The effect of sulfur on the structure of carbon nanomaterials synthesized by liquid-phase deposition method

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We have recently developed a novel catalytic method for synthesizing a wide variety of carbon nanomaterials in the organic liquid[1]. The method realized a simple, speedy and a high-purity growth of carbon nanomaterials in the organic liquids.We have reported that the added H_2S in the gas phase enhanced the sp^3 formation both in the CVD growth of the diamond and the carbon nanotube [2-3]. In the case of the liquid phase growth system, how affect the sulfur on the morphology and structure of the carbon nanomaterials is indispensable in the viewpoint of realizing a controllable process for obtaining the new carbons. In this study, a mixture of 1-octanethiol ($CH_3(CH_2)_7SH$; OcSH) and 1-octanol ($CH_3(CH_2)_7OH$; OcOH) was used as an organic liquid. We have investigated the effect of ratio of OcSH to OcOH on the morphology and structure of the grown materials.

The cobalt (Co) catalyst was sputtered on Si with approximately 6 nm thickness. For the oxidation pretreatment, the catalyst was annealed at 1173 K for 10 min in air. For the growth of carbon nanomaterials, the mixture of OcSH and OcOH was used as an organic liquid source. The ratio of OcSH to OcOH was 100 %, 50 %, 10 %, 5 %, 3 %, 1 % and 0 %. The catalyst-supported Si substrate was electrically heated in the temperature range from 973 K to 1173 K in the organic liquid. The morphology of the grown carbon nanomaterials were observed by a scanning electron microscopy (SEM). Laser raman spectroscopy was used to reveal structures.

Fig. 1 shows the nanomaterials synthesized by the liquid phase deposition method with using the mixture of OcSH and OcOH. The ratio of OcSH to OcOH was 100 % (fig. 1(a)), 50 % (fig. 1(b)), 3 % (fig. 1(c)) and 0 % (fig.1(d)), respectively. Both Fig. 1(a) and 1(b) showed that the thick fibriform materials and the film-like materials were obtained. As shown in Fig. 1(c), the grown nanomaterials were knotted fibriform materials. In the case of Fig. 1(d), the straight fibriform materials were obtained.The content of OcSH, namely, the amount of sulfur in the liquid phase carbon source resulted in a wide variety of morphologies in the grown nanomaterials.

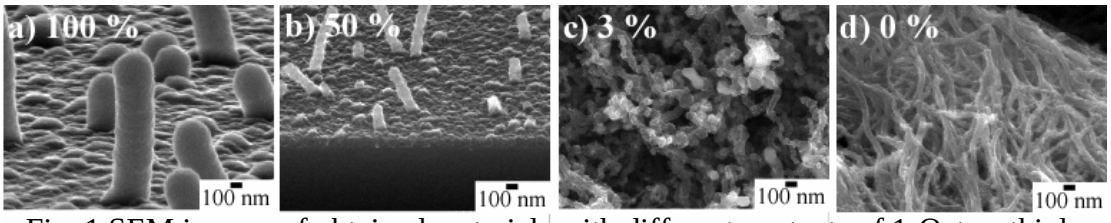

Fig. 1 SEM images of obtained materials with different contents of 1-Octanethiol of (a) 100 %, (b) 50 % , (c) 3 % and (d) 0 % for 1-Octanol in balance. The reaction temperature was 1073 K. The growth period was 10 min.

References

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