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Synthesis and characterization of silica nanoparticles and graphene oxide/nanosilica composite

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Ordinary sand is commonly used for water purification. Graphene oxide (GO) is capable of absorbing various water pollutants such as heavy metals and organic contaminants. The ability and the efficiency of water treatment process is proposed to be enhanced using silica nanoparticles and GO/nanosilica composites. Silica nanoparticles and GO/nanosilica composite were synthesized and characterized. Silica nanoparticles were synthesized using tetraethyl orthosilicate and following the sol-gel method. Graphene oxide was synthesized using the modified Hummers' method. Silica nanoparticles, graphene oxide membrane and GO/nanosilica composite were characterized using Fourier Transform Infrared Attenuated Total Reflection Spectroscopy (FT-IR ATR), Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Absorption Spectroscopy (ED-XAS) and X- ray Diffraction (XRD). The size of silica nanoparticles was found to be in the range of 50-110 nm with SEM data, which confirms the synthesis of nano-sized silica particles. The sheet like structure with aggregated and folded surfaces of graphene oxide was observed in the SEM analysis of graphene oxide. The interphase between silica and graphene oxide was observed in SEM analysis of GO/nanosilica composite. FT-IR ATR data supported for the identification of functional groups of silica nanoparticles, graphene oxide membrane and GO/nanosilica composite. The peak at 1093cm^{-1-} for asymmetric stretching of Si-O-Si bonds and the peak at 800 cm^{-1} for symmetric stretching of Si-O-Si bonds are characteristics peaks of silica. The peaks at 3441 cm^{-1} for the stretching vibration of hydroxyl groups, at 1739 cm^{-1} for the stretching vibration of carbonyl groups and at 1391 cm^{-1} for the stretching vibrations of epoxy groups are characteristics peaks of graphene oxide. The FT-IR ATR spectrum of GO/nanosilica composites showed peaks for both silica and graphene oxide. ED-XAS data showed the presence of corresponding elements in each samples. Data from ED-XAS of silica nanoparticles supported the presence of silicon and oxygen while the ED-XAS of GO/nanosilica showed that the presence carbon, oxygen, silicon as the main elements of the sample. XRD spectrum of silica nanoparticles showed a strong broad peak at 22.22 (2θ). A broad peak for silica was observed in the XRD spectrum of GO/nanosilica composite similar to the XRD spectrum of silica nanoparticles. The data from SEM, FT-IR ATR, ED-XAS and XRD confirms the successful synthesis of silica nanoparticles and GO/nanosilica composite.

Keywords: Water treatment, Silica nanoparticles, Graphene oxide, Synthesis, Characterization