ELECTRORHEOLOGICAL EFFECT IN SUSPENSIONS OF SILICA FUNCTIONALIZED WITH MERCAPTAN

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Electro-rheological (ER) fluids are colloidal suspensions of polarizable solid particles dispersed in a non-conducting liquid; these fluids are intelligent materials, that exhibiting drastic and reversible charge in rheological properties when an external electric field is applied via ordering of microstructure into electrode [1]. In order to promote the practical applications of ER technology, various potential ER materials including inorganic organic and composites have been developed since Winslow firstly discovered ER behavior [2].

This work introduces a new electro-rheological fluid: functionalized polyhedral silsesquioxane (POSS) with mercaptan groups prepared by sol-gel process, in silicone oil. To obtain the POSS-SH particles was made a mixture of deionizer water (3.0 mol) and isopropyl alcohol (0.3 mol). This solution has the pH fitted to 1 with chloride acid solution to 0.1N. Soon afterwards, 0.15 mol of 3- mercaptopropyl-trimethoxysilane 95% (MPTMS) and 0.15 mol of tetraethyl-orthosilicate 98% (TEOS) were added to mixture with pH controlled. The reaction was kept to 60 °C for 8 hours under strong agitation; the gel was dried to 80 °C for 12 hours. The electrorheological fluid were prepared by dispersing POSS-SH particle (2 and 7wt%) in silicone oil. These particles were dispersed in ultrasonic for 20 min. and the ER fluids were stored in a dessicator prior to use. Rheological measurements were performed using the Anton Paar Instruments Physical RMC 501, rheometer with electrorheological accessory (Generator HVS/ERD80) and plate-plate geometry (PP50/E-SN12613 gap 1.2 mm).

The electro-rheological response of the POSS-SH system increases exponential with increasing electric field, under conditions of low shear rates, $0.1s^{-1}$. The effect is observed in both fluids 2wt% and 7wt% of POSS-SH. The correlation of yield stress and electric fields can be represented by the following equation $\tau_y \propto E^{\alpha}$. The α values are 1.14 and 1.31 for fluid with 2wt% and 7wt%, respectively, which differ from that τ_y is proportional to the electric field strength E^2 predicted by the classic polarization model[3].

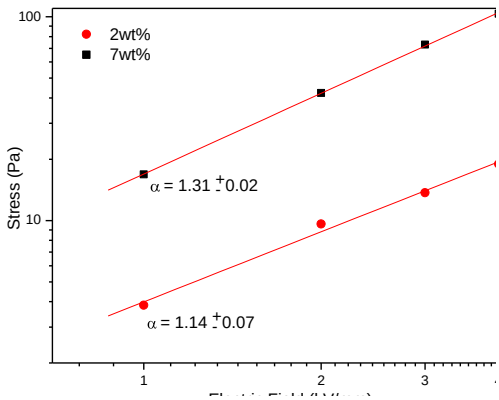

Figure 1: Stress as a function of electric field at low shear rate ($0.1s^{-1}$) as the electric field is increased for silica-SH at 2wt% and 7wt%.

A new electrorheological fluid of POSS functionalized polyhedral silsesquioxane (POSS) with mercaptan groups' particles in silicone oil has been investigated. The stress reflecting the response of the fluids are comparable to the stresses exhibited by conventional ER fluids, under the influence of electric field.

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