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PREPARATION AND CHARATERIZATION OF CARBON NANOTUBES FUNCTIONALIZED WITH SILICA AND THEIR APPLICATION IN SHEAR THICKENING FLUIDS

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Shear thickening fluids (STFs), flowable at low shear rates, become macroscopically rigid at high shear rates.A typical STF of silica suspension in polyethylene glycol (PEG) can be used for protective materials, such as bulletproof vests, at high shear rates. However, the brittleness and low resistance to mechanical stress of silica reduced the performance of silica/PEG STFs. To enhance the protective performance of the silica/PEG STFs, carbon nanotubes (CNTs) can be used as additional nanofillers. However, the effects of CNT addition are not expected to be good because of the low dispersibility of CNTs in silica/PEG STFs. In this study, to increase the dispersibility of CNT, silica-coated multiwalled carbon nanotubes (S-MWNTs) were prepared through covalent bonding and characterized. The effect of S-MWNT addition to silica/PEG suspension on the rheological property was also investigated. Amino group-introduced MWNTs (MWNT-NH2) with a nitrogen atom content of up to 20 wt% was prepared by reacting acid-treated MWNTs and ethylene diamine using 1-ethyl-3-(3-dimethylaminopropyl)carbodiimide hydrochloride and N-hydroxysuccinimide as catalysts. Then, various amounts of silica were formed through covalent bonding on the surface of the MWNTs initiating from the amino groups by using a sol-gel method. The silica formation on the MWNT surface was confirmed by FE-SEM, TEM, EA, and FTIR. The S-MWNTs exhibited good dispersion stability in water and PEG because of the increased hydrophilicity. When 5 wt% of pristine MWNTs was added to the silica/PEG suspension, they were not dispersed well in the suspension and the shear thickening property was not exhibited. On the other hand, the suspension containing 5 wt% of S-MWNTs showed similar shear thickening behavior to that of simple silica/PEG. The critical shear-thickening point of silica/S-MWNT suspension in PEG moved to a lower shear rate with increasing S-MWNT content.