by acidic peptide can be drawn into the gaps and grooves of the collagen fibers by capillary forces. Crystallization of the precursor leads to collagen fibrils embedded with HA nanocrystals, leading to compositions matching bone (over 70wt% mineral). Electron diffraction patterns of mineralized fibrils indicate that HA nanocrystals are [001] oriented with the collagen fiber axis, as in bone. Calorimetry, darkfield TEM, and selective etching studies reveal the interpenetrating structure of the mineral-collagen composite, which has a strikingly similar appearance to natural bone. We are currently examining the potential of this process for preparing synthetic bone graft substitutes with a composition and nanostructure that matches bone, potentially enabling the fabrication of hard tissue biomaterials that are both load-bearing as well as bioresorbable.

2:20 PM

(PACRIM8-S20-011-2009) Calcium phosphate/Biopolymer Nanocomposite Fibrous Scaffolds for Biomedical Engineering

T. Chae*, H. Yang, F. Ko, T. Troczynski, University of British Columbia, Canada

Electrospining (ES) applies electrostatic force to produce nanofibers from polymer solution, resulting in non-woven mesh nanostructures with 3D interconnected pores and high surface area. Such unique fibrous architecture mimicking extra-cellular matrix is an ideal scaffold for tissue engineering, wound dressing and drug delivery. In this study, we demonstrate novel ES scaffolds including synthetic biodegradable and natural biopolymer, hybridized with calcium phosphates. In-situ synthesized monetite in non-aqueous poly(lactic acid)(PLA) solution was electrospun into self-fused intra-nanoporous PLA fibers network with homogenous dispersion of the monetite nanocrystallites. Biomimetic precipitation of hydroxyapatite (HAp) along alginate nanofibers was induced, when electrospun sodium alginic acid containing $PO4^{3-}$ ions cross-linked into calcium alginic acid in Ca^{2+} ion solution. Homogenous coating of the HAp nanocrystals was achieved by optimization of PO_4^{3-} ion concentration and processing time. XRD, SEM, TEM, EDS, FT-IR, and TGA were used for characterization of the calcium phosphate/biopolymer nanocomposite fibrous scaffolds. The in-vitro biological performance is being evaluated through cellular activity tests. It is expected that the inorganic phases will increase biocompatibility, bioactivity and bioconductivity, and enhance structural stability of the scaffolds.

2:40 PM

(PACRIM8-S20-012-2009) Enzyme Grafting to Bioactive Glasses

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An interesting solution in order to improve tissue integration of implants and bone regeneration is the realization surfaces bioactive from both inorganic and biological point of view. The aim of this research work is enzyme grafting onto bioactive glasses in order to promote also a biological bioactivity. Two kinds of glasses, with different compositions and degree of bioactivity were studied. Samples have been firstly washed to expose hydroxyls groups and then silanized with 3-ammino-propyltriethoxysilane in order to introduce amino groups. Finally samples have been grafted with the enzyme alkaline phosphatase (ALP). Both silanized and only washed samples have been grafted with ALP. Different washings were performed after functionalization in order to study bonding stability. Hydroxyls exposition and silanization have been verified by means of contact angle measurements. ALP grafting has been studied by means of XPS analysis. After the addition of the specific substrate, the ALP activity was evaluated by UV-Vis spectroscopy. XPS spectra revealed ALP presence surfaces of grafted samples by enrichment in carbon and nitrogen and a decrease in constituents characteristic of the substrate. The detailed study of carbon region underlined peaks characteristic for the enzyme. Enzymatic activity tests showed that ALP maintains its activity after grafting and also that enzyme activity is reduced but maintained after different washings.

3:00 PM

(PACRIM8-S20-013-2009) From Biosilica Synthesis in Marine Sponges to Bioinspired Materials (Invited)

B. Schwenzer*, D. E. Morse, University of California, USA

We discovered that silicateins - proteins we found occluded in the glass skeletal elements of a marine sponge - self assemble to form macroscopic, crystallographically ordered filaments and govern the formation of the sponge skeleton. Genetic and biochemical analyses of the mechanism by which silicatein filaments catalyze and template the synthesis of silica in vitro revealed the following two mechanistic key principles for the mechanisms of biosilicification: (a) vectorially controlled catalysis of synthesis from a molecular precursor and (b) the use of an anisotropic reaction environment to provide kinetic and spatial control of crystal growth. Further research has shown that these filaments also are capable of catalyzing and templating the synthesis of a wide variety of silsesquioxanes (silicones) and metal oxides at low temperature and near-neutral pH from the corresponding molecular precursors. These findings led to the development of a generic new, biologically inspired low-temperature route for the kinetically controlled vapor-diffusion synthesis of a wide range of nanostructured metal oxide, -hydroxide, -phosphate and bimetallic perovskite thin films and nanoparticles without the use of organic template: Among the materials thus prepared are industrially important mat rials, such as semiconductors and ferroelectrics.

Mechanical Properties and Biomechanics

Room: Georgia A

Session Chair: Laurie Gower, University of Florida

4:10 PM

(PACRIM8-S20-014-2009) Microscopic Hypermineralized Interfaces Enhance Toughness in Antler and Bone (Invited)

J. G. Skedros*, Utah Bone and Joint Center, USA

In many bones, "toughness" (the energy required to propagate a crack through a material) is enhanced by the presence of secondary osteons (Haversian systems), which have concentric rings (interfaces) surrounding a capillary. But the most important interface for slowing microcrack propagation is at the osteon's outermost edge, and this is called the "cement line" (~5 microns wide). Secondary osteons are prevalent in adult humans but are comparatively few in antlers. Even in view of their low mineral content, it is not clear how antlers achieve great toughness without prevalent secondary osteons. In human bone, cement lines are relatively hypermineralized compared to surrounding bone. Hypermineralization at this microscopic level optimizes the function of the cement line in slowing microcracks by providing localized stiffness (modulus) mismatch at the physical interface. We speculated that antlers have a similar toughening mechanism that is independent of secondary osteon formation. Ten mule deer antlers were analyzed using quantitative backscattered electron imaging. Although secondary osteons are rare, antler microstructure is characterized by extensively convoluted and hypermineralized interfaces. Human limb bones and antlers enhance toughness by analogous means — microscopic interfaces with modulus mismatch. The mechanisms at work in achieving this microscopic heterogeneity are not known.

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(PACRIM8-S20-015-2009) Comparative Study of the Structure and Mechanical Properties of Antler and Bone (Invited)

P. Chen*, J. M. Curiel, R. M. Kulin, M. E. Laumey, J. McKittrick, K. S. Vecchio, UC San Diego, USA; R. O. Ritchie, UC Berkeley, USA

Deer antlers, one of the fastest growing tissues in the animal kingdom, have a primary function in intraspecific combat and have been designed for sustaining high impact loading and bending moment without fracture. In this study, structural features of North antler American elk (Cervus canadensis) at different hierarchical levels were