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Conducting Polyaniline-Titanium Dioxide Nanocomposites Prepared by Inverted Emulsion Polymerization

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Abstract

Conducting polyaniline (PAni)-titanium dioxide (TiO_2) nanocomposites have been synthesized by the inverted emulsion polymerization method. The resultant PAni-TiO_2 nanocomposites are characterized with their structural, morphological, conducting and optical properties.

Introduction

The syntheses of organic-inorganic hybrid nanoparticles with different combinations of two components have attracted more and more attention, since they have interesting physical properties and potential applications.

Conducting polymers, however, arouse a great interest among researchers because of their curious electronic, magnetic and optical properties. The PAni-TiO_2 nanocomposites are characterized by using various techniques and results are discussed in detail.

Experimental

Aniline monomer was distilled under a reduced pressure and kept below 0 prior to use. Titania nanopowder, cetyl trimethylammonium bromide, chloroform, hydrochloric acid, ammonium persulfate and other organic solvents were obtained from Aldrich as reagent grade and were used as received.

A typical inverted emulsion polymerization method for the PAni-TiO_2 nanocomposites was carried out by the routine synthesis.

Results and Discussion

FE-SEM images of bulk PAni powder and PAni-TiO_2 nanocomposites are displayed in Fig. 1. From Fig. 1a, one can see that the pristine PAni, synthesized without TiO_2 nanoparticles, shows typical morphology. In Fig. 1b, it shows the PAni-TiO_2 nano-sized composites with the diameter between 50 nm and 200nm are produced by the inverted emulsion polymerization method. The TEM image as shown in Fig. 1c also supports that the PAni-TiO_2 nanocomposites are produced with a preaggregated or glued titania in the cores (inside black components) and polymer in the shells (outside white components) morphological structures in our work successfully.

As a result, the formation of PAni-TiO_2 nanocomposites should be the effect of free aniline cation-radicals adsorb on the surface of TiO_2 nanoparticles growing together by the inverted emulsion polymerization method.

The FT-IR spectra of the bulk PAni powders and PAni-TiO_2 nanocomposites are given in Fig. 2. In the PAni spectrum (Fig. 2a), it is in correlation with previously reported results. The bands at 1572 and 1504 cm-1 show the characteristic C=C stretching of the quinoid and benzenoid rings. The peaks at 1306 and 827cm-1 can be assigned to the C-N stretchingof the secondary aromatic amine and an aromatic C-H out-of-plane bending vibration, respectively. Figure 2b indicates that all characteristic bands of polyaniline are present between 700 and 1600 cm 1 and these are all found in PAni-TiO_2 nanocomposites, the relative intensity of the some bands has changed due to presence of nano-TiO_2. And the presence of TiO_2 nanoparticles led to the shift of some peaks in PAni macromolecules.

UV-vis spectroscopy is used to observe the optical properties of the bulk PAni powders and PAni-TiO_2 nanocomposites in N-methylpyrrolidinone (NMP) solutions. For pristine PAni (Fig. 3a), two electronic bands are found at 320 and 596 nm. These bands originate from the π-π* transition of benzene rings and quinoid exciton bands, respectively. The presence of metal nanoparticles with polymer's oxidation states during the chemical synthesis is confirmed from the PAni-TiO_2 composite peak (Fig. 3b) by the blue shifting of corresponding peaks from 596 nm to 582 nm and from 320 nm to 294 nm as well as the change of their relative intensities.

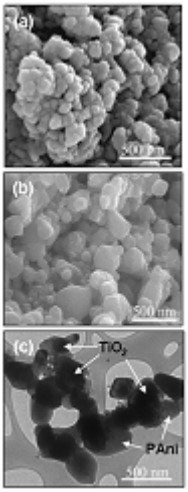

FIG. 1. FE-SEM images of (a) bulk PAni powders, (b) PAni-TiO_2 nanocomposites, and (c) TEM image of PAni-TiO_2 nanocomposites synthesized by the inverted emulsion polymerization method.

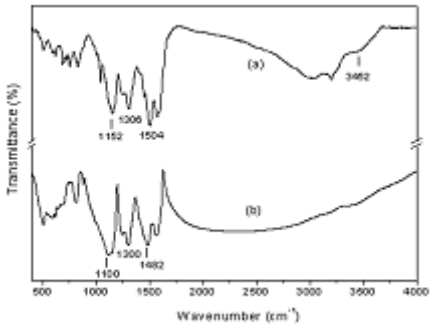

FIG. 2. FT-IR spectra of (a) bulk PAni powders and (b) PAni-TiO2 nanocomposites synthesized by the inverted emulsionpolymerization method.

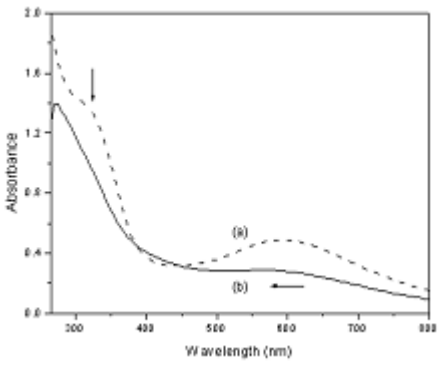

FIG. 3. UV-visible spectra of (a) bulk PAni powders and (b) PAni-TiO2 nanocomposites synthesized by the inverted emulsion polymerization method in NMP solution.