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Graphite oxide / TiO_2 advanced hybrid material using Sri Lankan graphite: Synthesis and characterization

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Sri Lanka has deposits of vein graphite consisting of a high crystallinity and high purity (> 99 % of carbon). Graphite being a lamellar structure that is both electrically and thermally highly conductive, allows it to be a versatile material for use in hybrid materials and nanocomposites. Graphite oxide (GO) which has a lamellar structure and is derived from graphite is a promising material for the synthesis of nanocomposites.

In this study, the synthesis of GO/TiO_2 hybrid material was carried out at low temperature using GO formed from Sri Lankan vein graphite and titanium oxysulfate ($TiOSO_4$) as reactants. Here we investigated the intercalation of nano-TiO_2 particles in the d-spacing of the lamellar structure of exfoliated GO from Sri Lankan vein graphite. Hummers' method was used to oxidize vein graphite to produce GO using potassium permanganate ($KMnO_4$) at 20 °C. Exfoliated graphite oxide (GO) was then used to intercalate with TiO_2 synthesized using a sonication method. Raw materials, intermediate products, and the hybrid material were analyzed using X-ray diffraction (XRD) analysis, thermal gravimetric analysis (TGA), scanning electron microscopy (SEM), and Fourier transform infrared spectroscopy (FTIR) to observe material characteristics and their physical and chemical properties. Graphite showed high crystallinity at the (002) plane at 26.5 degrees. For GO this (002) plane was shifted to a value of 9.84 degrees, indicating the expansion of the d-spacing. For the GO/TiO_2 hybrid material, the d-spacing has been reduced due to the shift of the (002) peak to a value of 11.48 degrees. SEM images obtained at 25 kV showed that the growth of TiO_2 on the composite surface was in agglomerate form with a particle size range of 100-500 nm. FTIR indicated a strong peak at 1580 cm^{-1} for vein graphite. There were multiple peaks for GO at 1580 cm^{-1}, 1680 cm^{-1}, 3400 cm^{-1}, 1100 cm^{-1}, and 1400 cm^{-1} indicating the presence of oxygen containing groups. The GO/TiO_2 hybrid material showed few extra peaks with small intensity in the Raman spectra at 640 cm^{-1}, 510 cm^{-1}, and 400 cm^{-1}. Photocatalytic activity of TiO_2 intercalated GO hybrid material was investigated using a methyl orange solution. The degradation of methyl orange in the presence of hybrid material was studied by employing UV-visible spectrophotometry and compared with pure nano-TiO_2 (< 25 nm). The results showed that after 60 minutes, the advanced hybrid material (GO/TiO_2) degraded 95% of methyl orange while nano-TiO_2 has only degraded 46% under UV irradiation.

Keywords: Graphite, Graphite oxide, , Hybrid material, Photocatalytic activity, Titanium dioxide