HIGH PERFORMANCE MOLD STEELS
FOR INJECTION OF
REINFORCED PLASTICS
Modern industrial parts production in mainly automotive and electronic industries is characterized by the trend to substitute metals by reinforced plastics. Being much lighter and therefore weight-saving, such plastic components help to reduce CO\textsubscript{2} emissions, which is a clear ecologic focus worldwide. Intricate geometries, thin wall-thicknesses and large areas of the parts are characteristics that call for a growing amount of glass or carbon fibers in the plastics to obtain sufficient stability.

Plastics reinforced by fibers tend to be much more abrasive than conventional plastics and thus may cause premature wear of an injection mold. In order to fight excessive and early wear in molds, BÖHLER Edelstahl is offering a wide variety of high-quality tooling steels that are setting new standards in the production of heavy-duty components made from reinforced plastics.
The plastic product

The plastics
REQUIREMENTS AND TRENDS

- New types of high performance plastics (GF, CF, fibre length, filler material)
- Increasing wear resistance requirements on mold material
- Increasing corrosion resistance of mold material
- Complexity of parts increased (light weight construction)
- Increase productivity through shorter cycle times (thermal conductivity)
- Higher closing pressures and working temperatures
Typical failure modes

**Slider in plastic mold**
PA66 + 30% GF
Premature fracture due to low material toughness

**Core Pin - Microstructure**
PBT + 45% GF
Corrosive attack due to insufficient corrosion resistance

**Mold Insert**
PVC + %20 GF
Massive wear on surface due to lack of wear resistance
# BEST APT STEEL GRADES FOR INJECTION OF REINFORCED PLASTICS

## Non corrosion resistant steels

<table>
<thead>
<tr>
<th>BÖHLER grade</th>
<th>Chemical composition (average, %)</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>Cr</td>
</tr>
<tr>
<td><strong>K490</strong></td>
<td>0.45</td>
<td>1.30</td>
</tr>
<tr>
<td><strong>K390</strong></td>
<td>0.36</td>
<td>5.00</td>
</tr>
<tr>
<td><strong>W300</strong></td>
<td>0.36</td>
<td>5.00</td>
</tr>
<tr>
<td><strong>W360</strong></td>
<td>0.38</td>
<td>5.00</td>
</tr>
<tr>
<td><strong>W400</strong></td>
<td>0.50</td>
<td>4.50</td>
</tr>
<tr>
<td><strong>W403</strong></td>
<td>1.10</td>
<td>8.30</td>
</tr>
<tr>
<td><strong>K340</strong></td>
<td>1.40</td>
<td>6.40</td>
</tr>
<tr>
<td><strong>K390</strong></td>
<td>2.50</td>
<td>4.00</td>
</tr>
</tbody>
</table>
## Corrosion resistant steels

<table>
<thead>
<tr>
<th>BÖHLER grade</th>
<th>Chemical composition (average, %)</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>Cr</td>
</tr>
<tr>
<td>M303 EXTRA</td>
<td>0.27</td>
<td>14,50</td>
</tr>
<tr>
<td>M310 PLAST</td>
<td>0.38</td>
<td>14,30</td>
</tr>
<tr>
<td>M333 PLAST</td>
<td>0.28</td>
<td>13,50</td>
</tr>
<tr>
<td>M349 PLAST</td>
<td>0.54</td>
<td>17,30</td>
</tr>
<tr>
<td>M368 MICROCLEAN</td>
<td>0.54</td>
<td>17,30</td>
</tr>
<tr>
<td>M390 MICROCLEAN</td>
<td>1.90</td>
<td>20,00</td>
</tr>
</tbody>
</table>
### MATERIAL SELECTION CRITERIA FOR MOLD-MAKER AND PARTS MANUFACTURER

#### Non corrosion resistant steels*

<table>
<thead>
<tr>
<th>BÖHLER grade</th>
<th>Plastic processed</th>
<th>Content of fiber</th>
<th>Mold hardness</th>
<th>Mold cavity</th>
<th>Mold design</th>
<th>Mold surface requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>BÖHLER K600 ISODUR®</td>
<td>PP, PE, ABS, PS, PC, PA</td>
<td>0 – 15 %</td>
<td>≤ 50 HRC</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
</tr>
<tr>
<td>BÖHLER W300 ISOBLOC®</td>
<td></td>
<td>0 – 20 %</td>
<td>≤ 50 HRC</td>
<td>★★★★★</td>
<td>★★</td>
<td>★★★</td>
</tr>
<tr>
<td>BÖHLER W400 VMR®</td>
<td></td>
<td>0 – 20 %</td>
<td>≤ 52 HRC</td>
<td>★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>BÖHLER W403 VMR®</td>
<td></td>
<td>0 – 30 %</td>
<td>≤ 52 HRC</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>BÖHLER W595 ISOBLOC®</td>
<td>All Thermo and Duroplasts products</td>
<td>0 – 65 %</td>
<td>≤ 57 HRC</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>BÖHLER K340 ISODUR®</td>
<td></td>
<td>0 – 65 %</td>
<td>≤ 62 HRC</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>BÖHLER K490 MICROCLEAN®</td>
<td></td>
<td>0 – 65 %</td>
<td>≤ 64 HRC</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
</tr>
<tr>
<td>BÖHLER K390 MICROCLEAN®</td>
<td></td>
<td>0 – 65 %</td>
<td>≤ 64 HRC</td>
<td>★</td>
<td>★</td>
<td>★★★</td>
</tr>
</tbody>
</table>

*Please note that this table has to be understood as general guideline only. Any deviating individual case has to be discussed separately.

#### Comparison chart – BOHLER Non Corrosion resistant steels

1. **Simple design**
   - Low-Medium Cavities
2. **Highest mold surface requirements**
3. **Abrasive wear resistance**
   - 0 – 15 %
   - 0 – 20 %
   - 0 – 20 %
   - 0 – 30 %
   - 0 – 65 %
   - 0 – 65 %
   - 0 – 65 %
   - 0 – 65 %
   - ≤ 50 HRC
   - ≤ 50 HRC
   - ≤ 52 HRC
   - ≤ 52 HRC
   - ≤ 57 HRC
   - ≤ 59 HRC
   - ≤ 52 HRC
   - ≤ 52 HRC
   - ≤ 62 HRC
   - ≤ 62 HRC
   - ≤ 64 HRC
   - ≤ 64 HRC
   - ≤ 64 HRC
   - ≤ 64 HRC
   - ≤ 65 HRC
   - ≤ 65 HRC
   - ≤ 65 HRC
   - ≤ 65 HRC
   - ≤ 65 HRC
   - ≤ 65 HRC
   - ≤ 65 HRC
   - ≤ 65 HRC
   - ≤ 65 HRC
   - ≤ 65 HRC

- **Mold design**
  - Very complex
  - Complex
  - Medium
  - Advanced
  - Simple

- **Mold cavity**
  - Very deep
  - Deep
  - Medium
  - Low-Medium
  - Low

- **Mold surface requirement**
  - Highest
  - High
  - Good
  - Advanced
  - Standard
## Corrosion resistant steels*

<table>
<thead>
<tr>
<th>BÖHLER grade</th>
<th>Plastic processed</th>
<th>Content of fiber (%)</th>
<th>Mold hardness</th>
<th>Mold cavity</th>
<th>Mold design</th>
<th>Mold surface requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>M303</td>
<td>PP, PE, ABS, PS, PC, PA, PVC, POM</td>
<td>0 – 10 %</td>
<td>≤ 40 HRC</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>M310</td>
<td></td>
<td>0 – 15 %</td>
<td>≤ 50 HRC</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
</tr>
<tr>
<td>M333</td>
<td></td>
<td>0 – 15 %</td>
<td>≤ 50 HRC</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>M340</td>
<td></td>
<td>0 – 55 %</td>
<td>≤ 56 HRC</td>
<td>★★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>M368</td>
<td></td>
<td>0 – 60 %</td>
<td>≤ 56 HRC</td>
<td>★★</td>
<td>★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>M390</td>
<td></td>
<td>0 – 65 %</td>
<td>≤ 62 HRC</td>
<td>★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
</tbody>
</table>

*) Please note that this table has to be understood as general guideline only. Any deviating individual case has to be discussed separately.

### Comparison chart – BÖHLER Corrosion resistant steels

- **BÖHLER M303**
  - **Extra**
  - **ISOPLAST**
  - **M303**
  - **EXTRA**

- **BÖHLER M310**
  - **ISOPLAST**

- **BÖHLER M333**
  - **ISOPLAST**

- **BÖHLER M340**
  - **ISOPLAST**

- **BÖHLER M368**
  - **MICROCLEAN**

- **BÖHLER M390**
  - **MICROCLEAN**

**Mold design**
- Very complex
- Complex
- Medium
- Advanced
- Simple

**Mold cavity**
- Very deep
- Deep
- Medium
- Low-Medium
- Low

**Mold surface requirement**
- Highest
- High
- Good
- Advanced
- Standard

**Maximal Content of Fiber (%)**
- 10 %
- 65 %
3 QUALITY LEVELS – 3 TECHNOLOGIES

PESR Manufacture

Improved service life due to:
- The least possible inclusion content
- Lower micro and macro segregation
- Good homogeneity and a higher degree of purity
- A homogenic structure throughout the entire cross-section and bar length
- Producing larger bar dimensions at a constant carbide distribution
- Uniform size change
- A broad range of application owing to a high degree of toughness

Microstructure of 8% chromium steel in ESR grade

VAR Manufacture

Material properties:
- Minimum gas contents
- Reduction of trace elements such as Pb, Bi, Te, As, Sn, Sb
- Minimum microsegregations in the ingot centre
- Low susceptibility to the formation of freckles (segregations)
- Highly precise chemical analysis
- High cleanliness

K455 VMR technology
Materials produced using powder metallurgy are increasingly being used to meet the most stringent requirements with various processing methods. These materials offer properties that meet demanding requirements:

- No segregation
- Extremely fine carbide distribution
- Homogeneous properties
- High wear resistance
- Very good dimensional stability
- High compressive strength
- High toughness with high hardness

**Production routes for BÖHLER MICROCLEAN**

1. Melting
2. Atomising
3. Filling capsules
4. Seal welding
5. HIP (Hot Isostatic Pressing)
Your partner: BÖHLER International GmbH
DC Tower, Donau-City-Straße 7
1220 Vienna, Austria
Phone: +43-50304 30-23100
Fax: +43-50304 70-23308
E-Mail: exportsales@bohler-international.com
www.bohler-international.com

The data contained in this brochure is merely for general information and therefore shall not be binding on the company. We may be bound only through a contract explicitly stipulating such data as binding. Measurement data are laboratory values and can deviate from practical analyses. The manufacture of our products does not involve the use of substances detrimental to health or to the ozone layer.