ROLE OF HYDRATION LAYER ON RHEOLOGY OF NANO ALUMINA SUSPENSIONS

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Technological implication of reduction in viscosity of nanosize ceramic suspensions with environmentally benign and inexpensive additives is not trivial. This presentation will discuss the flow characteristics of concentrated nano-alumina powder suspensions. Unusually high viscosities observed for suspensions of nanoparticles compared to those of micron size powders cannot be explained by current viscosity models. For a given solids content, as the particle size decreases so does the interparticle distance leading to overlapping interparticle forces. Concomitant with the particle size reduction, increase in surface area of the solids requires higher surfactant concentrations for effective steric stabilization. The rheology of nanosize alumina suspensions and its variation with solids content and with saccharide concentration were explored by rheometry. The mechanism of dramatic viscosity reduction by saccharide addition (primarily fructose) is studied by TGA, DSC, and NMR. The interparticle forces between the nanometric alumina particles in water and in fructose solutions were investigated by AFM.

The interactions between the nano-alumina particles in water can be explained by the DLVO theory. However, DLVO theory can not adequately describe the interactions between particles for suspensions containing saccharide. The interaction forces (amplitude and range) between nanometric alumina particles decrease with increasing saccharide concentration.

Formation of so-called hydration layer on alumina nanoparticles in water was hypothesized for years, but never observed experimentally. The direct visualization of hydration layer over nanosize alumina particles was realized with the fluid cell transmission electron microscopy *in situ.* The hydration layer over the particle aggregates was observed and it was shown that these hydrated aggregates constitute new particle assemblies which in turn alter the flow behavior of the suspensions. These nanoclusters alter the effective solids content and the viscosity of nanosize alumina suspensions. Our findings elucidate the source of high viscosity observed for nano particle suspensions and are of direct relevance to many industrial sectors including materials, food, cosmetics, pharmaceutical among others employing colloidal slurries with nanosize particles.