

SYNTHESIS, STRUCTURAL AND MAGNETIC PROPERTIES OF α -Fe₂O₃ NANOPARTICLES AND THEIR COMPOSITES WITH GRAPHITE, GRAPHENE AND GRAPHENE OXIDE

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Nanocomposites based on carbon allotropes, including graphene, and reduced graphene oxide (RGO), have received much recent attention owing to their relevant physical properties. These materials used separately, as well as in conjunction with semiconductor nanostructures, have been shown to be effective in applications including photocatalysis, supercapacitors, Li-ion batteries, solar cells and sensors [1-3]. Among metal oxides, hematite (α -Fe₂O₃) is a widely studied semiconductor photocatalyst because of its availability, low environmental impact and corrosion resistance. Lately, a significant enhancement of the photocatalytic water oxidation activity of hematite by incorporating nanoparticles on RGO nanosheets has been reported [1], while a positive synergic effect of RGO and hematite on the improvement of charge and discharge capacities of Li-ion batteries has also been recently observed [2].

α -Fe₂O₃ nanoparticles and their composites with graphene, graphite and GO, were synthesized by means of a sol-gel method of hydroxide precipitation at low temperature. The morphology, structure and composition of the samples were studied by X-ray diffraction (XRD), micro-Raman spectroscopy, scanning electron microscopy, high-resolution transmission electron microscopy (HRTEM) and energy dispersive X-ray microanalysis (EDS), while their magnetic properties were assessed by SQUID magnetometry.

The as-grown crystalline nanoparticles show an average size of 5 nm, as revealed by HRTEM observations. Raman and XRD measurements indicate that the synthesis route critically determines the crystallinity and phase composition of the final products. A homogeneous distribution of the nanoparticles on the graphene/GO/graphite sheets was observed by SEM, EDS and TEM observations. DC and AC magnetization measurements reveal a superparamagnetic behavior with strong dipolar interactions between the hematite particles in all the samples investigated. Moreover, zero field cooled memory experiments of the thermal variation of the magnetization allowed us to confirm that both the hematite nanoparticles and their composites with graphene and graphite show superspin-glass behavior.

References

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