

Accepted Manuscript

Title: Giant Rheological Effect of Shear Thickening Suspension Comprising Silica Nanoparticles with No Aggregation

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PII: S1005-0302(16)30079-2

DOI: <http://dx.doi.org/doi: 10.1016/j.jmst.2016.06.008>

Reference: JMST 728

To appear in: *Journal of Materials Science & Technology*

Received date: 4-1-2016

Revised date: 25-4-2016

Accepted date: 5-5-2016

Please cite this article as: Shuangbing Li, Jixiao Wang, Song Zhao, Wei Cai, Zhi Wang, Shichang Wang, Giant Rheological Effect of Shear Thickening Suspension Comprising Silica Nanoparticles with No Aggregation, *Journal of Materials Science & Technology* (2016), <http://dx.doi.org/doi: 10.1016/j.jmst.2016.06.008>.

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

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[Received 4 January 2016; Received in revised form 25 April 2016; Accepted 5 May 2016]

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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

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