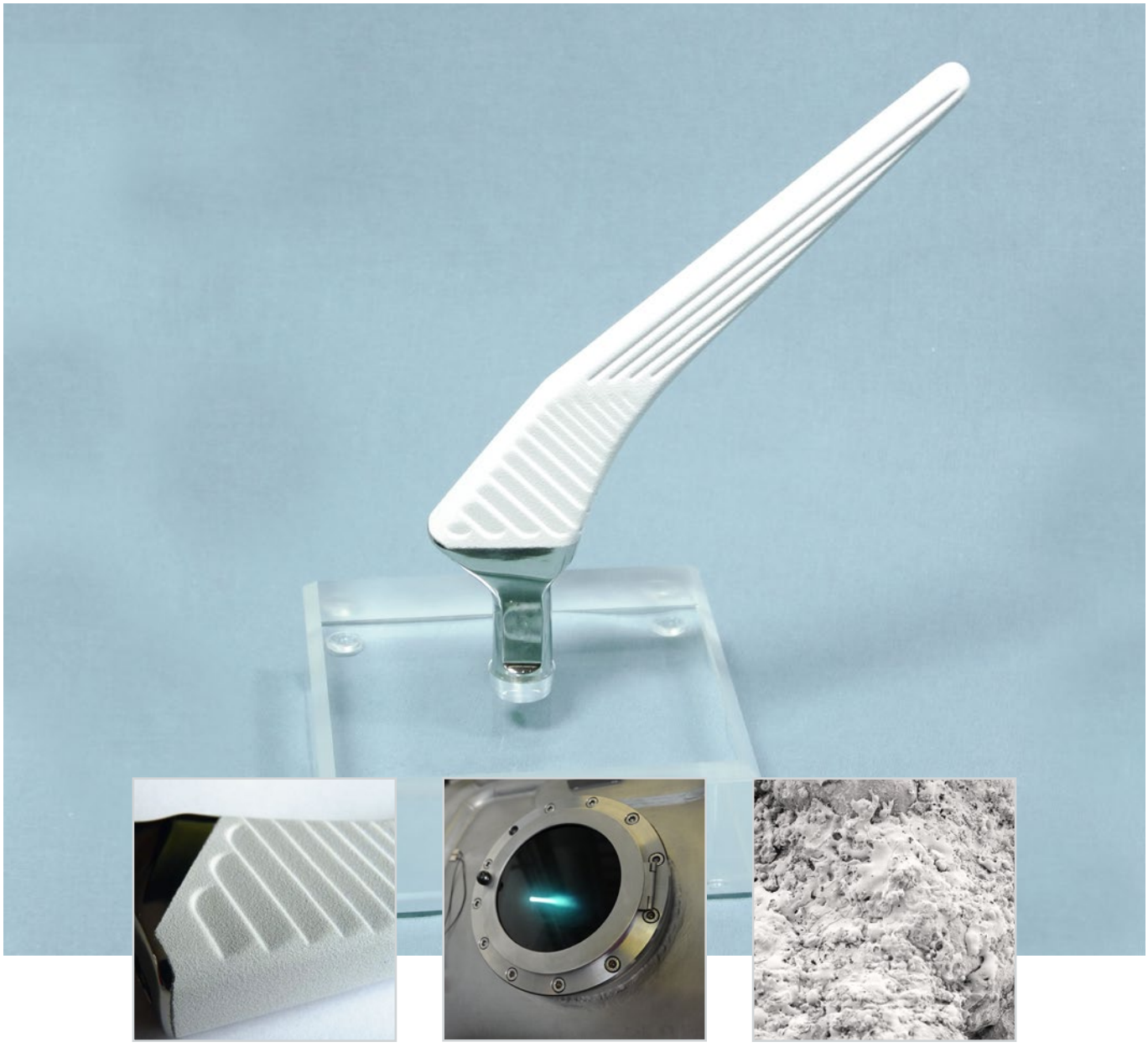
Plasma-Sprayed HA Coatings for Orthopedic Applications



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Principles

The technique of coating implant surfaces by using plasma-sprayed powders has a proven record of success that spans several years in the field of medical technology.
It is a successful means of reproducibly attaining highly adhesive, microporous and biocompatible implant surfaces with defined properties.
To be currently considered as optimal, an implant surface must be both macroporous and biocompatible with bone metabolism.
Calcium phosphates are used in the field of medical coating technology because they foster fast growth of bone tissue and promote a very strong connection between the implant and the surrounding tissue, reducing the healing phase as a consequence.

Technology

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 osseointegrative formation of new tissue on the implant surface.

Advantages

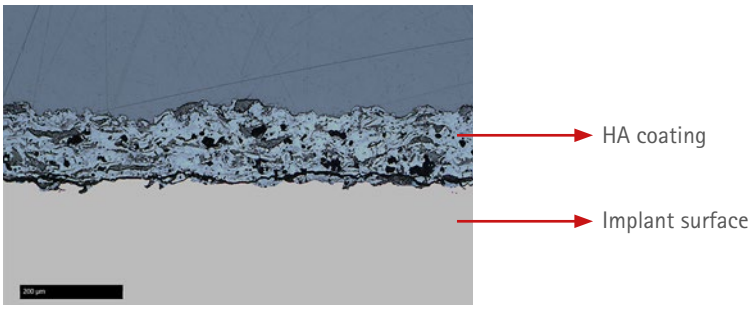
- Outstanding biocompatibility
- Surface enlargement
- Long term stability due to direct contact of ingrowing bone into the porous HA layer
- Flexible coating thicknesses possible
- Controlled resorption as a result of high crystallinity
- Increased purity and adhesive strength versus other methods (e.g.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

Properties

Physical & chemical properties

Property	Result
Color	Light gray to white
Coating thickness	20-200 µm *1
Adhesion strength	≥ 15 MPa
Roughness Ra	6-14 µm *1
Phase composition	HA ≥ 50 w% *2 α-TCP+β-TCP+TTCP ≤ 30 w% *3 CaO ≤ 5 w% *3

*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 of the crystalline HA



Micrograph of a HA-sprayed surface

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.

SEM pictures of a HA-sprayed surface

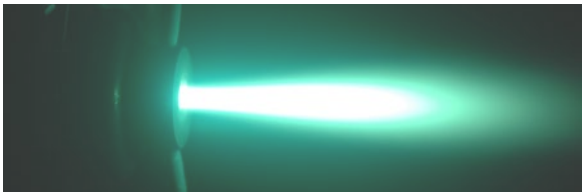
Coating testings

The following routine tests are performed on VPS-HA-sprayed implants:

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

Literature

- Aebli N., Krebs J., Stich H., Schawalder P., Walton M., Schwenke D., Gruner H., Gasser H., Theis JC (2003) In vivo comparison of the osseointegration of vacuum plasma sprayed titanium- and hydroxyapatite-coated implants. J Biomed Mater Res A.: 356-363.
- Borsari V., Fini M., Giavaresi G., Rimondini L., Consolo U., Chiusoli L., Salito A., Volpert A., Chiesa R., Giardino R. (2007) Osteointegration of Titanium and Hydroxyapatite Rough Surfaces in Healthy and Compromised Cortical and Trabecular Bone: In Vivo Comparative Study on Young, Aged, and Estrogen-Deficient Sheep. J Orthop Res September: 1250-1260.
- Chen Y.L., Lin T., Liu A., Shi M.M., Hu B., Shi Z.L., Yan S.G. (2015) Does hydroxyapatite coating have no advantage over porous coating in primary total hip arthroplasty? A meta-analysis. J Orthop Surg Res 10: 1-14.
- Geerdink C. H., Schaafsma J., Meyers W. G., Grimm B., Tonino A. J. (2007) Cementless hemispheric hydroxyapatite-coated sockets for acetabular revision. J Arthroplasty 22(3): 369-76.
- Nelissen R. G., Valstar E. R., Rozing P. M. (1998) The effect of hydroxyapatite on the micromotion of total knee prostheses. A prospective, randomized, double-blind study. J Bone Joint Surg (Am) 80(11): 1665-72.
- Sun L. Berndt C.C., Gross K.A., Kucuk A. (2001) Material Fundamentals and Clinical Performance of Plasma-Sprayed Hydroxyapatite Coating: A Review. J Biomed Mater Res. 58(5): 570-592.
- Voigt J.D. & Mosier M. (2011) Hydroxyapatite coating appears to be benefit for implant durability of tibial components in primary total knee arthroplasty. Acta Orthopaedica 82(4): 448-459.



We look forward to talking with you!

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