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On Synthesis of Nanoparticles and Carbon Nanotubes in Microwave Plasma Torch

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Microwave plasma torch is a laboratory plasma discharge that operates at atmospheric pressure and its gas temperature reaches several thousands of degrees. Therefore, it is a different plasma environment compared to other atmospheric pressure discharges used for plasma processing of materials, barrier discharges and cold plasma jets. MW torch has been successfully used for a fast surface bound synthesis of carbon nanotubes (CNTs) and a phase sensitive synthesis of iron oxide nanoparticles (NPs). The CNTs deposition from Ar/CH4/H2 mixture was studied with respect to the process of iron catalysis and catalyst poisioning. The phase of Fe catalyst and its transformation after plasma synthesis of CNTs were determined by Mossbauer spectroscopy. The effect of underlaying material was investigated for bare silicon, silicon oxide barrier layer and gold contacts. Tens of micrometer long multiwall nanotubes could be deposited on bare conductive silicon substrates. They were also grown on Fe thin film patterned by electron beam lithography and tested for emissive properties. Synthesis of iron oxide NPs was accomplished from Fe(CO)5 vapors mixed with Ar and optionally O2. High purity maghemite NPs were obtained at optimized conditions. At high oxygen flow rates the synthesized mixture of NPs contained also epsilon-Fe2O3 that has unique magnetic properties. Spatially resolved OES of the mw torch was performed in various conditions of synthesis. The torch was imaged by a fast ICCD camera that visualized its dynamics and stability. Electric field and gas flow were simulated by COMSOL Multiphysics software.

Keywords
PECVD
CNT
iron oxide