FROM CONCEPT TO COMPONENT

Additive Manufacturing
The next dimension in tooling for the plastic injection moulding industry
ADDITIVE MANUFACTURING
THE NEXT DIMENSION IN PIM TOOLING

For decades we have been recognized as a global leader in the manufacture and the supply of high performance tool steels for the plastic injection molding (PIM) industry, as a result we understand the unique production challenges our customers face.

Customer intimacy and technical understanding are essential factors when developing successful additive manufacturing solutions, as a result our attention to detail goes far beyond 3D printing.

Working together with our customers, using our state-of-the-art additive manufacturing and materials know how, we develop tailor-made AM solutions optimized specifically for the plastic injection molding industry.

Your trusted AM partner

OPTIMIZED DESIGN

Unique tools require unique solutions. We support our customers through a detailed consultation process to develop the right solution for the right application. Supporting the manufacturing process from initial concept through to functional parts. Where needed our PIM experts can help our customers re-design tools according to the exact requirements of their application.

Our data driven approach to cooling design analyses processing parameters and mechanical loads to develop detailed computer models of the customer process. This method of optimizing thermal management is essential to ensure the right balance between efficient cooling and the mechanical performance of the tool.

This process goes far beyond regular conformal cooling channel design. We provide you with optimized cooling performance.

We understand PIM.
We ensure the highest possible part quality, reliability and consistency by managing every step of the value chain from powder production to the delivery. Whether for a single part order or series production, our internal quality systems ensure we meet your requirements every time.

We use state-of-the-art tools to continually improve and refine our internal printing processes. Design of Experiments, Statistical Process Control, and Process Monitoring form the basis of our methodology. Continued innovation from our AM and materials groups ensures we deliver superior material properties in the most demanding applications. As a result, our customers can put parts into service with the highest degree of confidence.

We understand the interactions between laser and material. This deep understanding of AM and PIM allows customers to add value to their business and realize competitive advantage.
Our long history of developing materials for the plastic injection molding industry, ensures the powders used to print your tooling inserts are of the highest quality and will deliver superior tool life. Our AM powders are designed and manufactured by the same experts responsible for our class leading tool steels.

### Optimized Powder

Designed for tooling applications, where corrosion resistance is needed
- Corrosion resistant
- Recommended hardness 45 to 52 HRC

#### IN SHORT

<table>
<thead>
<tr>
<th>Grade</th>
<th>Achievable hardness</th>
<th>Corrosion resistance</th>
<th>Wear resistance</th>
<th>Polishability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2083 ESU</td>
<td>52 HRC(^5)</td>
<td>**</td>
<td>***</td>
<td>****</td>
</tr>
<tr>
<td>Uddeholm Corrax(^\circ) for AM</td>
<td>50 HRC(^5)</td>
<td>**</td>
<td>***</td>
<td>****</td>
</tr>
<tr>
<td>BÖHLER M789 AMPO</td>
<td>52 HRC</td>
<td>**</td>
<td>***</td>
<td>****</td>
</tr>
<tr>
<td>1.2343 ESU</td>
<td>53 HRC</td>
<td>/</td>
<td>***</td>
<td>****</td>
</tr>
<tr>
<td>BÖHLER W722 AMPO (~1.2709)</td>
<td>54 HRC</td>
<td>/</td>
<td>**</td>
<td>****</td>
</tr>
<tr>
<td>BÖHLER W360 AMPO</td>
<td>57 HRC</td>
<td>/</td>
<td>**</td>
<td>****</td>
</tr>
</tbody>
</table>

### Chemical Composition\(^1\)

<table>
<thead>
<tr>
<th>Grade</th>
<th>C</th>
<th>Cr</th>
<th>Ni</th>
<th>Mo</th>
<th>Al</th>
<th>Co</th>
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</thead>
<tbody>
<tr>
<td>Uddeholm Corrax(^\circ) for AM</td>
<td>0.03</td>
<td>12.0</td>
<td>9.2</td>
<td>1.4</td>
<td>1.6</td>
<td>free</td>
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<tr>
<td>BÖHLER M789 AMPO</td>
<td>0.02</td>
<td>12.2</td>
<td>10</td>
<td>1</td>
<td>0.6</td>
<td>1</td>
</tr>
<tr>
<td>BÖHLER W360 AMPO</td>
<td>0.50</td>
<td>0.20</td>
<td>0.25</td>
<td>4.5</td>
<td>3.00</td>
<td>0.55</td>
</tr>
</tbody>
</table>

### Mechanical Properties

Based on our own optimized printing parameters we can ensure superior mechanical properties of the printed parts

<table>
<thead>
<tr>
<th>Grade</th>
<th>Properties(^2)</th>
<th>Tensile strength(^3) [MPa]</th>
<th>Yield strength(^3) [MPa]</th>
<th>Elongation at break(^3) [%]</th>
<th>Notch impact energy(^4) [J]</th>
</tr>
</thead>
<tbody>
<tr>
<td>BÖHLER W360 AMPO</td>
<td>54-56 HRC(^5)</td>
<td>2000 - 2100</td>
<td>1600 - 1800</td>
<td>4 - 6%</td>
<td>★★★</td>
</tr>
<tr>
<td>BÖHLER M789 AMPO</td>
<td>52 HRC</td>
<td>1800 - 1900</td>
<td>1700 - 1800</td>
<td>7 - 10%</td>
<td>★★★</td>
</tr>
<tr>
<td>Uddeholm Corrax(^\circ) for AM</td>
<td>50 HRC</td>
<td>1700 - 1750</td>
<td>1600 - 1700</td>
<td>6 - 8%</td>
<td>★★★</td>
</tr>
</tbody>
</table>

1. BÖHLER W360 AMPO and BÖHLER M789 AMPO are brands of voestalpine Böhler Edelstahl GmbH & Co KG. Uddeholm Corrax\(^\circ\) for AM is a brand of Uddeholms AB. The chemical compositions & processing is protected by registered intellectual property rights.
2. All mechanical properties measured were from specimens with a relative density ~99.9%
3. Tensile test performed according to method DIN EN ISO 6892-1B, specified by VDI 3405 Part 2 at room temperature, the specimens were built according to DIN EN ISO 50125;
4. Charpy V-notch test according to DIN EN ISO 148-1 at 20°C;
5. Hardness test performed according to DIN EN ISO 6508-1
POLISHABILITY

Polishability is a hugely important factor in the PIM industry. The resulting polishability of the printed material depends on a number of factors such as the printing parameters and the quality of the powder. We have optimised our printing and powder manufacturing processes to ensure our printed inserts can be polished to meet SPI industry standards.

WEAR RESISTANCE COMPARISON
HOUSEHOLD COMPONENT GEARS

Our support does not end with the delivery of additive manufactured inserts. It goes far beyond that. Every tool has a certain lifetime and fails at some point. We analyse and examine your failed tool inserts to determine the cause of damage. For example, a crack can have many different causes. Only those who know the cause can take the necessary action to extend the service life and to solve the problem.

Top: Fracture surface and further cracks (longitudinal view; image from light optical microscope)
Bottom: Light microscope image of several corrosion spots in cross section

Wear and abrasion can be a significant problem when processing glass fibre impregnated plastics. Processing of household component gears made of PA66 + 35GF can be a particular challenge for traditional tool steels. In a recent customer case study BÖHLER W360 AMPO showed superior wear resistance when compared to 1.2343 ESU. The resulting tool life was increased by >300%.
Our three-pillared approach to additive manufacturing has shown to deliver significant performance improvements to our PIM customers across a range of applications.

**CUSTOMER CASE STUDIES**

**Application: insert for medical container**
- Cycle time reduction
- Performance compared to conventional cooled design:
  - Cooling time: -15%
  - Cycle time: -8%

**Application: flat iron - handle**
- Cycle time reduction
- Life time
- Performance compared to conventional design:
  - Cycle time: -2.5 sec.
  - Life time: +40% still running

**Application: insert for washing machine**
- Cycle time reduction
- Performance compared to CuBe inserts:
  - Cooling time: -12%
  - Cycle time: -8%

**Application: insert for engine housing**
- Cycle time reduction
- Life time improvement
- Performance compared to conventional cooled design:
  - Cycle time: -11%
  - Life time: +80%
  - Optimized PVD Coating applied
TAILORMADE SOLUTIONS

OPTIMIZED DESIGN. OPTIMIZED PRINTING. OPTIMIZED POWDER. OPTIMIZED FOR YOU.

As a global steel and technology leader, we offer the full suite of production technologies and services across the value chain. Starting with alloy development and powder production, through to design, manufacturing, heat treatment and post-processing. voestalpine AM solutions can be easily combined with premium PVD coatings (e.g. DLC coatings).

We offer the end-to-end solutions with the goal of being your trusted and reliable business partner. We deliver tailor-made solutions from concept to component.

FROM CONCEPT TO COMPONENT

Optimised design which fits to your requirements
Optimised printing with highest possible quality, reliability and economic efficiency
Optimized powder for your application
» Tailormade solution
» Application consulting
» Failure analysis

Metal Powder  Parameter Development  Design/Simulation  Additive Manufacturing
Heat Treatment  Machining  PVD Coating  Inspection/Testing