

## In situ Synthesis and Characterization of Spherical CdS/Polyacrylamide Nanocomposites by $\gamma$ -Irradiation in W/O Microemulsions

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Spherical CdS/polyacrylamide (CdS-PAM) nanocomposites were successfully synthesized in single step by  $\gamma$ -irradiation in a W/O microemulsion under ambient pressure at room temperature. The final product was characterized by various means such as XRD, IR, UV-vis, PL, ED and TEM. The TEM image clearly showed the homogeneous dispersion of CdS-PAM nanocomposites with the dimension of 50 nm.

Since inorganic/organic polymer nanocomposites own many intriguing optical, electrical, catalytic and mechanical properties and potential applications in microelectronics,<sup>1-4</sup> much attention has been paid to syntheses and characterization of kinds of composites. These composites not only combine the advantageous properties of inorganic materials and polymers, but also exhibit many new characteristics which single-phase materials do not own.

Many methods have been employed to synthesize the semiconductor/polymer nanocomposites. The first system involving dispersed semiconductor/polymer arrangements through embedding monograin CdS particles on the order of 40  $\mu\text{m}$  diameter in a thin, nonconductive polyurethane membrane was reported by Meissner in 1983.<sup>5</sup> Later, a new method of incorporating a dispersed semiconductor CdS throughout an ion-conductive Nafion polymer membrane was developed.<sup>6,7</sup> In the past decade, many semiconductor/polymer nanocomposites, such as PbS/poly(ethylene-15% methacrylic acid),<sup>8</sup> CdS/polystyrenes-*block*-poly(vinylpyridine)s,<sup>9</sup> CdS/poly(*N*-vinylcarbazole)<sup>10</sup> and CdS/polystyrene,<sup>11</sup> had been synthesized via a variety of methods. However, in these methods, to initiate the polymerization of monomers and the formation of semiconductor compounds, a relatively high temperature was often needed.

Recently,  $\gamma$ -irradiation method has been developed for the preparation of various semiconductor/polymer nanocomposites in aqueous solution containing aqueous soluble monomer and inorganic salts.<sup>12-14</sup> However, no reports of the preparation of semiconductor/polymer nanocomposites using this method in a microemulsion system were found in literatures.

Here, we report a novel method for the synthesis of spherical CdS/polyacrylamide (PAM) nanocomposites in single-step by  $\gamma$ -irradiation in a W/O microemulsion system at room temperature and under ambient pressure. In this W/O microemulsion system, octyl phenyl poly(ethylene oxide)-4 (OP-4) and octyl phenyl poly(ethylene oxide)-10 (OP-10) were selected as emulsifiers and kerosene as oil phase. The inorganic salts and AM monomers were dissolved in water before producing the microemulsion.

An aqueous solution containing CdCl<sub>2</sub>·2.5H<sub>2</sub>O (2.28 g), Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>·5H<sub>2</sub>O (3.38 g), isopropyl alcohol (10 mL) and AM monomers (5 g) was prepared in advance. The solution (10 mL) was then added into a 40 mL mixture of kerosene and OP-4 (7.0 g). OP-10 was titrated into the mixture under stirring until a transparent microemulsion suddenly formed. After the microemulsion

was irradiated in the field of a <sup>60</sup>Co  $\gamma$ -ray source for 6 h with an absorption dose of 18 kGy, a bright yellow semi-transparent microemulsion was obtained and de-emulsified by acetone and distilled water. The products were repeatedly washed with distilled water and ethanol, and dried in vacuum at room temperature for 4 h.

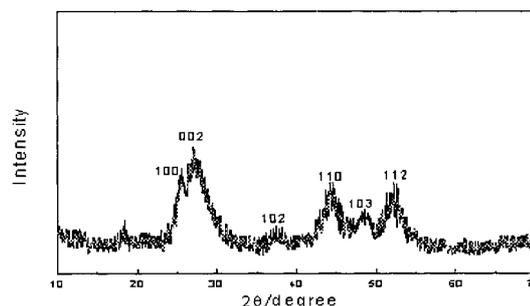


Figure 1. XRD pattern of CdS/PAM nanocomposites prepared by  $\gamma$ -irradiation in a W/O microemulsion, with the absorption dosage of 18 kGy.

Figure 1 shows the XRD pattern of the CdS/PAM nanocomposites obtained by  $\gamma$ -irradiation in the W/O microemulsion. The peaks with  $2\theta$  values of 25.7°, 27.0°, 37.8°, 44.1°, 48.4°, 52.4° correspond to the crystal planes of 100, 002, 102, 110, 103 and 112 of hexagonal CdS form by comparison with the data from JCPDS file no. 41-1049, respectively. According to Scherrer's equation,<sup>15</sup> the average size of CdS nano-particles is estimated to be about 2 nm. In addition, a weak absorption peak at 420 nm is found in UV-vis spectrum of the final product. Related to that of the bulk material of CdS (513 nm), an obvious blue shift can be observed. However, no PL peak is shown in the range from 300 nm to 800 nm in PL spectrum of the product.

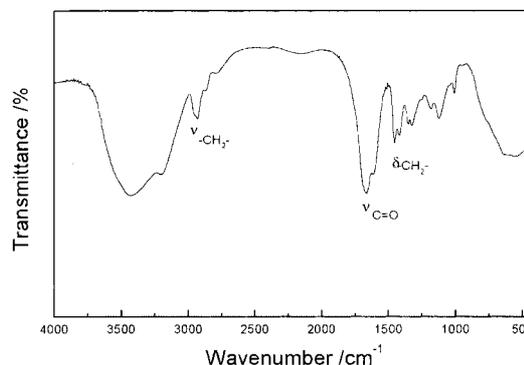


Figure 2. IR spectrum of the sample shown in Figure 1.

The organic content in the composite is so low that only a weak peak at  $2\theta = 18^\circ$  is seen in Figure 1. Nevertheless, the presence of polymer can be confirmed by IR spectrum of the product (see Figure 2). Comparing with the standard IR spectra of PAM

