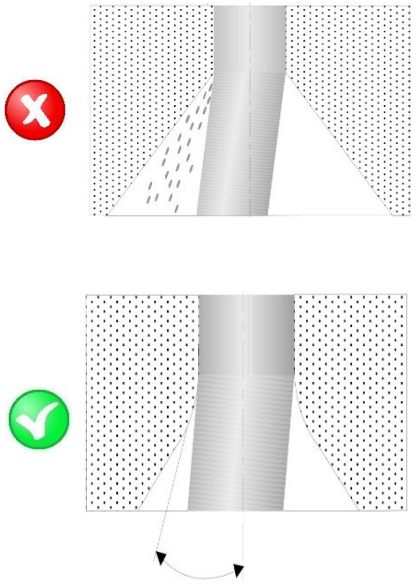
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Potential root cause analysis :



4. Die issues





Balloffet Check list of possible actions :

4 . Securing a premium quality on :

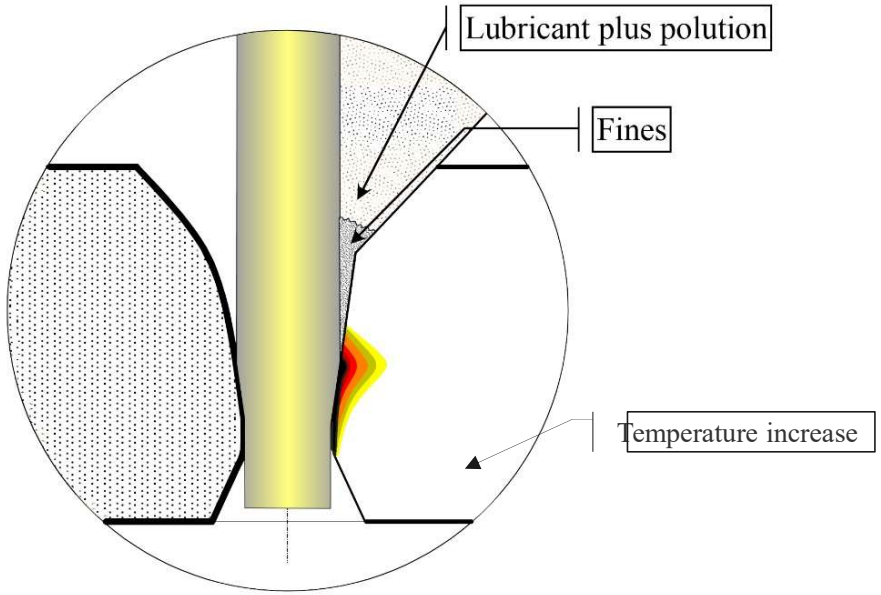
- Die Size Ø with adapted tolerances
- Die geometry
- Die blending
- Mirror polishing
  - same size (from the same position) and
  - inside the same die set in the machine.

Balloffet technical check list:

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Potential root cause analysis :

5 . Lack or incorrect lubrication



Balloffet Check list of possible actions :

5. Necessary to do:

- clean regularly the dies during the process
- controle the process – not producing fines
- lubricate continuously the dies during the process
- cool the dies by the lubrication to avoid thermal shocks.

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Balloffet technical check list:

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Potential root cause analysis :

6. Lack or perfect filtration and die cleaning.







Balloffet Check list of possible actions :

6 . Technical awareness about the necessity to :

- Limit as much as possible the quantity of metallic fines
- Die cleaning (with oriented jet of lubricant) during the drawing process

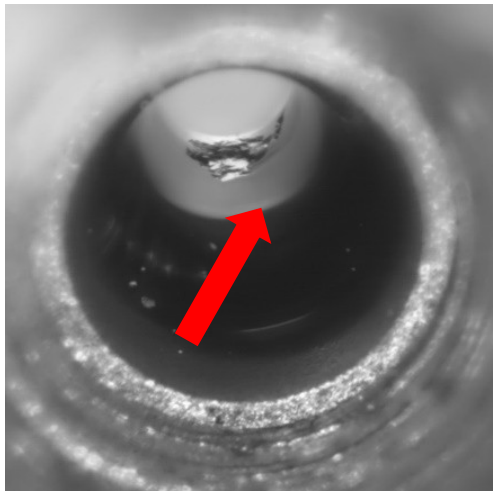
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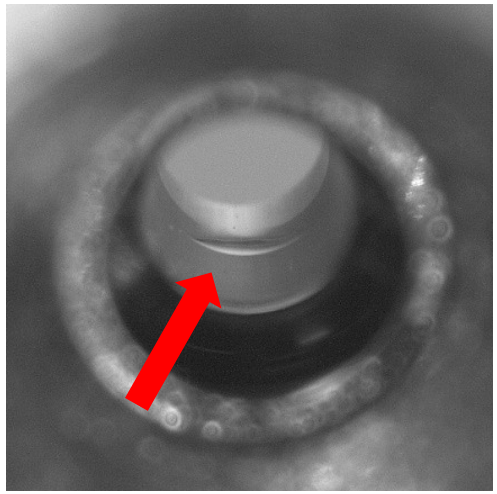
Balloffet technical check list:

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Potential root cause analysis :

7 . Extreme drawing parameters (high speed, ultra-fine sizes, reduced slip,…)





Balloffet Check list of possible actions :

7 . Use the diamond die as a diagnostic tool:

- dies keep some visual records of the drawing conditions:
  - thermal shock
  - diamond pull out
  - impact point
  - orientation problems …

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For more information:

www.balloffetdie.com

For detailed questions:

balloffet@balloffetdie.com

Thanks for your attention

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Christopher Folland
Carl Bechem GmbH

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Technical Manager Wire Drawing

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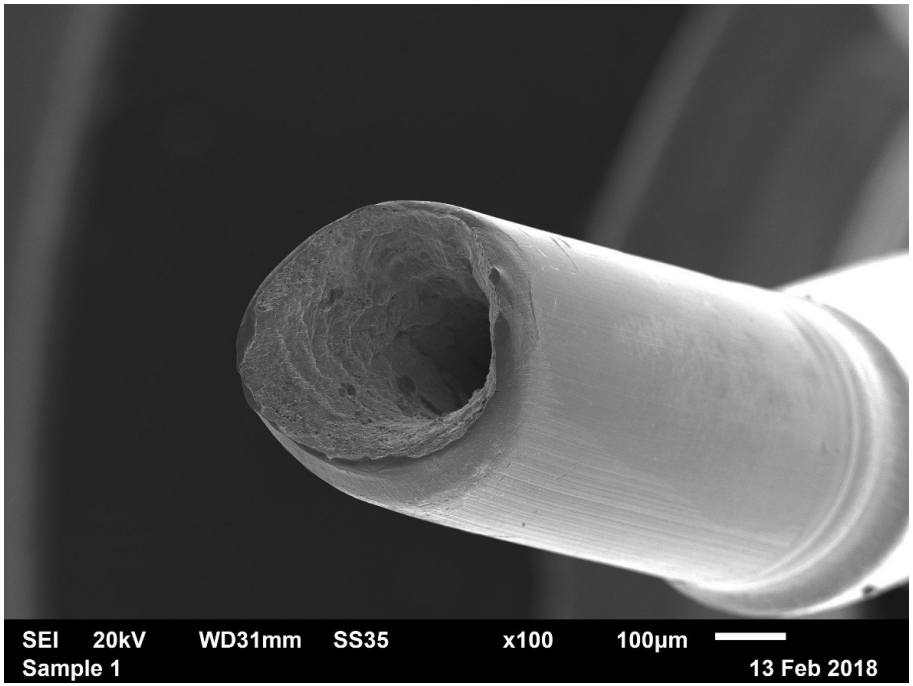
Cup and Cone breaks in relation with lubricants

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Generelly lubricants are not the first thing to point out for cup and cone breaks!

But, there can be breaks, which come from lubrication leaks in previous drawing steps.

Let me explain this on in the following minutes.



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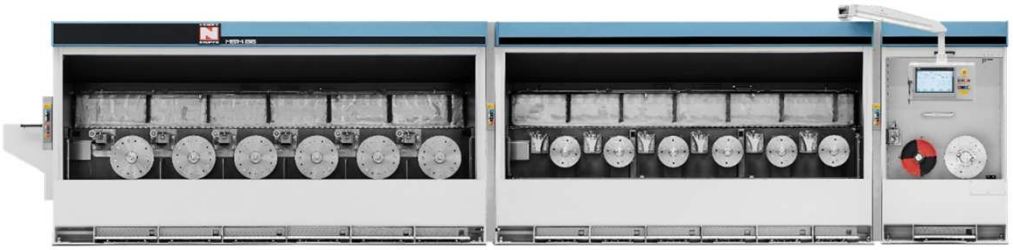
Cup and Cone breaks

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Driving options on a rod break down system

- Typically driven with 12 – 18 % lubricant concentration
- Possible to drive with 5 – 8 % without serious problems in the rod system
- Cost saving calculation:
  - Estimated System of 10 m³ and pricing of Lubricant 5 €/kg (theoretically)

concentration	lubricant volume in liters	cost for set up in €
15%	1500	7500
5%	500	2500
	saving on set up	5.000 €
	+ saving on top up	~ 5.000 €
	annual saving	~ 10.000 €



Picture provided by Niehoff

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CF2
CF3

Cup and Cone breaks

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Impact of these options on the drawn quality

- Rod break down, maybe a little bit slower as usually
- Possible damages on rod wire
- Enhanced wire breaks in multi wire and fine wire drawing



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CF2 Let´s have a look on the Mentimeter results
Christopher Folland; 06.10.2020

CF3 Handover to Stephan
Christopher Folland; 06.10.2020

CF2
CF3

Cup and Cone breaks

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Impact of these options on the drawn quality

- Due to the breaks enhanced machine down time and scrap production
- Please estimate, how the costs would be for these standing times and the additional scrap material in comparison to the enhanced costs for higher concentration.



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Folie 82

CF2 Let´s have a look on the Mentimeter results
Christopher Folland; 06.10.2020

CF3 Handover to Stephan
Christopher Folland; 06.10.2020



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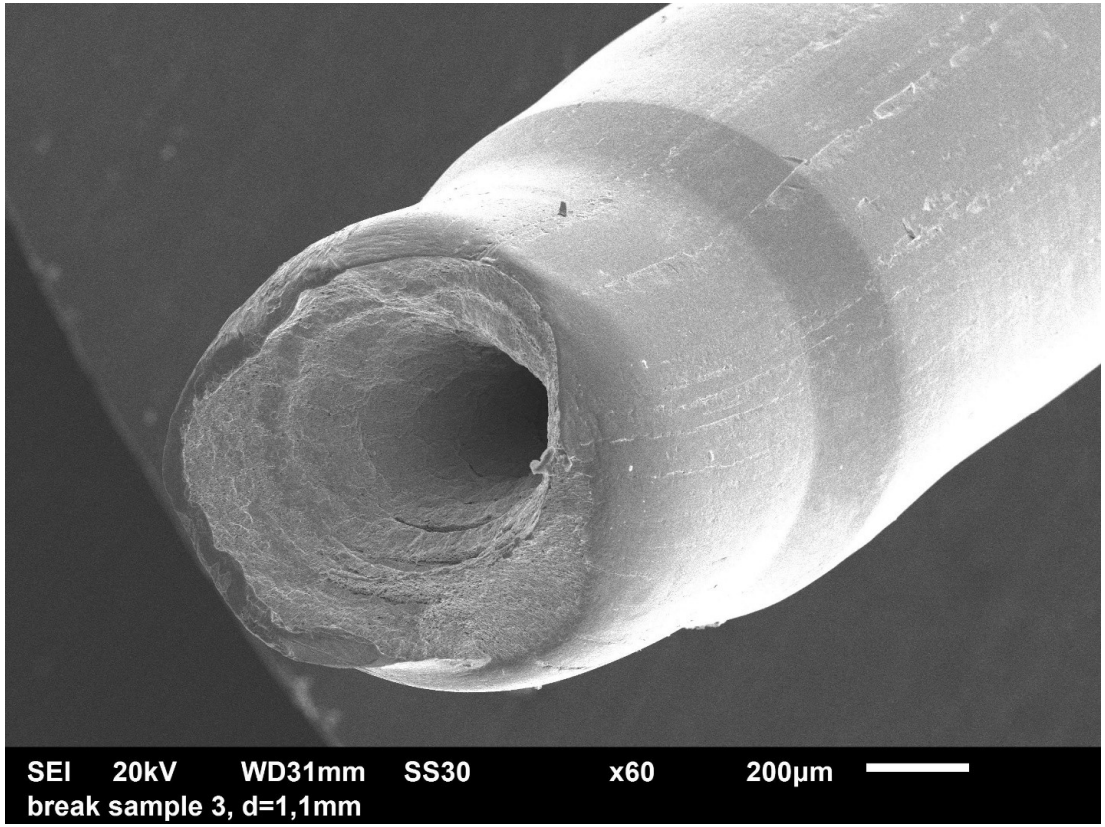
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Welcome to the Virtual NF Wire Forum online event 2020

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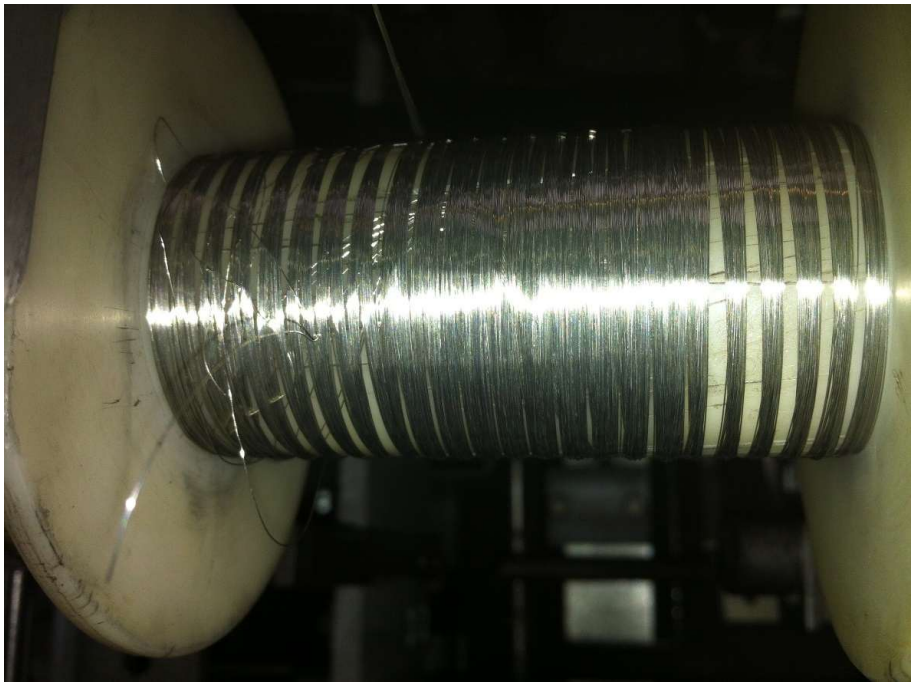


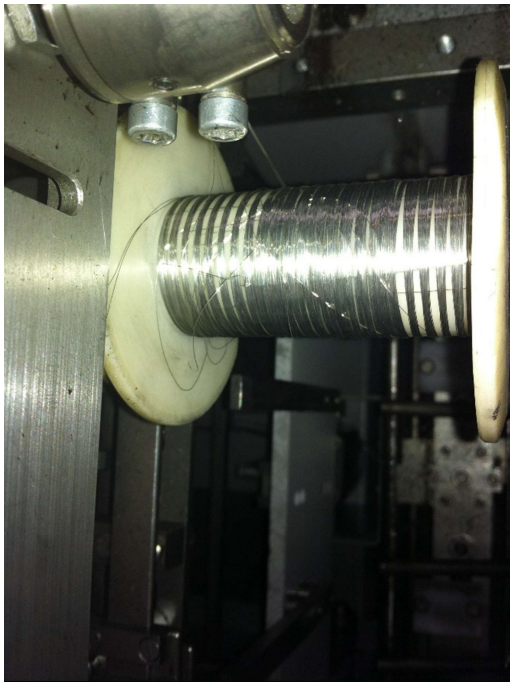
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Wire Breaks in Copper wire Production

NF Wire Forum

Occasional wire breaks are inevitable when drawing wire.



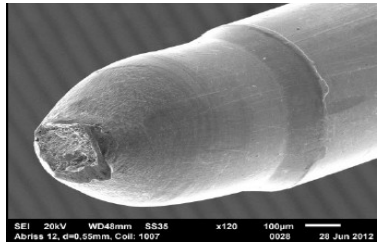


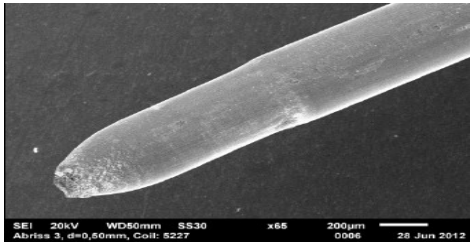
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Wire Breaks in Copper wire Production

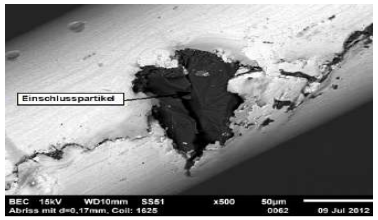
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Tensile Break

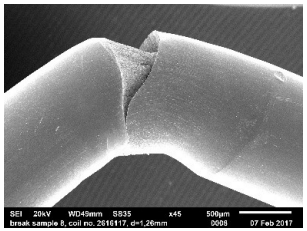




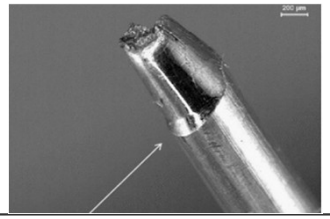
Inclusion Break

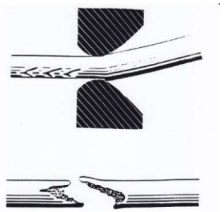


Cup and Cone Break



Wire Break with Surface Damages in Form of Crow's Feet

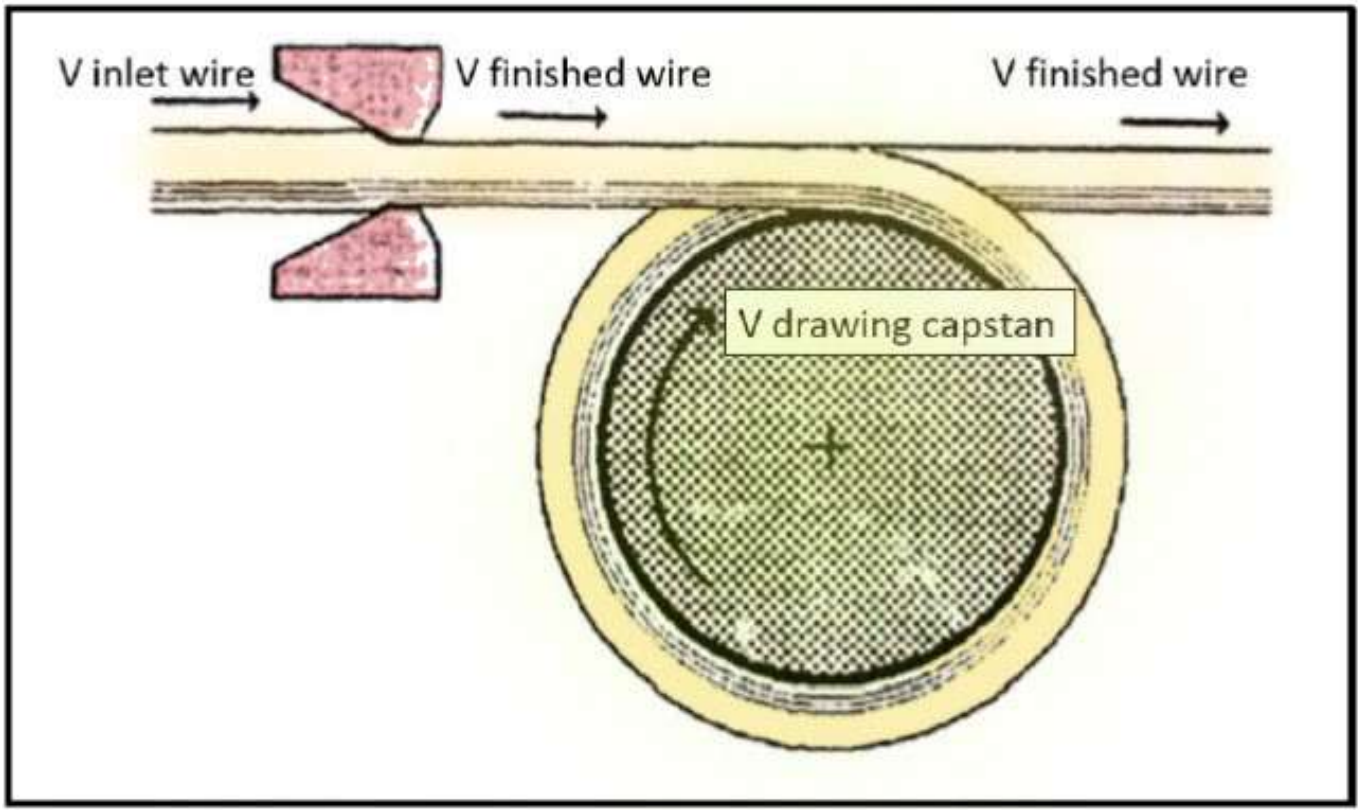




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The Working Principle of the Wire Drawing Systems

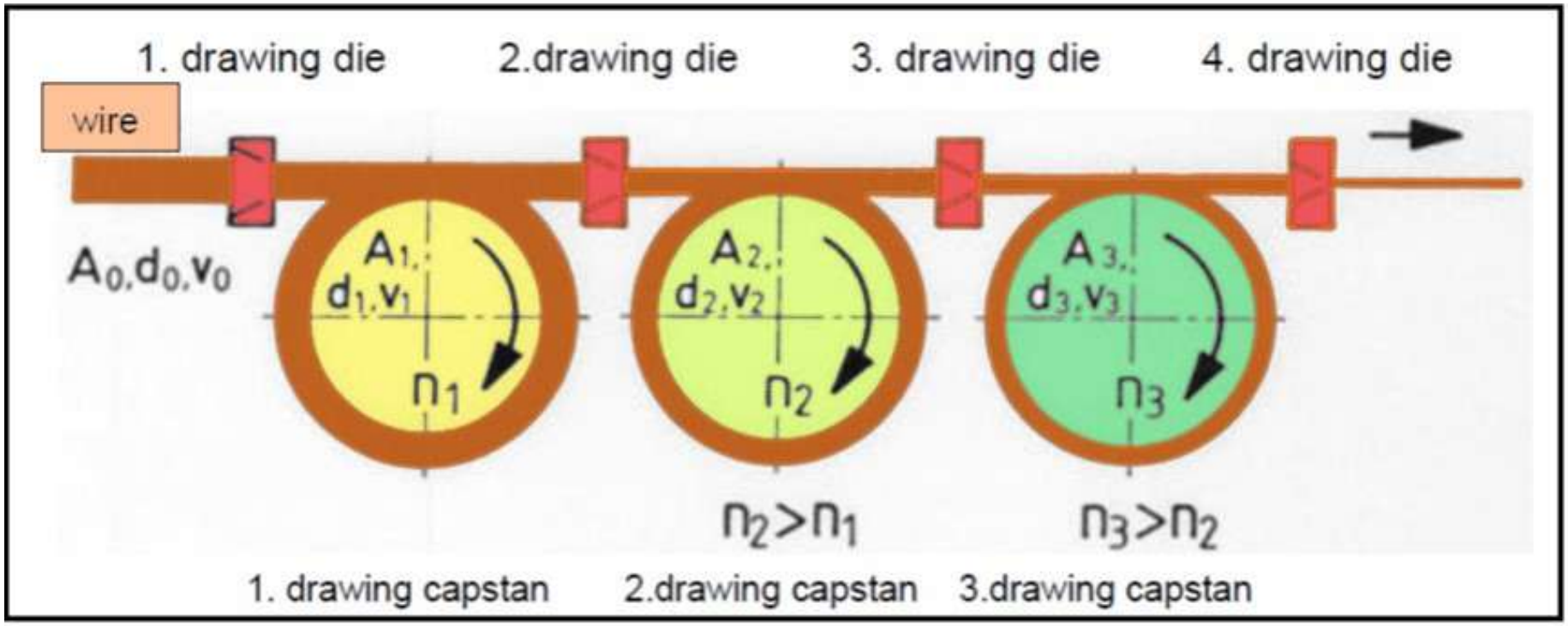
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The Working Principle of the Wire Drawing Systems

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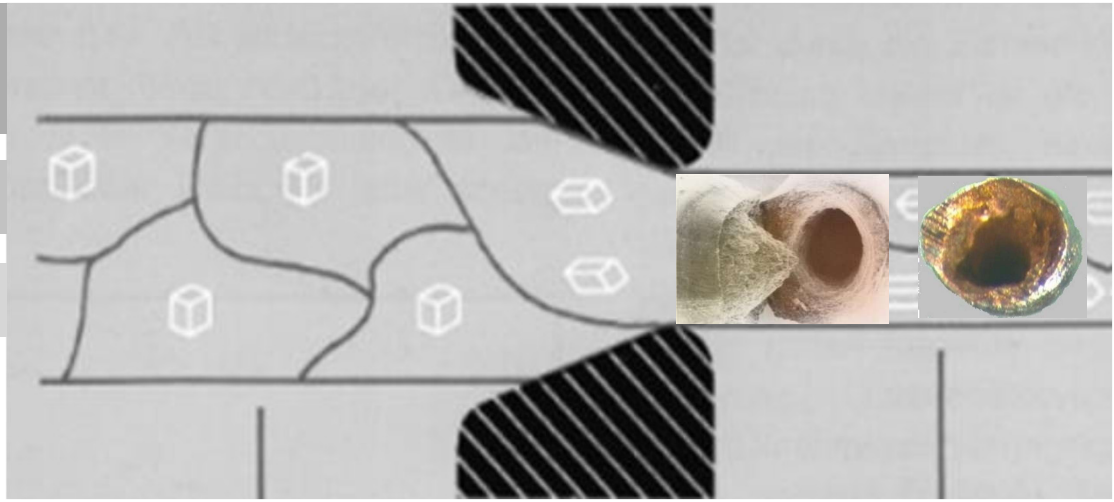
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Cup and Cone Break

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Possible causes for the cup and cone break:

- Combination of large cross-section area reduction and large deformation angels in the die (**die wear**)
- Too strong cross-section area reduction
- Lack of lubrication



In case of high friction in the die, wrong geometrie or too strong cross-section area reduction,

- *the outer skin of the wire is held back,*
- *the center of the wire moves faster,*
- *It comes to cracks in the wire interior.*

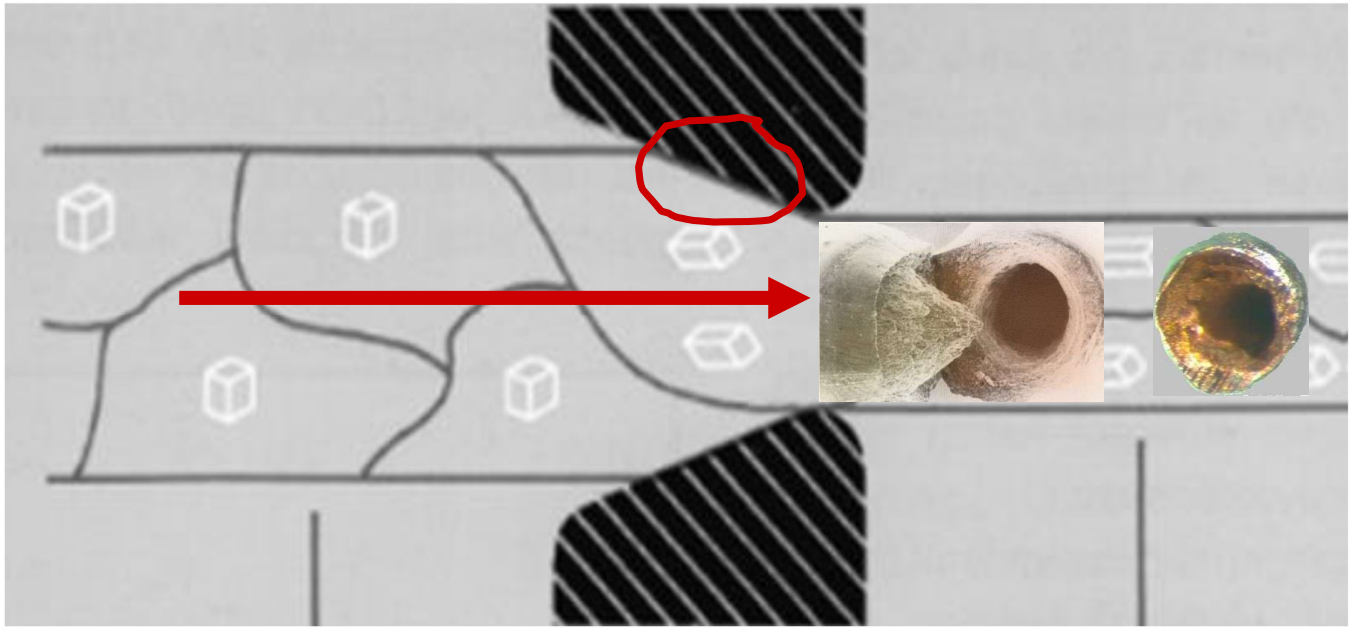
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Cup and Cone Break

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Possible causes for the cup and cone break:

a cup and cone break is caused in the die mostly



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Cup and Cone Break

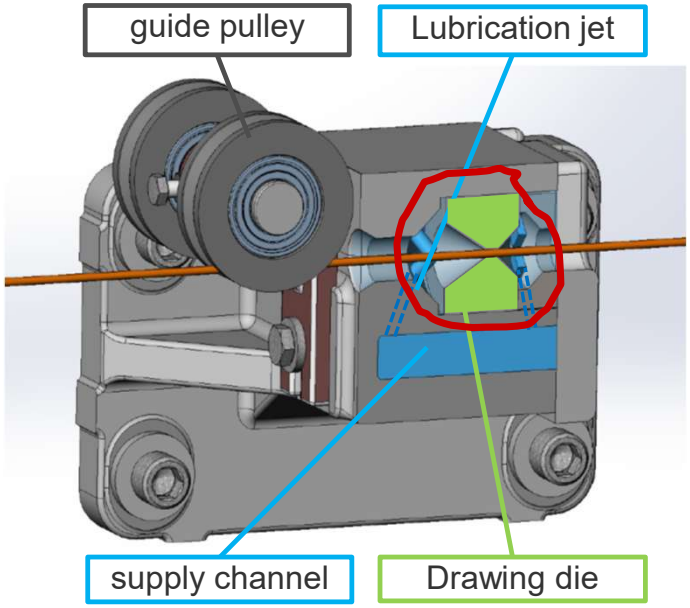
Possible causes for the cup and cone break:

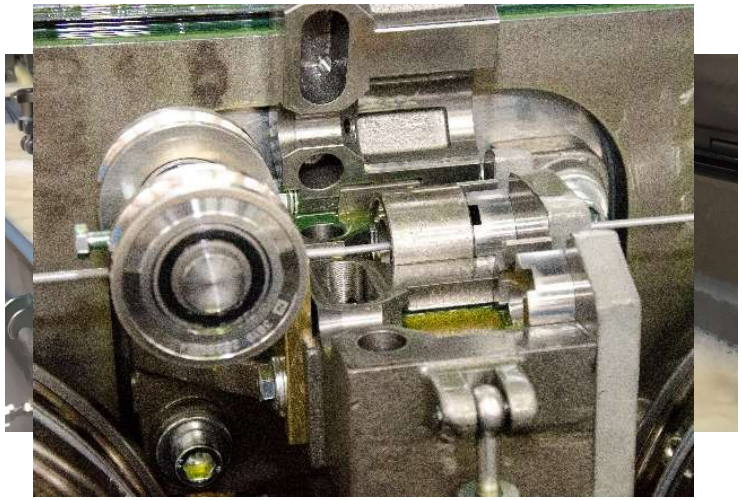
a cup and cone break is caused in the die mostly

damaged die



Drawing die emulsion Pressure circulation in the drawing die holder

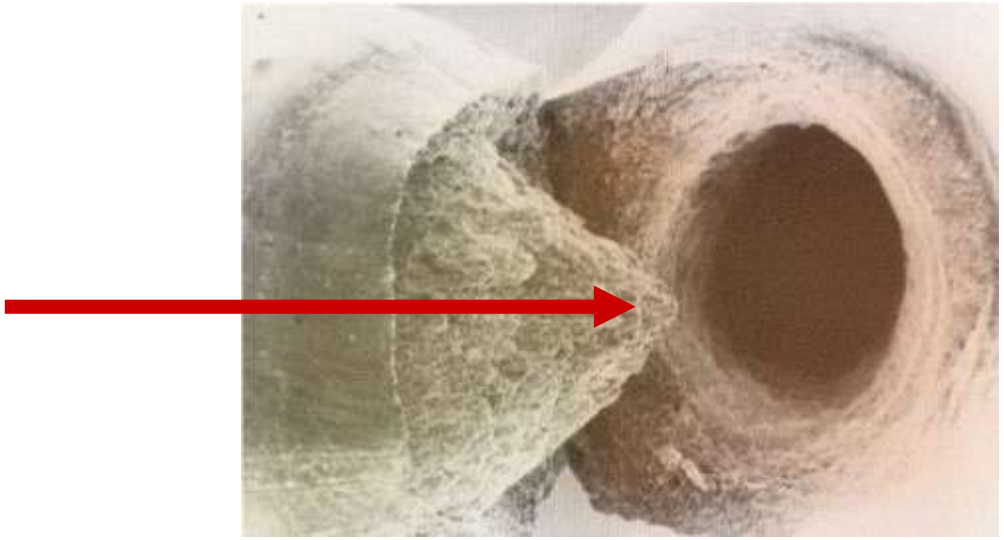




Cup and Cone Break

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The cone tip of the break always shows in the direction of drawing!



Notice: If in a finewire drawing machine (or multiwire machine) the cone tip shows against the drawing direction, then it's a clear indication that the error cause originated in the rod breakdown machine

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Cup and Cone Break



Requirements for trouble-free operation

Qualification of the operator

Careful handling of the machine

Regular inspection of:

- wire,
- drawing dies,
- emulsion,
- drawing cones

Regular cleaning of the machine

Cup and Cone Break

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Requirements for trouble-free operation

bad cones
that need to be replaced

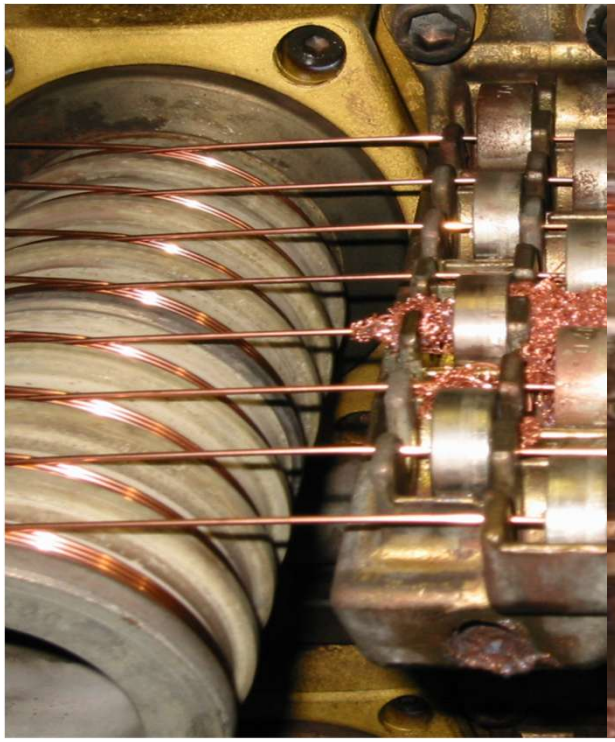


good cones
for optimal results

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Possible causes for a wire break:





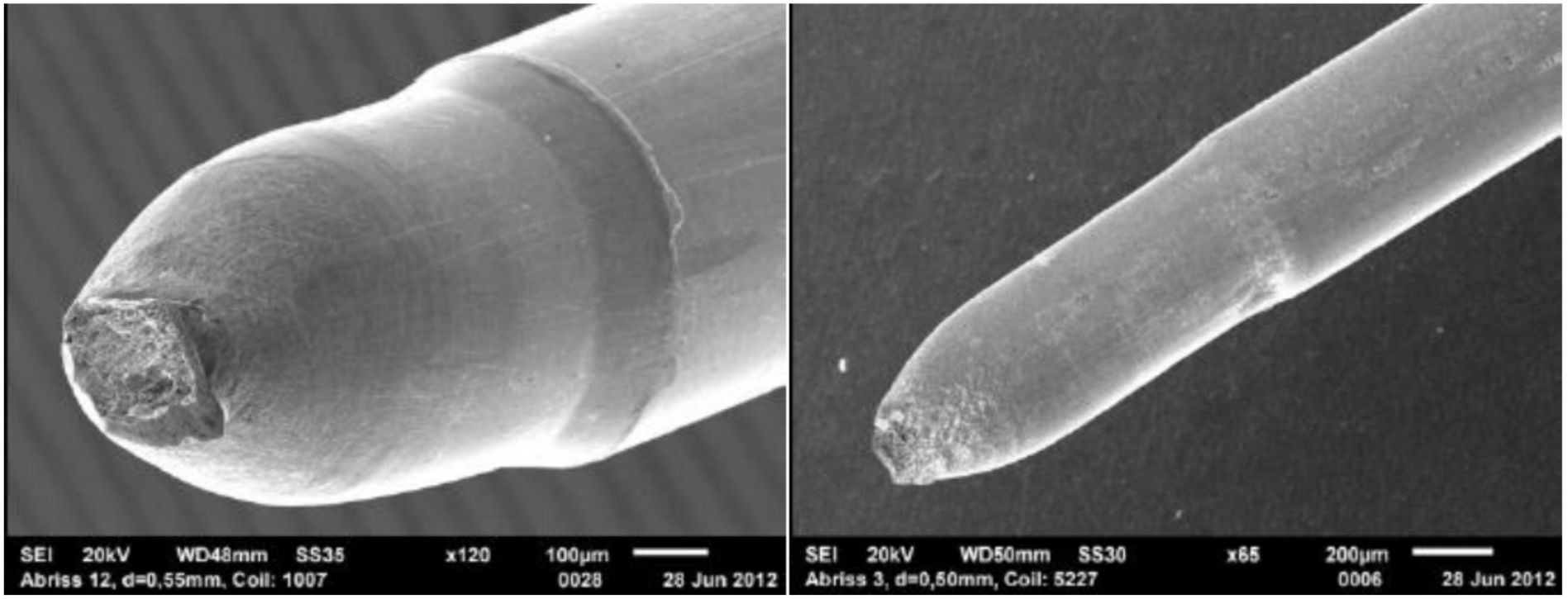


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Cup and Cone Break

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This wire break is not a cup and cone break, it is a tensile break!



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Thank you for your attention!

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What I always wanted to know

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Please post your questions for the upcoming panel discussion.

Go to **www.menti.com** and use the code **92 62 15 3**.

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Physical event planned for Antwerp

NF Wire Forum

Our customers will be invited to NF Wire Forum event in Antwerp, Belgium

March 23rd, 2021



Incl. a plant-tour at AURUBIS' plant in OLEN on March 22nd, 2021

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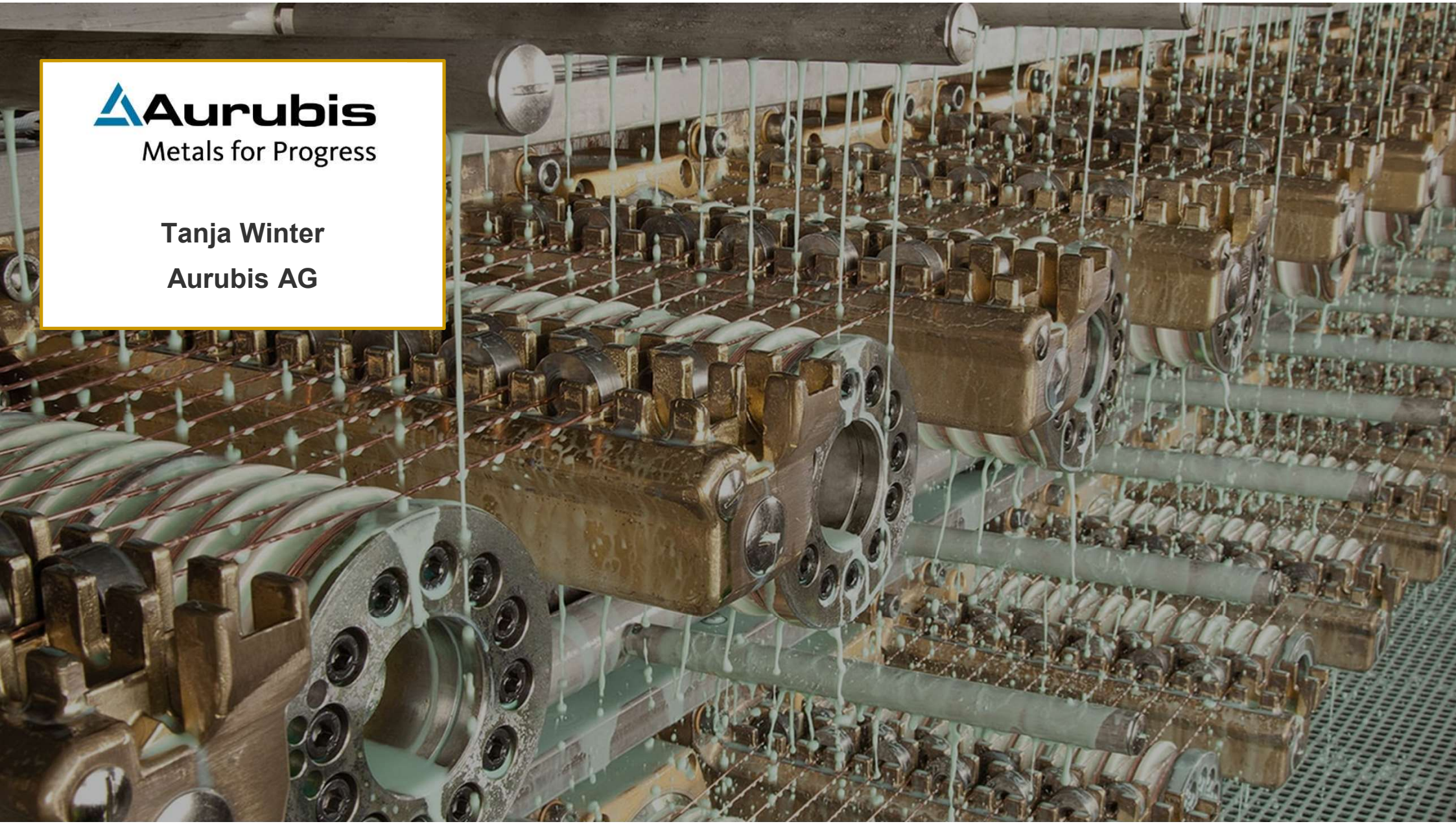
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Berufsverband e.V.