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Giant Rheological Effect of Shear Thickening Suspension Comprising Silica Nanoparticles with no Aggregation

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The spherical silica particles in narrow size distribution with different diameters of 90 nm, 200 nm, 320 nm and 400 nm were prepared by the modified Stöber method and characterized by scanning electron microscopy (SEM), transmission electron microscopy (TEM) and dynamic light scattering (DLS). The phase composition of particles was characterized by X-ray diffraction. The results indicated that each of the silica particle samples was in amorphous state. The shear thickening fluids (STFs) comprising 53 vol.% of silica particles and 47 vol.% of polyethylene glycol with molecular weight of 200 g mol^{-1} (PEG200) were prepared and evaluated. The influence of size and size distribution on the critical shear rate and the intensity of shear thickening were analyzed. The STFs prepared by silica nanoparticles with diameter of 90 nm showed the giant rheological effect with the critical shear rate of 2.51 s^{-1}, the largest viscosity of 45500 Pa·s and the yield stress of 181 kPa. The experiments and the analysis results demonstrated that the suspensions prepared by nanoparticles have high intensity of shear thickening.

Key words: Shear thickening; Silica nanoparticle; Size distribution; Rheology