From carbon shells to multipods - The role of nickel particle shape and size

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Abstract

The process of producing structured carbon nanofibers (CNFs) by decomposition of various hydrocarbons has attracted the attention of many researchers because of the unique properties of these carbon materials. The recent interest in CNFs and their potential applications emerges from their relationship to carbons with graphite like layers such as fullerenes and carbon nanotubes (CNTs), with particular focus on their synthesis[1,2]. However, control over the size and morphology of these materials still remains a challenge. It has been suggested that catalyst morphology plays an important role in controlling CNFs growth and its shape. Therefore one of the challenges is to produce catalyst particles that would yield the desired CNFs morphology. This study investigates the approach for controlling the size of CNFs by synthesizing metallic nickel nanoparticles (NPs) of particular morphology using microemulsion technique.

Trichloroethylene, acetylene and their mixtures were used as a carbon source to make CNFs over Ni nanoparticle catalysts in a chemical vapor deposition (CVD)[3] process in the temperature range 350-700 ^{0}C. TEM analysis of the Ni particles revealed that the Ni underwent a morphological change with increase time. Further, the shape of the carbon materials produced from the Ni catalyst was affected by temperature. The carbon shapes changed from carbon shells to bimodal, to tripod-like structures and eventually multipod-like structures with increase in temperature (350-700 ^{0}C). TEM image of a multipod-like structure is shown in Fig. 1. Irregular shaped materials were observed at temperatures greater than 500 ^{0}C. It was also found that when acetylene or an acetylene/trichloroethylene mixture was used at 450 ^{0}C, helical and linear fibers were produced. It was also demonstrated that H_2 had a dramatic influence on the morphology of CNFs. The results show that the catalyst morphology can be modified by the selective use of the carbon source to generate a wide range of carbon shapes.

References

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Figures

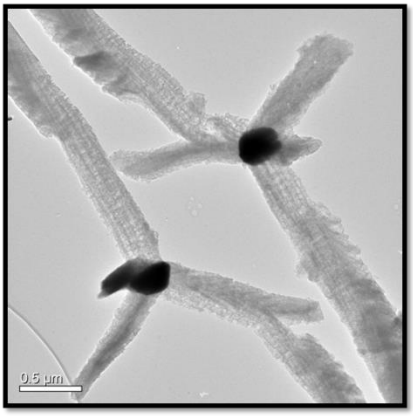

Figure 1. TEM image of multipod CNFs synthesised at 500 ^{0}C.