Plasma-Sprayed HA Coatings for Orthopedic Applications
HA-sprayed coatings are applied on the implants using a Vacuum Plasma Spraying (VPS) technique. During the plasma spray process, a mixture of gases (e.g. argon, hydrogen, helium) is heated with a highly-energized arc up to 20,000 °C and ionized. When heated to high temperatures, the gas expands and exits the nozzle at extremely high speeds that even exceed the speed of sound.

The powder coating material is melted in this highly-energized plasma jet and it is then deposited onto the material surface (e.g. implant). The microstructure, the density and the porosity of the coating are defined by the grain size of the coating powder used, the temperature and the speed of the particles. The essential advantage of the VPS process is that air contamination is eliminated, ensuring that an extremely clean, pure coating is achieved on the implant surface.

Furthermore, the possibility of modifying the surface topography of implants over a wide scale range is offered by VPS-HA coating technology. This has a defining influence on the osseo-integrative formation of new tissue on the implant surface.

**Advantages**

- Outstanding biocompatibility
- Surface enlargement
- Long term stability due to direct contact of ingrowing bone into the porous HA layer
- Flexible coating thicknesses possible
- Controlled resorption as a result of high crystallinity
- Increased purity and adhesive strength versus other methods (e.g. APS Atmospheric Plasma Spray)
- Raw material corresponds to the requirements of ASTM F 1185
- High primary stability of the implant due to rough surface
## Physical & chemical properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>Light gray-white</td>
</tr>
<tr>
<td>Coating thickness</td>
<td>20–200 µm *1</td>
</tr>
<tr>
<td>Adhesion strength</td>
<td>≥ 15 MPa</td>
</tr>
<tr>
<td>Roughness Ra</td>
<td>5–13 µm *1</td>
</tr>
<tr>
<td>Phase composition</td>
<td>HA ≥ 50 % *2, α-TCP, β-TCP, TTCP jeweils ≤ 10 % *3, CaO ≤ 5 % *3</td>
</tr>
</tbody>
</table>

*1 Other values possible on customer’s request  
*2 Relative to the total mass of the coating  
*3 Mass ratio of the foreign phases relative to the mass ratio of the crystalline HA

### Crystallographic properties

The crystallinity of the coating is ≥ 45 %. The molar calcium/phosphate ratio is in the range of 1.61–1.76. The high velocity of the particles results in a high adhesion strength of the HA coating.

A porous, crystalline surface is created by fusing the HA powder. Its structure offers the bone cells ideal conditions for firmly anchoring the implant in the bone tissue.
The following routine tests are performed on VPS-HA-sprayed implants:

- Coating thickness
- Roughness
- Ca/P ratio
- Coating adhesion (adhesion strength)

**Literature**