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Structure-Property Relationships in Biomineralized and Biomimetic Composites

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PREFACE

Current world technologies and environments rely in large measure upon a growing need for the development of new structural materials with high strength and durability, toughness, light weight, low cost, and complete recyclability. Such materials may be derived synthetically, but Nature has evolved efficient strategies, exemplified in the mineralized tissues of numerous species, that have led to low-weight structural materials that exhibit exceptional strength, durability, and other unique and important properties. In these biomineralized systems, minerals and proteins or additional molecules exist in close proximity and at a various length scales, through their hierarchical structure from nano- to microscale dimensions. Interactions at these inorganic-organic interfaces are vital to the functions of a great variety of structural materials and biological tissues found in the biosphere, including, for example, the shells of mollusks and the bones and teeth of vertebrates.

An active and constantly growing area of research explores the structure-mechanical property relationships of these biomineralized composites with the intention of applying this body of knowledge to the study and mimicry of biomimetic composite materials that can play key roles in developing new materials and structures. The resulting materials will offer a new combination of low weight, high strength/toughness and multifunctionality to break traditional engineering paradigms in a radical manner, and they could benefit a wide spectrum of applications including those related to the automotive industry, energy, shipbuilding, defense, and civil and aerospace engineering. Moreover, studies of biological materials, such as bones and teeth, are also of great importance in the health care arena. The development of biomaterials and tissue-engineered materials is crucial for those instances in which tissues and biological materials need to be replaced, repaired or regenerated because of congenital defects of individuals, injury and other forms of external/internal damage, or disease.

The characterization and study of these materials require the use of modern tools such as electron and scanning probe microscopy, small-scale mechanical testing capabilities, and advanced multiscale numerical models and simulation techniques. At the same time, these investigations are best accomplished through multidisciplinary approaches and so require the close collaboration between material scientists, chemists, physicists, mechanicians, bioengineers, clinicians and biologists. The main purpose of Symposium KK, "Structure-Property Relationships in Biomineralized and Biomimetic Composites," held April 14–17 at the 2009 MRS Spring Meeting in San Francisco, California, was to bring together hundreds of scientists and researchers working in the diverse and interdisciplinary areas of biomineralized and biomimetic composite materials. Over 90 oral and poster presentations were given over a period of four days, including those by 20 internationally recognized invited speakers from academia, national laboratories, industries, government, and international institutions. The topics discussed included modeling and simulation of mechanical properties in biomineralized and mimetic systems, experimental design, synthesis and properties of biomimetic composites, structure-function properties of biomineralized tissues, biomaterials for tissue engineering, investigation of biomineralized tissue ultrastructure (inorganic and organic), quantitation of the ultrastructural response of the organic and inorganic phases in biological composites to mechanical stresses, and use of high resolution *in situ*

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synchrotron and spectroscopic techniques. These specific subjects were categorized and detailed in ten sessions of Symposium KK, each demonstrating the interdisciplinary and distinctive nature of this interesting and significant area of research. A collection of several representative papers is included in this volume.

Finally, the organizers acknowledge that the success of Symposium KK depended critically on the full participation of excellent researchers and scientists as well as graduate students. The organizers are also extremely grateful to MRS for making this symposium possible through its dedicated work before, during and following the Meeting, and to the volunteer students who kindly assisted with audio and video help during the sessions. We also thank Gatan UK, the Journal of Materials Chemistry, Nanoforce Technology, Ltd., the Office of Naval Research and the U.S. Department of Energy for their generous and substantial financial support.

David Kisailus
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