Journal of Nanoparticle Research 2015 vol.17 N3

Stabilization of silica nanoparticles dispersions by surface modification with silicon derivative of thiacalix[4]arene

Gorbachuk V., Ziatdinova R., Evtugyn V., Stoikov I.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

© 2015, Springer Science+Business Media Dordrecht. For the first time, silica nanopowder functionalized with thiacalixarene derivatives was synthesized by ultrasonication of nanoparticles (diameter 23.7 ± 2.4 nm) with organosilicon derivative of thiacalixarene in glacial acetic acid. The protocol resulted in the formation of colloidal solution of low-disperse (polydispersity index of 0.11) submicron-sized (diameter 192.5 nm) clusters of nanoparticles according to the dynamic light scattering data. As defined by scanning electron microscopy (SEM), mean diameter of thiacalixarene-functionalized nanoparticles is equal to 25.5 ± 2.5 nm and the shape is close to spherical. SEM images confirm low aggregation of thiacalixarene-modified nanoparticle compared to initial silica nanopowder (mean diameter of aggregates 330 and 429 nm, correspondingly). According to the thermogravimetry/differential scanning calorimetry and elemental analysis of the nanoparticles obtained, 5 % of the powder mass was related to thiacalixarene units. The effect of thiacalixarene functionalization of silica nanoparticles on linear polydimethylsiloxane (PDMS)—silica dispersions was modeled to achieve high resistance toward liquid media required for similar sol–gel prepared PDMS-based materials applied for solid-phase microextraction. In such a manner, the influence of thiacalixarene-modified nanofiller on thermal stability and resistance against polar organic solvents was estimated. Similarity of decomposition temperature of both thiacalixarene-functionalized nanoparticles and non-functionalized silica nanoparticles was found. Swelling/solubility behavior observed was related to partial dissolution of PDMS/silica (10 % mixture) in alcohols. Thiacalixarene-functionalized silica particles exerted significantly higher resistance of PDMS/silica composites toward alcohol solvents.

http://dx.doi.org/10.1007/s11051-015-2932-6

Keywords

Colloid particles, Polydimethylsiloxane, Silica dispersion, Silica nanopowder, Swelling, Synthesis, Thermal decomposition, Thiacalix[4]arenes