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Analytical Model to study the effect of presence of water in PECVD chamber on the growth and characteristics of Carbon Nanofibers

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The authors have developed an analytical model to study the advances in growth characteristics of carbon nanofibers (CNFs) in the plasma enhanced chemical vapor deposition (PECVD) system in the presence of acetylene, hydrogen, and water vapors. The model is divided into two parts: (i) plasma sheath model that accounts the kinetics of all plasma species (electrons and ions and neutrals of hydrocarbons, hydrogen and water molecules) in the bulk plasma, (ii) surface deposition model that accounts the deposition of plasma species on the catalyst-substrate surface via various surface deposition processes, poisoning of catalyst surface, and accumulation of carbon species in the form of stacked-rolled graphitic layers or carbon nanofibers. It has been observed that water vapors in the acetylene-hydrogen mixture act as the catalyst activity enhancer by removing the amorphous carbon species from the catalyst active sites. This results into the much enhanced growth of CNFs as compared to the CNF growth without water vapours. The variations of CNF growth rate have also been observed at the different concentrations of water vapors and it has been obtained that only few amount of water vapors are required to increase the CNF growth rate. The presence of excess amount of water vapors in the plasma leads to decrease in CNF growth rate. The theoretical findings obtained in the present study are in accordance with the experimental observations.

Reference

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