Carbon nanotubes grown using cobalt silicide as catalyst and hydrogen pretreatment

歐耿良
Wen HC;Yang KH;Ou KL;Wu WF;Luo RC;Chou CP

Abstract

Cobalt catalytic-layers 25 nm were deposited by sputtering on silicon substrates. At the pretreatments, hydrogen plasma was conducted for 4–16 min at 600 C in a MPCVD system. Pretreated samples were characterized using SEM and AFM. Surface morphologies of catalytic-layers were changed after hydrogen plasma pretreatments. The cobalt layers became discontinuous and some nanoparticles were formed. With pretreatments for a long time, nanoparticles tended to agglomerate to reduce surface energy and larger nanoparticles were observed. It is believed that the optimum pretreatment condition for the growth of carbon nanotubes could be achieved because relatively high growth failure and nanofibers (>100 nm) was observed for shorter and longer than 12 min pretreatment, respectively. It is found that the hydrogen pretreatment is a crucial step for the making of nucleation sites in the synthesis of carbon nanotubes using cobalt silicide as catalyst on Si substrates. After the pretreatment, mixture gases of hydrogen and methane were then flowed into the chamber for 12 min, samples were characterized using SEM, TEM and Raman spectrum. Carbon atoms were adsorbed on the islands of catalysts, and then diffused into the edge of nanotubes. Cobalt silicides were formed due to high processing temperature, and cobalt atoms tended to diffuse and stay on the silicon substrates, which enhance carbon nanotubes to grow under the root growth mechanism.