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Dispersion of powders in complex systems

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DISPERSION OF SIMPLE AND COMPLEX POWDERS IN COMPLEX COLLOIDAL SYSTEMS

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This talk will discuss our colloidal and interfacial as well as materials chemistry approaches for manipulating and dispersing complex material systems. The talk focuses mostly on aqueous dispersion schemes, but the physical chemistry and utility of the ethanol-water system in preparing colloidal suspensions for diagnostic and drug delivery systems for human healthcare will also be presented. Complex material systems covered can include the following topics: fine ceramic multi-component powder dispersion; managing aqueous dispersion with thermodynamically unstable materials via interfacial passivation strategies; and dispersion of nanoscale particulates in simple and complex physiological environments. Many ceramic and metal systems in suspension are intrinsically thermodynamically unstable. Complex metal oxide, exemplified by perovskite, ABO_3, materials (e.g., $BaTiO_3$), have a leachable component (Ba^{2+}) and a passivating component (TiO_2) that can result in abnormal grain growth during sintering after colloidal processing in aqueous suspension. A passivation-dispersion strategy that manages such complex ceramic and metallic systems will be presented. Another example of managing complex material systems is all non-oxide ceramics (silicon nitride, aluminum nitride, etc.) develop oxide surfaces that may in turn passivate the underlying non-oxide material (silicon nitride below pH 9) or promote transformation and/or dissolution (aluminum nitride converting to a hydrated alumina at all pH regimes) in aqueous suspension. Furthermore, most ceramic materials are combinations of various materials. For example, silicon nitride-based materials are usually composed of silicon nitride, alumina, aluminum nitride and yttria or, in some cases ytterbium oxide particles. The wide disparity in colloidal and interfacial chemistry for this multicomponent material system can be managed by surface chemical strategies that create a leveling effect with the specific surface chemistry recognized and treated to enable a common dispersant to be deployed for stable colloidal suspensions of the complex mixture of materials. Finally, the issues associated with dispersions of both simple and complex colloidal systems into complex liquids such as blood for nanomedical applications will be presented. The novel synthetic scheme, laundering, and bioconjugation strategies associated with nanocolloids for imaging contrast agents and drug delivery, particularly for oncology diagnosis and treatments is presented. Both well known issues and less poorly understood issues for dispersion of nanoparticles in complex fluids and passage of nanoparticles through the animal and human circulatory systems to detect and treat disease are discussed. In conclusion, this talk will summarize the basic science and best engineering practices to disperse particles in liquids.