EXPLORATION OF FRACTAL NATURE OF WO_3 NANOWIRE AGGREGATES

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ABSTRACT. The morphology of WO_3 aggregates formed by spherical nanoparticles (D ~ 40 nm) and nanowires of different aspect ratios (2, 4, 6, and 10 μm nominal lengths) dispersed in commonly used polar solvents without dispersant agents are investigated using small angle light scattering technique and by means of fractal theory. Nanoparticles follow particle-cluster aggregation mechanism (D_f ~ 2.6), whereas 2 μm nanowires with low aspect ratio (L/D ~ 10) follow a slow cluster-cluster aggregation mechanism with no discernable change in fractal dimension (D_f ~ 2.1) monitored in an extended period of six months, despite a noted growth in size (R_g = 1.8 to 3.1 μm). For higher aspect ratio nanowires, scattered intensity profiles which migrate towards the Porod regime qualitatively obey the Lorenz-Mie theory predictions. 10 μm nanowires with very high aspect ratio (L/D ~ 250) are observed to form stable dispersions in a time span of six days. Analytical methods based on spherical primary particle formulations predict D_f > 1.9, 1.7 and 1.4 for 4, 6, and 10 μm nanowires, respectively.

Key Words: fractal dimension, aggregation, static light scattering, size parameter, Porod regime