Synthesis and Properties of Conducting Polymer Composite Films Containing Nanometer-Sized Magnetite Particles of Fe$_2$O$_3$

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Four polymer films containing Fe$_2$O$_3$ nanoclusters were prepared by casting and spin-coating techniques. The films were examined using transmission electron microscopy (TEM). The electric conductivity and magnetic property of the films were also investigated.

Much interest has recently been directed towards the polymer materials containing magnetic nanometer particles in both technological and theoretical aspects. Practically they are developed in the fabrication of magnetic data-recording media as well as in the form of thin films in a range of protective or sensitive coatings. In this work, we report the preparation of nanometer-sized Fe$_2$O$_3$ magnetic clusters and the composite films in polymer matrix.

Preparation of nanoparticulate magnetic Fe$_2$O$_3$ was based on the method as followed: 15 ml aqueous solution of 3.5 g FeCl$_3$·4H$_2$O was mixed with 15 ml water solution of 6.2 g FeCl$_3$, and 15 ml concentrated NH$_4$OH (15 M) was added dropwise in the mixture under stirring with magnet bar. Stopped stirring, the black precipitate was settled down the bottom of container. After the supernatant solution was decanted, the solid was suspended in 40 ml of 0.5 M NH$_4$OH and stirred for 20 min., then the magnetic precipitate was reseparated by settlement and decantation. The solvent in the solid was exchanged from water to absolute ethanol and finally to chloroform in order to get miscible particles within organic solvents in fabricating polymer composite films. The precipitate was transferred to a round-bottom flask of 50 ml and the residue of water was removed by rotary evaporation. A solution of 0.8 g of lauric acid in 40 ml
of absolute ethanol was added to the flask which was then placed in a sonication bath to speed the dispersion of the particles for 60 minutes. The ethanol was removed by rotary evaporation, and 30 ml of chloroform was added to the flask. The redispersion of magnetite was again aided by using the same method and subsequent extraction of the chloroform gave a dry magnetic powder.

Polyaniline (PANI) was synthesized from an aqueous solution of aniline, ammonium peroxydisulfate, \((\text{NH}_4)_2\text{S}_2\text{O}_8\), and HCl. Poly(phenylacetylene) (PPA) was prepared by using Rh-complex as catalyst in this research group.\(^3\) \(\text{HC}≡\text{C(CH}_2)_2\text{COO-biph-p-CN}\) was polymerized using \(\text{Mo(nbd)}(\text{CO})_4\) (nbd: norbornadiene) as catalyst in \(\text{CCl}_4\) at 60°C. Other polymer (e.g., PVK) was purchased from Aldrich.

The composite films containing nanometer-sized magnetic particles were fabricated by dissolving polymers using appropriate solvents with the prepared magnetic particles.

The films obtained were examined by TEM and the conductivity and magnetic properties were also studied.