# Surface Design and Effects in Biological Environment

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A surface can be defined as the arrangement of particles and associated defects in a system across the size range from nanometers to centimeters. The properties of a surface may change drastically when it comes in contact with a biological system. Thus, tailoring of surfaces for biomedical applications is key to the surface engineering of bio/material interfaces. Structural stability of these materials is important when applying these coatings or components in a biological environment from the standpoint of stability, compatibility, or evaluating its toxicity in the system. The following articles under the topic of Surface Modification in Bioapplications are part of a continuing effort to explore surface engineering for various fields of advanced applications. The earlier topics in the series included Surface Engineering and Nanotechnology (*JOM*, December 2005), Nanomaterials and Surfaces (*JOM,* October 2004), Nanoscale Surface Science and Engineering (*JOM,* January 2004), High Performance Functional Coatings (*JOM,* September 2001), and Functional Coatings (*JOM,* January 2000).

In this issue, Narayan et al. discuss functionally gradient materials tailored for unique biological, chemical, or mechanical functionalities in next-generation medical devices. The development of functionally gradient zirconium-niobium alloys, hydroxyapatite coatings, and diamond-like carbon-metal coatings are reviewed.

The loss of bone density with age, especially for women, is one of the most serious health complications affecting humans. In their paper, Maroothynaden et al. investigate the hypothesis that chemical effects responsible for enhanced osteoblast differentiation and proliferation observed in-vitro and in-vivo at 1-gravity with bioactive glasses may be sufficient to prevent the 'turn-off' of bone cells that occurs in micro-gravity or other reduced loading environments as a consequence of age or immobility. Various models are described to understand the mechanisms involved in stress shielding of bone caused by orthopedic prostheses, as well as bone disorders associated with aging or induced by space flight.

Kurella et al. emphasize the role of surface engineering in improving the biocompatibility of hard tissue replacements. Interest in developing hierarchical bioactive structures for effective osseointegration is discussed. The chemical and morphological evolution of these bio-actively textured coatings was studied along with biomimetic precipitation of calcium phosphates when immersed in simulated body fluids.

Ong et al. present a unique perspective on plasma-sprayed bioactive coatings to optimize bone-implant interactions. Advantages and disadvantages of the process are discussed in tailoring the properties of the coatings. Among the experimental methods reviewed are the high-velocity oxy-fuel deposition process, electro-deposition, sputtering, and solution coating.

Osseointegrated dental implants are one of the options available for replacing missing teeth. Yang et al. present a scenario where the success of implants is due to osseointegration or the direct contact of the implant surface and bone without a fibrous connective tissue interface. This article presents evidence on the enhancement of osseointegration by means of anodized microporous titanium surfaces, functionally macroporous graded titanium coatings, nanoscale titanium surfaces, and different bioactive factors.

While nanotechnology has attracted considerable attention to the scientific community, several reports have suggested the negative impact of nanomaterials on living cells. The diverse array of surface properties achieved due to reduction in particle size that catalyzes the surface chemistry of nanoparticles is responsible for their toxic potential. Karakoti et al. further discuss the physical parameters such as surface area, particle size, surface charge, and zeta potential and their role in providing mechanistic details in the uptake, persistence, and biological toxicity of nanoparticles inside the human body. This review further provides insights of the physical, chemical, and interfacial parameters on the toxic potential of nanomaterials.

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