Martensitic Stainless Steels
- a hidden champion?!

International Stainless & Special Steel Summit 2015
Vienna

Marc André Müller
BGH Edelstahlwerke GmbH
Outline

- BGH Edelstahlwerke GmbH
- Martensitic Stainless Steels
- The Stainless Steel long product market
- Trends and applications
- Conclusions
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• BGH Edelstahlwerke GmbH

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• Trends and applications

• Conclusions
We are **EXCELLENCE** in Specialty Steel!

- Five production sites in Germany and one in Poland.

- Worldwide service through regional sales offices and distribution partners.

- Sustainability through continuous investments and long-term partnerships.

- Approx. 2000 employees

- Annual sales: 180000 t
Sales & Applications

- Tool Steel
- Stainless
- Alloy Steel
- Special Alloys

- Oil & Gas
- Chemical Engineering
- Power Generation
- Mechanical Engineering
- Automotive

Excellence in Specialty Steel
BGH Edelstahlwerke GmbH

Production of Stainless Steels

- AOD
- EAF 50 t / 44 t
- VD/VOD
- LF
- HCC
- VAR
- ESR
- PESR
- VIM 7 t
- Ingot casting

- Rolling Billets
  - Bars
  - Wire

- Single drawing
  - Multiple drawing

- Drawing coil - bar

- GFM Flat rolling mill

- Continuous rolling mill

- 2 Forging machines

- 5 Forging presses 10 – 40 MN

- Wet drawing

- Peeling
  - Turning
  - Grinding

- Straightening

- Heat treatment

- Shot blasting
  - Pickling

Excellence in Specialty Steel
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Definitions

„Hidden champion“

- High value / value product
- Diversification through process know how
- Strategic fit to production capabilities
- Applications in several, independent markets
- Long term market / development potential
Definitions

Martensitic Stainless Steels

• **Standard martensitic grades**
  e.g.: X20Cr13, X46Cr13, X50CrMoV15, X90CrMoV18

• **Soft martensitic grades**
  e.g.: X3CrNi13-4, X4CrNiMo16-5-1

• **Precipitation hardening martensitic grades**
  e.g.: X5CrNiCuNb16-4, X5CrNiCuNb15-5-4
Definitions

Martensitics in the world of Stainless Steel

- Martensitic
- Duplex / Super Duplex
- Nickel Alloys
- Austenitic / Super Austenitic

Minimum Yield Strength [MPa] vs. PREN (Cr + 3.3(Mo+0.5W) + 16N)
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## Stainless Steel long products

<table>
<thead>
<tr>
<th>Long Products</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Martensitic STS [kt]</td>
<td>624</td>
<td>654</td>
<td>698</td>
<td>704</td>
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<tr>
<td>STS total [kt]</td>
<td>5162</td>
<td>5329</td>
<td>5646</td>
<td>5666</td>
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</tbody>
</table>

- ≈ 13% of STS long products are martensitic

- CAGR slightly higher than the average of STS long products

Source: SMR GmbH, 2015
Stainless Steel long products

Use of martensitic Stainless Steels by application

- Chemical, Petrochemical & Energy: 41%
- Consumer Goods and Medicals: 21%
- Automotive & Heavy Transport: 19%
- Industrial & Heavy Industry: 14%
- ABC & Infrastructure: 2%
- Others: 3%

Source: SMR GmbH, 2015
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Trends and applications

Oil & Gas Industry

- ≈ 40 % STS long products are martensitic
- 13 % Cr steel are the *working horse*

⇒ Increase yield strength within limits of NACE MR0175

Source: SMR GmbH, 2014
Trends and applications

... but what is beside the Oil & Gas Industry?
# Trends and applications

## Automotive

<table>
<thead>
<tr>
<th>Injector</th>
<th>Valve</th>
<th>Turbocharger</th>
<th>Hydraulic/Pneumatic</th>
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<tbody>
<tr>
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<td>1.4418 (ESR)</td>
<td>1.4748</td>
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</table>

- Higher temperatures
- Higher pressures
- Higher corrosion resistance
- Magnetic properties
## Industry

<table>
<thead>
<tr>
<th>Chemical Industry</th>
<th>Pumps</th>
<th>Cutter knives</th>
<th>Plastic / glass processing</th>
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<tbody>
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<td>1.4418 ESR</td>
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</table>

⇒ Application tailored mechanical properties
# Trends and applications

## Medicals & Lifestyle

<table>
<thead>
<tr>
<th>Chirurgical Instruments</th>
<th>Dental drills</th>
<th>Knifes</th>
<th>Axle / Shafts</th>
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</thead>
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⇒ Cutting capability  
⇒ Edge-holding-property  
⇒ Polishability

Photo: Stahlkrebs
## Energy

<table>
<thead>
<tr>
<th>Turbine blades</th>
<th>Conventional power plants</th>
<th>Hydropower</th>
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<tr>
<td>1.4939</td>
<td></td>
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</tbody>
</table>

⇒ Higher temperatures
⇒ Creep resistance
**Trends and applications**

**Trends – Product Development / Applications**

- Increase yield strength from 13 % Cr grades (up to 140 ksi / 965 MPa)
- Increase toughness from soft martensitic grades (low temperatures)
- Further improvement of microstructure by ingot design, horizontal continuous casting and ESR/VAR remelting
- Nitrogen alloyed grades to increase strength and corrosion resistance
Trends and applications

Trends – Production / Market

• Improved availability from stock for several martensitic grades in many markets

• Cost reduction by innovative production routes (melting, hot forming, heat treatment, machining…)

Excellence in Specialty Steel
Trends and applications

New Straightening- and Peeling Line

Max. bar weight: 25 t
Max. diameter: 610 mm
Max. length: 18 m
Straightness: max. 0.3 mm/m; max. 2 mm/bar
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