Calcium phosphate biomaterials in orthopaedic and dental applications

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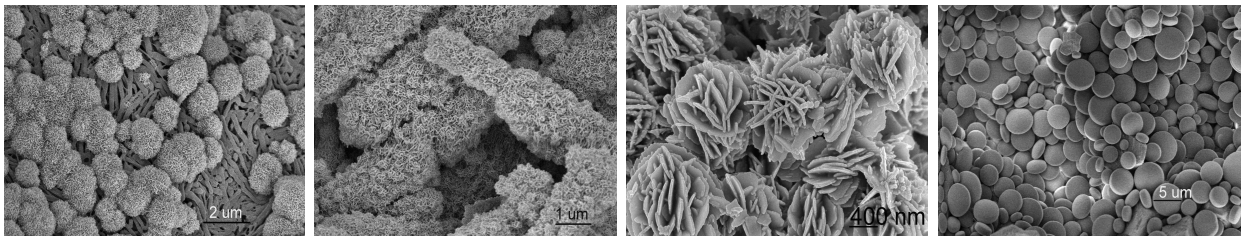
Given the bone tissue's superb ability to adapt its mass and morphology to *in vivo* functional requirements, its aptitude to repair itself without leaving a scar, its longevity, and its capacity to rapidly mobilize mineral supplies on metabolic demand, bone tissue is, in fact, the ultimate "smart" structural material present in biological systems.

Human bones (either *trabecular* or *cortical*) contain almost all the elements present in human blood plasma. Mineralized portions of bones can be oversimplified by the formula: $Ca_{10-x+\omega}Na_yK_z(PO_4)_{6-x}(HPO_4, CO_3)_x(OH)_{2-x+\omega}$. To start with a complex formula such as this, presents one of the many challenges facing the materials chemist synthesizing the bone mineral. However, acellular synthetic body fluids are shown to simulate the biomineralization and calcification processes. Over the last decade, biomimetic formation of nanocrystalline calcium phosphates has successfully been observed and investigated at numerous ceramic-metal, ceramic-polymer, and ceramic-ceramic interfaces in synthetic body fluid systems. Synthetic body fluids contain Posner's clusters. Understanding of biomineralization interactions with the organic matrix and the non-collagen bone proteins is also a principal aspect of biomimetic material synthesis. Understanding of the calcification processes taking place at the nano-scale will lead to important technological innovations and to the development of new biomedical devices with improved functionality.



Only the synthetic bone substitute materials of high BET surface areas, which closely mimic the Na- and K-doped, carbonated nature of human bones are found to readily take part in the bone remodeling processes. Non-cytotoxic calcium phosphate-based biomaterials do come in a variety of forms, such as, porous granules, porous prismatic blocks, bone mineral-coated metallic implants, polymer-blended bioceramics, self-setting injectable orthopedic cements, and nanowhiskers/single crystals. In order to preserve the above-mentioned delicate stoichiometry of the calcium phosphate-based human bone mineral in an ideal bone substitute, the development of novel, biomimetic synthesis techniques are still awaited. This presentation (with some picture highlights are shown above) will summarize our studies on the synthesis of porous CaP bioceramics and granules, CaP self-setting cements, biomimetic coatings on metals, ceramics and polymers, biomimetic powder synthesis procedures, synthesis of whiskers of calcium phosphates and the results of *in vitro* cell culture tests performed on such synthetic calcium phosphates, accompanied with IR spectroscopic and *X*-ray diffraction characterization studies.