By applying a protective layer of powder consumable, it is possible to prolong the operating life of new parts and to refurbish worn. Thus, there is a huge potential for cost savings and minimising downtimes. In order to achieve the best results, it is vital to have a thorough knowledge about how to optimise the combination of powder consumable, process and surfacing treatment technique.

Höganäs’ product portfolio consists of a wide range of powder consumables suitable for all surfacing techniques. The focus of this brochure is on overlay welding and thermal spraying techniques for reconditioning:

- Advancing overlay welding techniques
- Plasma Transferred Arc Welding (PTAW)
- Laser cladding
- Thermal spraying
- Höganäs powders and services
- Quick guide to Höganäs’ powders

Marine engine applications need regular maintenance as a result of wear and corrosion. At some point of time, the parts even have to be replaced by new parts.

Höganäs Marine Solutions

Play an Important Protective Role

Marine engine applications need regular maintenance as a result of wear and corrosion. At some point of time, the parts even have to be replaced by new parts.

By applying a protective layer of powder consumable, it is possible to prolong the operating life of new parts and to refurbish worn. Thus, there is a huge potential for cost savings and minimising downtimes. In order to achieve the best results, it is vital to have a thorough knowledge about how to optimise the combination of powder consumable, process and surfacing treatment technique.

Höganäs’ product portfolio consists of a wide range of powder consumables suitable for all surfacing techniques. The focus of this brochure is on overlay welding and thermal spraying techniques for reconditioning:

- Advancing overlay welding techniques
- Plasma Transferred Arc Welding (PTAW)
- Laser cladding
- Thermal spraying
- Höganäs powders and services
- Quick guide to Höganäs’ powders

Figure 1 Overlay welding of shaft

Play an Important Protective Role

Marine engine applications need regular maintenance as a result of wear and corrosion. At some point of time, the parts even have to be replaced by new parts.

By applying a protective layer of powder consumable, it is possible to prolong the operating life of new parts and to refurbish worn. Thus, there is a huge potential for cost savings and minimising downtimes. In order to achieve the best results, it is vital to have a thorough knowledge about how to optimise the combination of powder consumable, process and surfacing treatment technique.

Höganäs’ product portfolio consists of a wide range of powder consumables suitable for all surfacing techniques. The focus of this brochure is on overlay welding and thermal spraying techniques for reconditioning:

- Advancing overlay welding techniques
- Plasma Transferred Arc Welding (PTAW)
- Laser cladding
- Thermal spraying
- Höganäs powders and services
- Quick guide to Höganäs’ powders

Figure 1 Overlay welding of shaft
Welding techniques for achieving metallic coating layers are characterised by metallurgical bonding to the substrate. It is very important to be able to control the process and minimise coating dilution by the substrate. This ensures the coating layer surface achieves the specific properties required.

For overlay welding, coating layer thickness can vary a lot depending on the technique but it should always achieve the thickness and chemical composition required. Care must be taken to avoid excessive substrate temperatures which can lead to deformation and other undesirable effects.

**Why use advanced overlay welding techniques?**

Conventional overlay welding techniques such as Metal Inert Gas (MIG/GMAG), Tungsten Inert Gas (TIG) and Submerged Arc Welding (SAW) have been and are still being successfully applied to a wide range of applications. However, a series of drawbacks, mainly associated with their high heat input to the workpiece, can compromise the result or prohibit their use in some cases.

Advanced overlay welding techniques such as Plasma Transferred Arc Welding (PTAW) and laser cladding provide excellent opportunities to improve production and reconditioning capabilities, reduce costs and enhance reliability.

**Wear and corrosion**

There are many forms of wear, from abrasive and adhesive to erosive that occur in the maritime environment. Metal to metal wear that occurs between valves and valve seats is one example. Typically these surfaces are coated to extend the service interval. Höganäs’ wear laboratory supports our efforts to supply high wear resistant materials.

Applications working in corrosive environments, for instance tail shafts that come in contact with sea water, require particular protection. A non-porous coating layer without defects or cracks, deposited with a material with excellent corrosion resistance, can significantly minimise the risk of corrosion. The general influence of the alloying content on corrosion resistance is illustrated in Figure 2. Pitting corrosion is of particular interest in sea water environments. The performance of a Co-based material (2528-00) is compared to a typical stainless steel (316L) in Figure 3.

---

**Figure 2** Ni, Cr, Mo and Cu improve corrosion resistance, C and B reduce it.

**Figure 3** Corrosion data comparison for 316L and 2528 laser cladded depositions.
PTAW

PTAW enables a metallic bonding with the base material with minimal dilution of the substrate (recommended 5-15%). A collimated stream of gas in the plasma state (20000K) provides the heat required to melt the filler and substrate materials. The gas, typically Argon, is excited inside the welding torch by flowing through an arc formed between a tungsten electrode and a water-cooled copper nozzle.

With the aid of a potential difference between the torch and the substrate, the excited gas is driven to the substrate. Powder filler metal is provided coaxially with the nozzle where it is preheated by the plasma gas and flows to the melt pool on the surface of the base material. Shielding gas is also provided coaxially for the protection of the molten materials.

Applications

Marine exhaust valve spindles/seats | Co-based hardfacing alloys and Ni-based super alloys are widely used by OEM part manufacturers and reconditioning centres.

Marine valve seats | For applications requiring excellent corrosion and wear resistance, such as valves operating at high temperatures and requiring metal-to-metal sealing.

Pipes and pumping system parts | The lower dilution levels of PTAW offer a good alternative to TIG with hotwire filler material feed.

Main benefits:

- High energy concentration and low heat input to substrate
- Reduced residual stress and distortion
- Low hydrogen technique compared to SAW
- Excellent control of welding bead geometry
- Good process repeatability
- Easy CNC integration
- Suitable with a wide range of filler metals such as cobalt-, nickel-, and iron-based materials as well as carbide cermets

Figure 4 Marine valve seat (left) and valve (right). Photo courtesy of Abanqobi Spares, South Africa.

<table>
<thead>
<tr>
<th>Powder grade</th>
<th>Particle size µm</th>
<th>C %</th>
<th>Co %</th>
<th>Cr %</th>
<th>Mn %</th>
<th>Si %</th>
<th>B %</th>
<th>Ni %</th>
<th>Mo %</th>
<th>Fe %</th>
<th>W %</th>
<th>Others %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nickel-base</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>625</td>
<td>53-150</td>
<td>≤ 0.03</td>
<td>-</td>
<td>21.5</td>
<td>-</td>
<td>0.40</td>
<td>-</td>
<td>Bal.</td>
<td>9.0</td>
<td>1.4</td>
<td>-</td>
<td>Nb = 3.8</td>
</tr>
<tr>
<td>718</td>
<td>53-150</td>
<td>&lt; 0.04</td>
<td>Max 1.0</td>
<td>18.0</td>
<td>-</td>
<td>Max 0.35</td>
<td>-</td>
<td>Bal.</td>
<td>3.0</td>
<td>19.0</td>
<td>-</td>
<td>Al = 0.3</td>
</tr>
<tr>
<td>1540-00</td>
<td>53-150</td>
<td>0.25</td>
<td>-</td>
<td>7.5</td>
<td>-</td>
<td>3.5</td>
<td>1.6</td>
<td>Bal.</td>
<td>-</td>
<td>2.5</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>1550-00</td>
<td>53-150</td>
<td>0.45</td>
<td>-</td>
<td>11.0</td>
<td>-</td>
<td>3.9</td>
<td>2.3</td>
<td>Bal.</td>
<td>-</td>
<td>2.9</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>Cobalt-base</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2528-00</td>
<td>53-150</td>
<td>0.25</td>
<td>Bal.</td>
<td>27.0</td>
<td>-</td>
<td>1.0</td>
<td>-</td>
<td>2.8</td>
<td>5.5</td>
<td>1.5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2537-00</td>
<td>53-150</td>
<td>1.1</td>
<td>Bal.</td>
<td>28.5</td>
<td>-</td>
<td>1.0</td>
<td>-</td>
<td>1.5</td>
<td>-</td>
<td>1.5</td>
<td>4.4</td>
<td>-</td>
</tr>
<tr>
<td>2537-10</td>
<td>53-150</td>
<td>1.3</td>
<td>Bal.</td>
<td>28.5</td>
<td>-</td>
<td>1.0</td>
<td>-</td>
<td>1.5</td>
<td>-</td>
<td>1.5</td>
<td>4.4</td>
<td>-</td>
</tr>
<tr>
<td>2541-00</td>
<td>53-150</td>
<td>1.4</td>
<td>Bal.</td>
<td>28.5</td>
<td>-</td>
<td>1.1</td>
<td>-</td>
<td>1.5</td>
<td>-</td>
<td>1.0</td>
<td>8.0</td>
<td>-</td>
</tr>
<tr>
<td><strong>Iron-base</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>316L</td>
<td>53-150</td>
<td>≤ 0.03</td>
<td>-</td>
<td>17.0</td>
<td>1.5</td>
<td>0.8</td>
<td>-</td>
<td>12.0</td>
<td>2.5</td>
<td>Bal.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>420S</td>
<td>53-150</td>
<td>0.25</td>
<td>-</td>
<td>13.0</td>
<td>1.2</td>
<td>0.5</td>
<td>-</td>
<td>&lt;1.0</td>
<td>-</td>
<td>Bal.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>410L</td>
<td>53-150</td>
<td>≤ 0.03</td>
<td>-</td>
<td>12.5</td>
<td>0.1</td>
<td>0.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Bal.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3533-00</td>
<td>53-150</td>
<td>1.75</td>
<td>-</td>
<td>28.0</td>
<td>0.8</td>
<td>1.3</td>
<td>-</td>
<td>16.0</td>
<td>4.5</td>
<td>Bal.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3533-10</td>
<td>53-150</td>
<td>2.1</td>
<td>-</td>
<td>28.0</td>
<td>1.0</td>
<td>1.2</td>
<td>-</td>
<td>11.5</td>
<td>5.5</td>
<td>Bal.</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Laser Cladding

Laser cladding, a process currently gaining momentum, achieves minimal dilution (<5%) by precisely controlling thermal input. Minimal heat input to the part gives higher welding quality and efficiency. To melt the substrate and filler metals, a high power laser beam is used. This allows a higher energy concentration in comparison to an arc.

All injected energy is confined within a small spot with no diffusion due to convection from hot gas or electromagnetic forces taking place. The filler metal can be added by pre-placing on the workpiece and welded afterwards. Another option is to inject it in the form of powder during welding in a single stage process.

Applications

Critical shafts and engine parts | Welding with minimal distortions allows the processing of critical parts such as propeller shafts, crankshafts, pump shafts, camshafts, piston rods, crosshead pins, etc.

Turbomachinery | In-situ laser cladding allows fast and cost-efficient repair of low pressure blades of steam turbines. Small turbo rotors can be repaired without distortion.

Other parts | Local repairs can be made on cast iron parts, such as expensive cylinder cover castings, and pump impellers at minimum cost and post machining.

The lower dilution of laser achieves the correct material chemistry after 1 layer with 1 mm height. The MIG/GMAG process requires 3 layers and 8 mm (see Figure 5).

Figure 5 Laser cladding requires less machining than MIG/GMAG to reach final dimensions after deposition. This is due to the bead form or shape and the overlap.

Main benefits:
- Minimum distortion and residual stress in reconditioned parts
- Very low dilution levels (<5%) with very fine overlay thicknesses
- Impeccable control of welding bead geometry and overlay thickness attainable
- Local processing capability
- Deposition rates up to more than 12 kg/h
- Good fusion between substrate and filler materials
- Excellent mechanical properties

<table>
<thead>
<tr>
<th>Powder grade</th>
<th>Hardness</th>
<th>Melting range (°C)</th>
<th>Thermal expansion co-efficient (10⁻⁶/°C)</th>
<th>Hall flow (sec/50g)</th>
<th>Density (g/cm³)</th>
<th>Recommended use /Features/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nickel-base</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>625</td>
<td>200*</td>
<td>1290-1350</td>
<td>15.6 (20-800°C)</td>
<td>14.2</td>
<td>8.4</td>
<td>IN 625 ¹</td>
</tr>
<tr>
<td>718</td>
<td>240*</td>
<td>1200-1300</td>
<td>16.0 (25-800°C)</td>
<td>15.5</td>
<td>-</td>
<td>IN 718 ¹</td>
</tr>
<tr>
<td>1540-00</td>
<td>40*</td>
<td>1010-1140</td>
<td>14.4 (25-600°C)</td>
<td>15.4</td>
<td>8.1</td>
<td></td>
</tr>
<tr>
<td>1550-00</td>
<td>52*</td>
<td>1000-1110</td>
<td>13.6 (20-600°C)</td>
<td>15.4</td>
<td>7.9</td>
<td></td>
</tr>
<tr>
<td>Cobalt-base</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2528-00</td>
<td>340*</td>
<td>1185-1385</td>
<td>15.6 (20-800°C)</td>
<td>15.7</td>
<td>8.3</td>
<td>Stellite 21 ²</td>
</tr>
<tr>
<td>2537-00</td>
<td>41*</td>
<td>1285-1375</td>
<td>15.6 (20-800°C)</td>
<td>15.8</td>
<td>8.3</td>
<td>Stellite 6 ²</td>
</tr>
<tr>
<td>2537-10</td>
<td>43*</td>
<td>1285-1375</td>
<td>15.6 (20-800°C)</td>
<td>15.8</td>
<td>8.3</td>
<td>Stellite 6 ²</td>
</tr>
<tr>
<td>2541-00</td>
<td>44*</td>
<td>1280-1315</td>
<td>15.2 (20-800°C)</td>
<td>16.4</td>
<td>8.5</td>
<td>Stellite 12 ²</td>
</tr>
<tr>
<td>Iron-base</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>316L</td>
<td>160*</td>
<td>1375-1430</td>
<td>19.5 (20-800°C)</td>
<td>16.4</td>
<td>7.9</td>
<td>316L ³</td>
</tr>
<tr>
<td>420S</td>
<td>55*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>410L</td>
<td>220*</td>
<td>1480-1530</td>
<td>-</td>
<td>14.5</td>
<td>-</td>
<td>416L ³</td>
</tr>
<tr>
<td>3533-00</td>
<td>33*</td>
<td>1220-1320</td>
<td>-</td>
<td>15.0</td>
<td>7.8</td>
<td></td>
</tr>
<tr>
<td>3533-10</td>
<td>42*</td>
<td>-</td>
<td>16.1 (25-800°C)</td>
<td>14.8</td>
<td>7.7</td>
<td></td>
</tr>
</tbody>
</table>

* Value measured after PTAW
Thermal Spraying

Thermal spraying includes techniques where a hot filler material is sprayed with high velocity against the workpiece to create an overlay. Many applications in the marine industry are repaired by the available techniques described below.

Flame Spray
By utilising combustible gas such as hydrogen, acetylene, propane and natural gas, the flame spray process creates the energy required to soften the coating material. The semi-molten particles flatten under impact and interlock with the base material and with each other to form a mechanical bond.

To form a dense coating strongly adhered to the substrate, spraying is typically followed by a fusing process. This can be achieved by passing a gas torch over the deposit at about 1000°C or by heating in a furnace with controlled atmosphere.

Applications
- Restoration of various parts, for example bearing journals and rotor shaft sealing areas.

Plasma Spray
This method employs a technique essentially similar to flame spraying. It differs in that the flame comprises an electrically excited plasma of high velocity and temperature (≈15 000K). This permits a denser coating (95-98%). Deposition rates are from 2-8 kg/hour, and surfacing thickness from 0.1-2.5 mm.

High Velocity Oxygen Fuel (HVOF)
HVOF is a thermal spraying process using high gas velocity. Fuel and oxygen is combined to create rapidly expanding combustion gases inside a specially designed combustion nozzle. At speeds around 5 Mach, the powder filler metal is accelerated through the flame. In most HVOF systems, the transient time of particles within the flame is such that they do not melt.

The melting process is supported by the plasticising of particles as they collide with the substrate. This feature is particularly useful when applying carbide cerments where the carbide particles should remain below melting temperatures and retain their properties.

The high collision velocities allow for very dense (<0.5% porosity) and uniform coatings with excellent adhesion, wear and corrosion properties.

Applications
- Hydraulic piston rods
- Two-stroke engine piston rods
- Exhaust valve stems

Plasma and HVOF spraying grades

<table>
<thead>
<tr>
<th>Powder grade</th>
<th>Particle size µm</th>
<th>C %</th>
<th>Co %</th>
<th>Cr %</th>
<th>Mn %</th>
<th>Si %</th>
<th>B %</th>
<th>Ni %</th>
<th>Mo %</th>
<th>Fe %</th>
<th>W %</th>
<th>Others %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nickel-base</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1660-02</td>
<td>20-53</td>
<td>0.75</td>
<td>-</td>
<td>14.8</td>
<td>-</td>
<td>4.3</td>
<td>3.1</td>
<td>Bal.</td>
<td>-</td>
<td>3.7</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1660-02+WC</td>
<td>20-53</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cobalt-base</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2628-02</td>
<td>20-53</td>
<td>0.25</td>
<td>Bal.</td>
<td>27.0</td>
<td>-</td>
<td>0.9</td>
<td>-</td>
<td>2.5</td>
<td>5.5</td>
<td>1.5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2637-02</td>
<td>20-53</td>
<td>1.1</td>
<td>Bal.</td>
<td>28.5</td>
<td>-</td>
<td>1.0</td>
<td>-</td>
<td>1.5</td>
<td>-</td>
<td>1.5</td>
<td>4.4</td>
<td>-</td>
</tr>
<tr>
<td>Iron-base</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>316L</td>
<td>20-53</td>
<td>≤ 0.03</td>
<td>-</td>
<td>17.0</td>
<td>1.5</td>
<td>0.8</td>
<td>-</td>
<td>12.0</td>
<td>2.5</td>
<td>Bal.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3650-02</td>
<td>20-53</td>
<td>1.75</td>
<td>-</td>
<td>28.0</td>
<td>0.8</td>
<td>1.3</td>
<td>-</td>
<td>16.0</td>
<td>4.5</td>
<td>Bal.</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
### Valve stem
- Powder: WC
- Method: HVOF

<table>
<thead>
<tr>
<th>Powder grade</th>
<th>Hardness HRC</th>
<th>Melting range (°C)</th>
<th>Hall flow (sec/50g)</th>
<th>Density (g/cm³)</th>
<th>Recommended use/Features/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nickel-base</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1660-02</td>
<td>780*</td>
<td>970-1200</td>
<td>12.6</td>
<td>7.7</td>
<td></td>
</tr>
<tr>
<td>1660-02+WC</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>Cobalt-base</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2628-02</td>
<td>300**</td>
<td>1185-1385</td>
<td>11.5</td>
<td>-</td>
<td>Stellite 21&lt;sup&gt;1)&lt;/sup&gt;</td>
</tr>
<tr>
<td>2637-02</td>
<td>380*</td>
<td>1275-1375</td>
<td>11.6</td>
<td>-</td>
<td>Stellite 6&lt;sup&gt;2)&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Iron-base</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>316L</td>
<td>160**</td>
<td>1275-1430</td>
<td>13.0</td>
<td>7.9</td>
<td>316L&lt;sup&gt;3)&lt;/sup&gt;</td>
</tr>
<tr>
<td>3650-02</td>
<td>500**</td>
<td>1220-1320</td>
<td>13.1</td>
<td>7.8</td>
<td></td>
</tr>
</tbody>
</table>

*Indicative value
**Measured value
Höganäs Powders

Recommendations for overlay welding and thermal spray
Höganäs manufactures a wide range of metallic materials with a proven track record including the compositions required for marine and offshore applications. These are available in a range of particle size intervals to function in all equipment brands.

It is important to choose the right powder grade, chemical composition and hardness etc., but also the right particle size range. Our powder grades have seven main standard sieve ranges (see Figure 6).

Choice of material
Classification society rules specify the material suitable for each application. Based on these recommendations a range of materials can be seen on page 11.

Figure 6
Recommended Storage Conditions

- Bottles should be tightly sealed at all times during storage
- Opened bottles must be resealed immediately after use
- Bottles should be stored in clean and dry conditions at all times
- Storage temperatures of 15-25°C are considered optimum

**Important**
Shake bottles well before use. No large and fast temperature changes should occur during storage as this will cause humidity inside the cap even when it is sealed.

If for some reason the powder moisture content has increased this can be lowered by drying. Dry the powder at 80°C (max 100°C) for one hour. Preferably under rotation for best effect.

Services

Independent consulting service for laser cladding may be requested for choice and enabling of equipment, staff training and as a speaking partner – request quote.

Classification societies may require the preparation of welding coupons that will be used for the construction of specimens for mechanical testing. As a technical service, we can provide customers with coupon evaluation – request quote.

<table>
<thead>
<tr>
<th>Powder designations</th>
<th>1 6 20 – 1 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: Alloy Base</td>
<td>A B C – D E</td>
</tr>
<tr>
<td>1 = Nickel (Ni)</td>
<td>1 = modified</td>
</tr>
<tr>
<td>2 = Cobalt (Co)</td>
<td>2 = modified</td>
</tr>
<tr>
<td>3 = Iron (Fe)</td>
<td>3 = modified</td>
</tr>
<tr>
<td>4 = Tungsten Carbide (WC)</td>
<td>4 = modified</td>
</tr>
<tr>
<td>B: Standard Particle Size Range</td>
<td>1 = modified</td>
</tr>
<tr>
<td>0 = 20 – 106 µm</td>
<td>2 = modified</td>
</tr>
<tr>
<td>1 = 20 – 71 µm</td>
<td>3 = modified</td>
</tr>
<tr>
<td>2 = 36 – 106 µm</td>
<td>4 = modified</td>
</tr>
<tr>
<td>3 = 45 – 125 µm</td>
<td>5 = modified</td>
</tr>
<tr>
<td>4 = 53 – 150 µm</td>
<td>6 = modified</td>
</tr>
<tr>
<td>5 = 53 – 150 µm</td>
<td>7 = modified</td>
</tr>
<tr>
<td>6 = 15 – 53 µm</td>
<td>8 = modified</td>
</tr>
<tr>
<td>7 = 63 – 212 µm</td>
<td>9 = modified</td>
</tr>
</tbody>
</table>

**Foot notes**
1) Registered trademark Inco Corp.
2) Registered trademark Kennametal Stellite
3) A.I.S.I. standard
4) Spherical particles
5) This sieve is especially designed for HVOF
# Quick Guide to Höganäs Powder Grades

## Marine and offshore applications

<table>
<thead>
<tr>
<th>Powder</th>
<th>Typical HRC</th>
<th>Typical HV$_{30}$</th>
<th>Method</th>
<th>Parts</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>1550-00*</td>
<td>52</td>
<td></td>
<td></td>
<td></td>
<td>Exhaust valve seat region</td>
</tr>
<tr>
<td>2537-00*</td>
<td>41</td>
<td></td>
<td>PTAW or Laser Cladding</td>
<td>Valve stem</td>
<td></td>
</tr>
<tr>
<td>2537-10</td>
<td>43</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2541-00*</td>
<td>44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>718</td>
<td>240</td>
<td></td>
<td>HVOF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>316L*</td>
<td>160</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>625</td>
<td>200</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1660-02 +WC</td>
<td>-</td>
<td>-</td>
<td>HVOF</td>
<td>Valve stem</td>
<td></td>
</tr>
<tr>
<td>2537-00*</td>
<td>41</td>
<td></td>
<td>PTAW or Laser Cladding</td>
<td>Valve seat</td>
<td></td>
</tr>
<tr>
<td>420S</td>
<td>55</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>316L*</td>
<td>160</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>410L</td>
<td>220</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>410L</td>
<td>220</td>
<td></td>
<td>PTAW or Laser Cladding</td>
<td>Valve cage</td>
<td></td>
</tr>
<tr>
<td>2537-00*</td>
<td>41</td>
<td></td>
<td>PTAW or Laser Cladding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2528-00</td>
<td>340</td>
<td></td>
<td>Laser Cladding</td>
<td>Turbo rotor</td>
<td></td>
</tr>
<tr>
<td>410L</td>
<td>220</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3533-10</td>
<td>42</td>
<td></td>
<td>Laser Cladding</td>
<td>Hydraulic piston rod</td>
<td>Depends on corrosion requirement</td>
</tr>
<tr>
<td>625</td>
<td>200</td>
<td></td>
<td>laser Cladding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>420S</td>
<td>55</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>625</td>
<td>200</td>
<td></td>
<td></td>
<td>Intermediate shaft</td>
<td></td>
</tr>
<tr>
<td>3533-00</td>
<td>33</td>
<td></td>
<td>PTAW or Laser Cladding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>316L*</td>
<td>160</td>
<td></td>
<td></td>
<td>Final shaft</td>
<td></td>
</tr>
<tr>
<td>410L</td>
<td>220</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1540-00a</td>
<td>40</td>
<td></td>
<td>Laser Cladding</td>
<td>Piston crown</td>
<td>4 stroke engine a</td>
</tr>
<tr>
<td>2537-00b</td>
<td>41</td>
<td></td>
<td>Laser Cladding</td>
<td>Piston groves</td>
<td>2 stroke engine b</td>
</tr>
</tbody>
</table>

Equipment specific products on request. *Express deliveries www.hoganasthermalspray.com
Power of Powder®

Metal powder technology has the power to open up a world of possibilities. The inherent properties of metal powders provide unique possibilities to tailor solutions to match your requirements. This is what we call Power of Powder, a concept to constantly widen and grow the range of metal powder applications.

With its leading position in metal powder technology, Höganäs is perfectly placed to help you explore those possibilities as your application project partner.

Power of Powder is being applied far beyond its traditional role in the production of components for vehicles. Iron powder is used in food fortification to combat anaemia. Nickel powders are vital ingredients in valve coatings to enhance wear resistance. Specially formulated iron-based powders offer new solutions for high-temperature brazing. Soft Magnetic Composites with 3D magnetic properties are opening the way for innovative electric motors. In fact, metal powder technology generates virtually endless possibilities.

To find out how you can apply the Power of Powder, please contact your nearest Höganäs office.

www.hoganasthermalspray.com | www.hoganas.com