Sinha, J Powder Metall Min 2014, 3:2
http://dx.doi.org/10.4172/2168-9806.1000e129

Powder Metallurgy & Mining

Editorial Open Access

Biomimetic Materials

Arvind Sinha*

CSIR-National Metallurgical Laboratory, Jamshedpur 831007, India

Material based classification of the different ages of human civilization, namely stone, wood, iron, bronze and now silicon, clearly highlights the appreciation for role of materials in the growth of human civilization over time. With time, the manifestation of human intellect leading to industrialization of the society, could take primitive materials from implements to implants, making the present millennium as the age of materials. A rapid growth of Materials Science & Technology could be attributed to (i) availabilty of advance analytical tools capable of looking deep into structure and property of materials, and (ii) an integration of physical sciences with biological sciences. The combined effect of above two approaches has made it possible for the scientists to reveal secrets of mother nature involved in the synthesis of multi-functional materials and structures through a time tested sustainable process under ambient conditions. It has been exciting to note that nature works on the principle of maximum from minimum and thus involving most abundant raw materials and minimum energy and creating almost no waste. Looking at the structures and composition of biologically produced functional materials, it has been confirmed that all of them are hybrid composites of organic and inorganic phases, having a hierarchical self assembly of nano sized building blocks, assembled together by secondary forces. Mother nature uses its composite materials for constructing and systematically running its entire kingdom comprising different types of living structures. Materials and structures produced by nature being nanocomposites exhibit remarkably controlled organic-inorganic interfaces, uniformity in the dimensions and morphology of inorganic crystals precipitated in organic matrix and their highly controlled crystallographic orientation with respect to matrix and the hierarchical self assembly of nanostructures, creating a ordered microstructures and ultimately a three dimensional macrostructure. Length scales involved in the self assembly induces multifunctional properties in such structures ranging from self generation, adaptation, sensing to self heeling. A human bone is among the best example of biologically produced nanocomposite structure, which is now treated as best working model to design futuristic load bearing structures having in-built property of self healing.

Structural sophistication at different length scales present in biologically produced materials, makes them different in properties with respect to their synthetic counter parts. The shell of the mollusc abalone, made of essentially calcium carbonate, has 3000 times greater fracture resistance than the single crystal of calcite. Such examples together with increasing pressure towards the conservation of the environment have led materials scientists and engineers to carefully study natural systems, their design and their methods for the synthesis of constituent materials. Similarly, spider dragline silk is far superior to steel of comparable dimensions and the energy to fracture on equivalent weight basis is 100 times higher. It may, however, be noted that unlike industrial production of engineering materials through a rapid chemical synthesis in polar or non-polar solvent, nature synthesize its materials through a matrix mediated nucleation and growth process, where the organic matrix and its conformation plays an important role in controlling the entire synthesis process and shape, size and crystallographic details of nucleating phase through a interfacial molecular recognition process. Molecular recognition is a complex process depending upon various crystallographic and surface chemistry and topographic factors.

With the advancement of technology, the exponential increase in demand of custom tailored materials in general and nanomaterial's in particular under revised environmental regulations, have motivated material scientist to give a "out of box" alternative to conventional "heat and beat" process. However, it took a long time to materials scientist to realize the working models provided Mother Nature in solving complex materials problem, but to-day the translation of concepts of biology, into materials science and engineering has led to a new paradigm known as BIOMIMETICS. In the 21st century, Biomimetics has become a full scientific discipline in itself and biomimetic nanomaterial's and Nano composites are available in the field of tissue engineering and as bio-instructive biomaterials, however, the best is yet to come.

***Corresponding author:** Arvind Sinha, CSIR-National Metallurgical Laboratory, Jamshedpur 831007, India, Tel: 06572346053; E-mail: arvind@nmlindia.org

Received February 10, 2014; **Accepted** February 11, 2014, 2013; **Published** February 12, 2014

Citation: Sinha A (2014) Biomimetic Materials. J Powder Metall Min 3: e129. doi:10.4172/2168-9806.1000e129