Recent Advances in Biological Materials Science and Biomedical Materials

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There is a growing demand in the United States, Europe, Japan, and other regions with rapidly aging populations for replacements of damaged or missing tissues. Many medical devices that are now taken for granted in developed countries, including drug-eluting coronary stents, intraocular lenses, and hip replacement prostheses, exist due to advances in biomaterials science over the past half century. The development of novel metals, polymers, ceramics, and composites for use in medical devices has required integration of concepts traditionally associated with materials science, biology, and clinical medicine.

In this *JOM* topic, several authors describe recent advances in research and training involving biomedical materials and devices.

John Nychka et al. describe how the wetting of solids by biological fluids relates to in vivo cell behavior, including cell attachment and cell proliferation. Methods for characterizing the surface properties of biological materials are discussed.

Ryan K. Roeder discusses a novel paradigm for integrating biology with materials science and engineering in order to pursue work in biomaterials, biological materials, biomimetic materials, and other interdisciplinary areas. This methodology will be beneficial for pursuit of research and training involving hierarchical structures, which are commonly observed in biological materials and biological tissues.

Ryan D. Boehm et al. employed piezoelectric inkjet printing to prepare microscale patterns of medical adhesives and sealants, including a hydrogel-based medical sealant, a cyanoacrylate tissue adhesive, and a biological adhesive derived from the blue mussel. Piezoelectric inkjet printing enabled patterns of two-component materials to be produced; for example, the effect of iron on mussel adhesive protein structure was observed.

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Vamsi Krishna Balla et al. describe the use of tantalum, including open-cell foam, in load-bearing orthopedic implants. Tantalum oxide (Ta_2O_5) enables formation of bone-like apatite material on the implant surface and attachment to bone. Processing of porous tantalum using a solid freeform fabrication process known as laser engineered net shaping (LENS™) is discussed.

Michael Sygnatowicz et al. processed silver-doped hydroxyapatite nanopowders by means of a sol-gel based method; these powders contained hydroxyapatite, silver, silver phosphate, and tricalcium phosphate. The antimicrobial properties of these materials were demonstrated using quantitative and qualitative in vitro methods.

Nicholas W. Meghri et al. used freeze casting to prepare three-dimensional scaffolds for tissue engineering out of chitosan as well as chitosan-gelatin composite materials. Growth of blood vessel inner lining (endothelial) cells on these materials was evaluated. The antimicrobial properties of these materials were demonstrated using quantitative and qualitative in vitro methods.

Finally, Devendra Bajaj et al. utilized indentation fracture and incremental crack growth approaches for understanding the fracture properties of human enamel. Observation of extrinsic toughening mechanisms in inner enamel and outer enamel using the incremental crack growth technique is discussed in detail.

It is hoped that this issue will stimulate discussions among TMS members as well as other stakeholders (e.g., biologists, physicians, and surgeons) regarding the society's role in terms of conferences, publications, continuing education, and professional certification in the rapidly growing area.

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