115c Phase Composition of Fumed Alumina Nanoparticles

George Fotou, Lawrence Murphy, and Robert Picthall

Fumed alumina nanoparticles are produced in high temperature hydrogen-air flames and are used in several applications that involve products of every day use. These applications include Chemical Mechanical Planarization (CMP) of silicon wafers in semiconductor manufacture, paper coating for inkjet printing and catalysis. In CMP, the unique combination of aggregate structure, crystalline phase composition and particle size make fumed alumina ideal for polishing metals such as Cu and W which are used as interconnects in multilayer integrated circuits. In paper coating applications, again it is the right combination of particle characteristics which provide optimum gloss and ink absorption properties. Alumina is also used as a catalytic support in several processes such as automotive catalytic converters. In this application, thermal stability is of essence.

The phase composition of fumed alumina plays an important role in the above applications since it determines properties such as hardness, reflectivity, and colloidal and thermal stability. Therefore, understanding the parameters that influence the phase composition during its flame synthesis is essential in the design of alumina nanophase particles with tailored crystalline composition. We have developed an X-ray diffraction technique that allows the identification and quantification of the various polymorphs that are present in fumed alumina. Particles produced under various flame conditions were characterized and a phase diagram specific to fumed alumina was developed. The phase ratio changes as a function of flame temperature. Crystallite sizes for each phase were determined from line broadening using Sherer's equation. This quantitative method has proven a significant tool in the fundamental understanding of process effects such as flame temperature, burner scale and residence time on the crystal phase composition of alumina.