FORMATION AND CHARACTERIZATION OF METAL-CERAMIC NANOCOMPOSITES

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Project Description:
Aluminum is important for many structural applications, particularly automotive, due to its relatively low density, combination of favorable mechanical properties, and corrosion resistance. Attempts to improve the properties of aluminum have been aimed at increasing its hardness and wear resistance, particularly at elevated temperatures, while maintaining the advantages offered by a ductile metal. Nanocrystalline aluminum and aluminum nanocomposites are being explored as possible avenues for property enhancement. The driving force behind these nanoscale investigations is the concept that as the crystal grain size decreases, either for the metal or reinforcement, the surface to volume ratio of the particles increases dramatically, as does the interfacial area between the particles. As much as 20-50% of the nanocrystalline material consists of interface. Hence, the bulk properties can be at least influenced and, at most, dictated, by the intergranular and interfacial regions of the material.

The type of nanocrystalline metals of concern here are those produced by mechanical attrition; a.k.a., *high energy ball milling*. This method has advantages over other methods of nanoscale formation (such as electrodeposition, sputtering, and thermochemical synthesis) primarily because it relies upon structural decomposition instead of cluster assembly. The reinforcement of aluminum by ceramic particles and fibers is also well researched, but very little work has been done on the development of novel MMCs that contain both nanoscale matrix and reinforcement phases.

The purpose of this project is manufacture and characterize aluminum/mullite nanocomposites and to optimize their mechanical/corrosion properties.

Project Objectives:
? Use high energy ball mill to form nanocrystalline metals and ceramics in various proportions.
? Prepare pre-pressed pellets to send out for Hot Isostatic Pressing (HIP).
? Analyze HIPed nanocomposites for physical properties (density), mechanical properties (strength and modulus) and corrosion resistance.
? Optimize composition and processing conditions to give best combination of properties in composite.

Prerequisites:
Completion of sophomore year in any of the natural or physical sciences or engineering. Student should have completed calculus, physics and chemistry sequences. Good communication skills and an ability to work with one's hands are a must.