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Preparation and Characterization of Iron Oxide Nanoparticle/Poly (maleic monoester) Nanocomposite Films

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Abstract The iron oxide nanoparticle with around 80 Å diameter were successfully synthesized in aqueous solution and its nanocomposite film was prepared with poly(maleic monoester) by Langmuir-Blodgett techniques. The deposition of iron oxide nanoparticle in the polymer film was identified with FT-IR and UV-vis spectrophotometer.

Keywords: nanocomposite film; iron oxide

INTRODUCTION

The nanoparticle has brought much attention in chemistry, physics, and applied science. Especially, iron oxide particle has been used as a magnetic recording materials. The conventionally used materials for the information storage system is metal oxide like iron oxide, nickel oxide, and cobalt oxide.[1-3] Furthermore, fortunately, the information system has brought rapid attention

on the magneto-optics to increase the capacity of storage in the unit volume and the recording speed. The point here for the information storage system with the magnetic recording media is the synthesis of magnetic nanoparticle of iron oxide and their Langmuir-Blodgett ultrathin film of poly(maleic monoester) (PMA). The prepared films are characterized with pressure-area isotherm, FT-IR and UV-vis spectrophotometer.

EXPERIMENTAL

The nanoparticle of iron oxide was synthesized as the procedure described before.[4] The size distribution of iron oxide nanoparticle was checked as diameter of 80 ± 8 Å with TEM. PMA was synthesized by the procedure described previously.[5] The pressure-area isotherm and Langmuir-Blodgett film was prepared in KSV MINITROUGH. FT-IR and UV-vis studies were carried out in Perkin-Elmer Spectrum 2000 and Hitachi Model U-3210 Spectrophotometer, respectively. The clear hydrosol of iron oxide was prepared at pH = 4.0 to be used as a subphase of the Langmuir monolayer trough. The concentration of iron ion in hydrosol was determined as 9.29×10^{-5} M with atomic absorption spectrophotometer, Shimatzu AA-680. The pressure-area isotherm of PMA in pure water and hydrosol of iron oxide were obtained at room temperature. The preparation of Langmuir-Blodgett film of PMA/iron oxide nanoparticle was carried out by transferring onto the CaF_2 and quartz plate for FT-IR and UV-vis at surface pressure of 30 mN/m.

RESULTS AND DISCUSSION

The isotherm of PMA in the iron oxide nanoparticle hydrosol subphase showed a similar mean molecular area at specific surface pressure compared

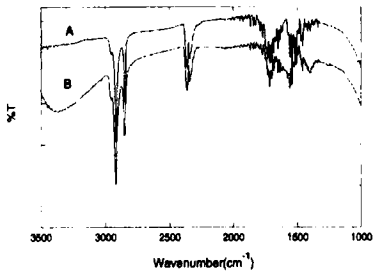

FIGURE 1. FT-IR spectra of Langmuir-Blodgett films of PMA deposited at 30 mN/m surface pressure in the subphase of pure water (A) and iron oxide nanoparticle hydrosol (B) with 25 layers.

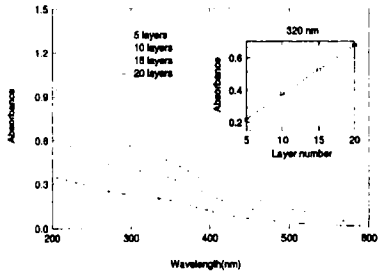

FIGURE 2. UV-vis spectra of PMA Langmuir-Blodgett films of 5, 10, 15, 25 number of layers deposited at 30 mN/m surface pressure in the subphase of iron oxide nanoparticle hydrosol and the optical absorbance at 320 nm versus number of layers.

to the pure water subphase. The collapse pressure of the PMA Langmuir monolayer in the iron oxide nanoparticle hydrosol was slightly lower than that in pure water subphase. This is contrast with the previous results with stearic acid and poly (octadecene-co-maleic anhydride).[6,7] The electrostatic interaction of iron oxide nanoparticle with carboxylate group of PMA was successfully identified with FT-IR results as shown in Figure 1. The IR spectrum of PMA in the pure water subphase showed the carbonyl stretching vibration around 1700 - 1740 cm^{-1} of carbonyl group of carboxylic acid and ester group. This peak intensity was decreased to half intensity in the iron oxide nanoparticle hydrosol subphase by complexation of carboxylic acid group with iron oxide nanoparticle and changed into the carboxylate. This is shown by the appearance of twin peak at 1400 and 1525 cm^{-1}.

The complexation of iron oxide nanoparticle with carboxylate group of PMA and accumulation of iron oxide nanoparticle into Langmuir-Blodgett film is also indirectly indicated in the optical absorption density around 320 nm. The optical absorbance was almost linearly increased with increasing deposition layer number of PMA Langmuir-Blodgett film transferred in the iron oxide nanoparticle hydrosol subphase as shown in Figure 2. This indicates that the increasing deposition layer number increases the number of iron oxide nanoparticle in the unit volume of the Langmuir-Blodgett film.

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