

Matching between Reaction and Catalyst Conditions in Growing VA-SWNTs by ACCVD

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In the direct growth of SWNTs on substrates by CVD methods, preparation of the catalyst nanoparticles is a crucial issue. Co-Mo binary catalysts effectively grow SWNTs either from CO [1] or from alcohol [2]. However, different values are reported as the optimum Co/Mo atomic ratio; 1/3 for the former [1] and 1.6/1 for the latter [2]. The structure of catalyst nanoparticles should be determined not only by the composition but also by the amount of catalyst metals, and optimum conditions should depend on the CVD conditions.

In this study, SWNT growth by alcohol catalytic CVD with Co-Mo catalyst was systematically investigated, by mapping the SWNT yield against the orthogonal gradient thickness profiles of Co and Mo [3]. Vertically-aligned SWNT forests grew in 10 minutes at several regions including Co/Mo ratios of 1/3 and 1.6/1 mentioned above. The temperature for catalyst reduction before CVD did not affect the regions for forests so much compared to the temperature for CVD. Maximum heights of forests were about 30 μm either at 1123 K or 1023 K under different catalyst conditions. Figure 1 shows TEM images of the as-grown SWNTs obtained under the optimum condition and histograms of their diameter distribution. SWNTs had a monomodal diameter distribution when they were grown by Co-Mo catalyst at 1123 K, on the other hand it had bimodal distribution when they were grown by Co catalyst at 1023 K. The bimodal distribution was possibly caused by the bimodal size distribution of catalyst particles evolved by Ostwald ripening process during CVD.

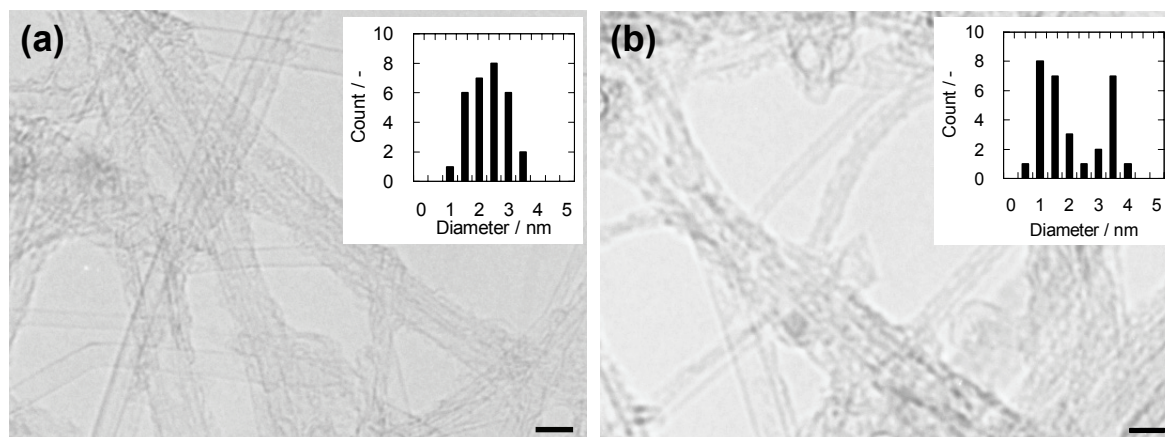


Fig. 1 TEM images and histograms of diameter distribution of as-grown SWNTs

(a) Co:0.22nm Mo:0.14nm Temperature:1123 K (b) Co:0.78nm Mo:0nm Temperature:1023 K

Scale bar: 5 nm

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