Advances in Biological Materials and Biomaterials Science

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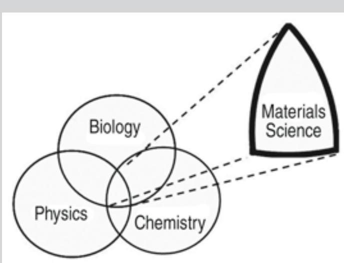
The incorporation of biology into materials science and engineering (MSE) is one of the most exciting current developments in this field. It is not a passing fad, but represents the expansion of the frontiers of MSE. In the 1960s, M.E. Fine, the MSE pioneer, proposed and implemented for the first time (at Northwestern University, Evanston, Illinois) a unified approach to the study of metals, ceramics, polymers, and composites under the same curriculum. Indeed, the traditional metallurgy and ceramics departments have for the most part been replaced by MSE departments. In addition, new fields such as biology are now incorporated into many MSE programs.

Figure 1a shows how the MSE of tomorrow will be rooted in the basic sciences of physics, chemistry, and biology. The first two have been the basic anchors of MSE; the third is finding its way into new curricula. Indeed, the 2007 TMS symposium on biological materials addressed these new curricular developments. Thus, one can consider biological materials (natural materials) and biomaterials (synthetic materials used in a biological environment) as integral parts of MSE. This new direction can be clearly seen by the increasing research activity in this area and by the industrial opportunities in the medical devices and biotech industry. A sizable proportion of faculty openings in MSE departments emphasize the nano-bio-technology aspects.

In line with these developments, TMS has sponsored four symposia on biological materials at its annual meetings (2005–2008), and complementary symposia at its fall meetings. A growing participation demonstrates a vibrant interest in this field. Concurrently, the Biomaterials Committee was created and successfully launched. This issue of *JOM* presents biological materials papers representing topics of general interest to the MSE public.

One can grasp an overall view of this field through Figure 1b, which shows a slightly modified version of the biological materials pentahedron proposed by E. Arzt.[1] It emphasizes the unique aspects of this field. The pentahedron has five vertices: ambient temperature synthesis in aqueous environment, multifunctionality, hierarchy of structure, self-assembly, and evolution/environmental effects. The schematic is indicative of the complex contributions and interactions necessary to fully understand and exploit (through biomimicking) biological systems.



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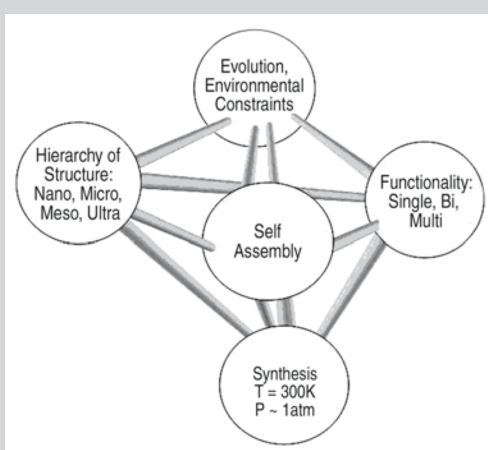

b

Figure 1. A schematic representation of (a) contributing scientific fields and (b) constraints/components in the study of biological systems. (Modified from E. Artz in Reference 1.)

The articles comprising this technical topic cover a broad spectrum and represent original contributions in both biological materials and biomaterials. The first article represents a joint effort by a television program (The History Channel's *Modern Marvels*) and an academic group (University of California at San Diego). It represents the results of an intellectual inquiry into sharp edges in biological materials. The other articles represent research efforts into biomaterials. The three classes of materials, ceramics, polymers, and metals, are represented.

The themes of these four contributions are: nanoporous materials for biomedical devices, synthesis and biomedical applications of nanoceramics, hydroxyapatite-reinforced polymer biocomposites (for synthetic bone substitutes), and the initial results for the potential use of ultrafine grained titanium in dental implants.

Reference

1. E. Arzt, "Biological and Artificial Attachment Devices: Lessons for Materials Scientist from Flies and Geckos," *Materials Science and Engineering C*, 26 (8) (2006), pp. 1245–1250.

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