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Fabrication of Ordered Macroporous CdS and ZnS by Colloidal Crystal Template

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Abstract: Ordered macroporous semiconductors CdS and ZnS with regular arrays of spherical pores have been fabricated by poly (styrene-acrylic) (PSA) colloidal crystal template. It was found that the exact three-dimensional (3D) structure of the template had been imprinted in the final material.

Keywords: CdS macroporous structure, chemical synthesis, transmission electron microscopy.

The study of ordered macroporous materials is the focus of recent research in this field owing to their current and potential applications[1]. Many techniques[2-4] have been contributed to the fabrication of porous materials. Among them, colloidal crystal template-directed synthesis[5] has been demonstrated to be a convenient and versatile method. Recently, there is a special attention paid to the macroporous II-IV semiconductor solids. Norris reported an ordered macroporous semiconductor solid by inducing quantum dots inside a self-organized silica template[1]. Braun developed an electrochemical deposition technique to create 3D periodic macroporous CdS and CdSe[6]. Herein, we suggest a succinct chemical deposition path for fabrication of CdS and ZnS solids with long-range ordering and uniform porosity using PSA colloidal crystal as template. It was found that the 3D ordered structure of template had been imprinted in the final material.

Synthesized by emulsion co-polymerization, monodispersed PSA latex spheres could directly self-assemble to 3D ordered arrays when the solvent was evaporated. Sulfide could form around the latex after template pellet was sunk into the cadmium acetate and thiacetamide (TAA) saturated ethanol solutions respectively. Then the composite was washed by tetrahydrofuran (THF) to removal the template, leaving porous sulfide behind.

The SEM image of the template **(Figure1)** suggests that the ordering extends over 3D. In the typical SEM image of porous CdS product **(Figure 2)**, three dark regions inside each hollow region indicate that the pores are close packed. The average wall thickness is about 30 nm and the diameter of each pore is nearly 260 nm. It can be conclude that the 3D ordered structure has been preserved after the removal of template.

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Figure 1 SEM image of the PSA colloidal crystal template, taken on an X-650 scanning electron microanalyzer

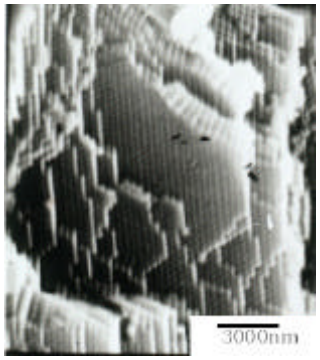

Figure 2 SEM image of macroporous CdS solid

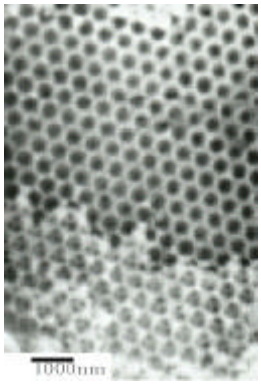

Figure 3 TEM image of the macroporous ZnS, taken with Hitachi H-800 microscope operated at 200kv

ZnS macroporous solid has also been prepared using zinc acetate instead of cadmium acetate *via* the same procedure. Its TEM image is shown in **Figure 3**. Some layers of the voids on the edge of the sample also demonstrated the 3D nature of the material. PSA latex was beneficial to the penetration of the precursor solution owing to its better wettability. And the nucleophilic carboxyl on the PSA spheres surface is also favorable for the infusion of the inorganic salts.

Acknowledgments

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