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Yan Li [a] , Jinghua Wan [a b] & Zhennan Gu [a]

[a] Department of Chemistry, Peking University, Beijing, 100871, P. R. China

[b] Mechanical Engineering College in Shijiazhuang, Hebei, ChinaVisiting scholar from the

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Synthesis of ZnS Nanowires in Liquid Crystal Systems

YAN LI, JINGHUA WAN* and ZHENNAN GU

Department of Chemistry, Peking University, Beijing 100871, P. R. China

The synthesis of ZnS nanowires in hexagonal liquid crystal systems was studied. It was found that the hexagonal liquid crystal can act as the synthesis template in proper condition.

Keywords: hexagonal liquid crystal; ZnS nanowire; synthesis template

INTRODUCTION

Nanowires of metals and semiconductors are of special importance in material technology [1,2]. The nanowires are often prepared with physical methods[2]. Recently, the supramolicular template synthesis of nanomaterials is being taken more and more interest[3]. There are mainly two kinds of templates, i. e. "hard" template and "soft" template. A lot of studies about the hard templates have been reported[4,5], but seldom on soft template method. Qi et al.[6] reported the synthesis of $BaCO_3$ nanowires in reverse micelles. But the surfactant assemblies did not act as the synthesis template in this case. Braun et al.[7] prepared the superlattices of CdS nanoparticles with the hexagonal liquid crystal as the template. Many one-dimensional spaces surrounded by surfactant molecules exist in the hexagonal liquid crystals. Hence, we suggest that such system could act as

* Visiting scholar from the Mechanical Engineering College in Shijiazhuang, Hebei, China

the template for the synthesis of nanowire superlattices. We therefor studied the template synthesis of ZnS nanowires in hexagonal liquid crystals in this paper.

EXPERIMENTAL

AEO-7, $C_nH_{2n+1}(OCH_2CH_2)_7$-OH (Henkel Co.), used as purchased. All other chemicals used are of analytical reagent grade. The liquid crystals are all of the phase ratio of 1:1 (V_W:V_S). The nanowires of ZnS are prepared by the controlled reaction between Cd^{2+} and H_2S. The structure of the liquid crystal was studied with a Rigaku D/MAX2000 XRD Meter. The samples were dispersed in ethanol, dropped on copper nets and investigated under a JEM-200CX TEM.

RESULT AND DISCUTION

The XRD result (FIGURE 1) show that the ratio among the Bragg distances is in consistent with that of the hexagonal liquid crystal, which is $1:1/\sqrt{3}:1/\sqrt{4}:1/\sqrt{7}:1/\sqrt{12}$. It was calculated out that the diameter of the surfactant cylinders is 11nm, the size of the gaps among the cylinders is 2.9nm.

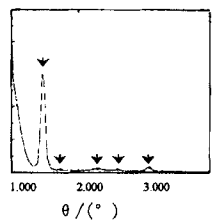

FIGURE1 The XRD pattern of the liquid crystal

The TEM results are shown in TABLE 1 and FIGURE 2. It was found that the crystal shape is very sensitive on the H^+ concentration, the

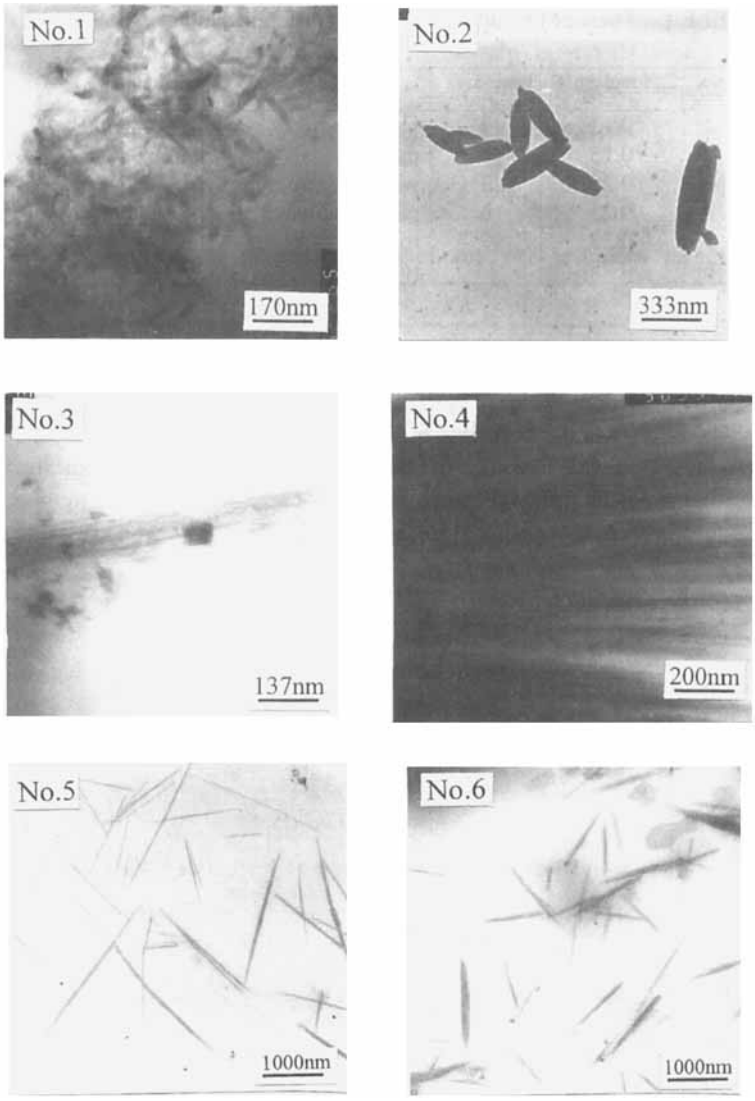

FIGURE 2 The TEM images of ZnS formed in liquid crystal systems

TABLE 1 The TEM results of samples at different synthesis conditions

No.	C_{H^+}(mol dm^{-3})	Time(day)	Image Shape	Size(nm×μm)
1	0.13	3	particles	20×0.1
2	0.13	9	particles	130×0.8
3	0.25	3	wire-like structure	
4	0.25	6	paralleled wires	1×8
5	0.25	9	rods	40×3
6	0.25	14	rods	100×1.2

concentration of 0.25 mol dm^{-3} is proper for the growth of nanowires. The crystal will become thicker but shorter along with the prolonged reaction period, six days is the best time for nanowires' growth. In sample 4, the nanowires are as thin as 1 nm, and they lie in parallel form. This indicates that the nanowires should grow in the gap water phase among the hexagonally packed cylinders of surfactant molecules.

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