DIVISION OF ENGINEERING - SEMINAR NOTICE

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Processing-microstructure-biological property relationship of Hydroxyapatite-Mullite Biocomposites and Influence of Electric field on Cell-Material interaction

In this talk, some interesting and important experimental results from my research group will be presented to illustrate some of the outstanding issues that are related to both the processing aspect as well as on the aspect of understanding the structure-property-performance relationship for the bioceramic composites. For biomedical applications, Hydroxyapatite (HAp) is a promising material because of its excellent bioactive properties, but it lacks from its inherent brittleness. To this end, metals, like Titanium (Ti) or mullite exhibit better physical properties i.e. toughness; however they are inherently bioinert. Such complementary properties have been the driving force to develop HAp-based biocomposites materials with Mullite as reinforcement. Another important issue in developing HAp based bulk composites is the phase stability of HAp and its influence on microstructure development and biocompatibility. On the first aspect, the results of a planned set of sintering experiments, carried out on different HAp-Mullite compositions (10-30 wt%) in the temperature range of 1000-1400^{0}C under air atmosphere, will be presented. Based on the combined study of XRD, FT-IR, DTA/TGA and thermodynamic analysis, the feasibility of various possible sintering reactions will be discussed. The results of the sintering experiments will be critically discussed in reference to the microstructure development and it will be shown how challenging is to adopt appropriate processing strategy to restrict the reactions between HAp and second phase. To this end, the recent results of the spark plasma sintering experiments will be presented to show how such challenges can possibly be overcome by adopting very high heating rate and thereby, inhibiting the sintering reactions. TEM analysis will be presented to demonstrate the evidence of liquid phase sintering of the composites. Finally, it will be shown that despite incorporating large amount of bioinert phase, like mullite in HAp composites, it is possible to retain good biocompatibility property, as will be illustrated by the results of a number of biochemical assays (MTT, ALP, Osteocalcin) as well as *in vivo* short term implantation tests in rabbits for time periods of up to 12 weeks. Preliminary results of the genotoxicity evaluation will also be presented.

Towards the end of the presentation, recent modeling efforts to understand cell-Electric field interaction will be presented. The implication of our analytical solution will be discussed in reference to the cellular adaptation processes, like atrophy/hypertrophy as well as the variation of electrical transport properties of cellular membrane/cytoplasm/nuclear membrane/nuceloplasm. The design of the experimental set up to verify the analytical results will be briefly presented.

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