Bioinspired synthesis of nanocomposites using self-assembling block copolymers

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Abstract

In order to understand and mimic the extracellular matrix of natural bone, where nucleation and growth of carbonated hydroxyapatite (CO_3HAp) is presumed to occur on collagen, block copolymers based on the nonionic, zwitterionic, anionic, and the peptide-conjugated polymers were employed as templates for the growth of calcium phosphate and zirconia from aqueous solutions. All block polymers used in this study were thermoreversibly gelling at or above room temperature. Calcium phosphate nanoparticles were formed at the polymer-inorganic interface presumably nucleated by the ionic interactions. Zirconium precipitated as amorphous hydroxide. Nanocomposites were characterized by solid state NMR, TGA, FTIR, and X-ray scattering techniques. Nanocomposite formation was confirmed by solid state NMR. Inorganic content of the nanocomposite depends on the critical gelling concentration and ionic nature of the polymer matrix employed as well as the pH values of solution. FTIR spectra of calcium phosphate nanocomposite showed characteristic features of organic matrix, phosphate, and carbonate species. Hydroxyapatite was shown to grow in the form of thin, elongated crystallites as evidenced by electron microscopy and small angle X-ray scattering technique. For the zirconia nanocomposite, crystallization by heat treatment suggests metastable cubic phase formation before tetragonal ZrO_2. Our work offers routes for bioinspired bottom-up approaches for the development of novel nanocomposites.

Acknowledgment: This work was supported by the U.S. Department of Energy through Ames Laboratory. Ames Laboratory is operated through the U.S. Department of Energy by Iowa State University under contract number DE-AC02-07CH11358.