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Ti PARTICLES IN DICALCIUM SILICATE IMPROVES BONDING IN ARTIFICIAL PROSTHESES

The durability and mechanical properties of silicate ceramic coatings can be improved by several methods. The addition of insoluble materials as a second phase is considered to be a critical factor. Titanium and zirconia are preferred as reinforcing additives because of its characteristics such as toughness and high strength, good compatibility and corrosion resistance. In addition to the above characteristics, the formation of titanium oxide during atmospheric plasma spraying can induce cell growth and enhance osteoblast adhesion.

Researchers at the City University of Hong Kong, Hongkong have studied dicalcium silicate composite coating with 70 wt% titanium content. The researchers evaluated the biocompatibility by monitoring the adhesion and differentiation behavior of human osteogenetic cells planted on the coating surfaces. The coatings' durability was assessed by studying the dissolution behavior--in Tris-HCl solution, Young's modulus and bending strength changes in simulated body fluid (SBF).

Explains Paul Chu to *Technical Insights*, "In our previous work, we evaluated several composite coatings with various titanium contents. We found that the composite coatings with less than 70 wt% titanium exhibited good bioactivity and bone-like hydroxyapatite (HAP) formed on the coating surface after seven-day immersion in SBF".

In this work, researchers chose titanium particles--80 micrometers to 140 micrometers--as scaffolds in the synthesis of bioactive dicalcium silicate--finer than 20 micrometers--coating by atmospheric plasma spraying. Researchers observed a bonding strength as high as 49 MPa between the coating and the substrate. The high bonding strength is attributed to factors such as the high titanium content in the coating and the similar thermal expansion coefficients of the coating and the substrate.

The melted or half-melted large titanium particles during the plasma spraying process facilitate the formation of a net-like structure consisting of small dicalcium silicate localized in the mesh. The dissolution of dicalcium silicate and the release of Ca_2+ ions help in the formation of (silicon-oxygen) groups. These groups facilitate the precipitation of bone-like hydroxyapatite on the surface and adhesion and proliferation of human osteogenetic cells.

Explains Chu to *Technical Insights*, "Young's modulus shows that the durability of the coating is enhanced by the interconnected titanium particles. All in all, this composite coating not only possesses good long-term stability, but also introduces suitable dissolution for faster initial bone fixation".

With applications in artificial prostheses such as bone implants and hip joints, the research team feels that the better understanding of the process as well as *in vivo* tests are needed before commercialization. The research team are working with City University of Hong Kong and Shanghai Institute of Ceramics to develop the technology and products.

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