Photothermal Study of the Formation Dynamics of Fumed Silica Thin Films

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Fumed silica is a material that has been used as a thickening agent due to the fact that it has chain-like particle morphology. When mixed with a liquid, the chains bond together via weak hydrogen bonds forming a three dimensional network. This induces liquid trapping and increases the viscosity. In this work the formation of thin films by evaporation of liquid mixtures of agglomerated amorphous untreated fumed silicon dioxide nanoparticles is analyzed. The experiments were performed on samples deposited on a metallic substrate. Thermal waves were generated by sending a modulated laser beam at constant frequency onto the substrate. These waves are transmitted to the evaporating solution allowing the monitoring of the formation of the film. The photoacoustic signal presents the typical behavior of this kind of experiments, a constant value during the first stage, followed by a decrease in the signal due to the thermal wave interference when the thermal diffusion length is comparable with the thickness of the film and a last stage in which the signal grows up to values close to the photoacoustic signal without sample solution. It is shown that the last stage of the formation of the film is not only a function on silica concentration, but also depends critically on the mixing process of the particles with the solvent. Our experimental data are compared with the predictions of effective thermal properties models.