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Exploring Plasma Mechanisms of Carbon Nanostructures Synthesis in Arc Discharge

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Plasma enhanced approached are widely used for synthesis of carbon nanostructures. Among several methods for synthesis carbon nanostructures (single wall carbon nanotubes (SWNT), multi-wall carbon nanotubes (MWNT), graphene) arc discharge is the most practical one for scientific and technological purposes due to the number of advantages in comparison with other techniques. Firstly, arc discharge method yields highly graphitized nanostructures with very small defects, because the synthesis occurs at a very high temperature. As results, arc-grown SWNTs demonstrate the highest time of emission capability degradation than those produced by other techniques. Secondly, nanotubes produced in arc usually demonstrate a high flexibility, thus eventually demonstrating higher strength characteristics. The primary focus of this presentation is to review state of the art understanding of SWNT synthesis mechanism in arc discharge, methods and approaches to control parameters of arc discharge. Fundamental issues related to synthesis of SWNTs, which is relationship between plasma parameters and SWNT characteristics will be considered. It is believed that characteristics of synthesized SWNTs can be controlled by means of plasma parameters and arc discharge conditions. Effects of electrical and magnetic fields applied during SWNT synthesis in arc plasma will be explored. For instance, our recent experiments suggest that magnetic field has very strong effect on the arc discharge and the carbon nanostructures synthesis. It is also demonstrated that the magnetic field has a profound effect on the length of a SWNT synthesized in the arc discharge. An average length of SWNT increases by a factor of 2 in discharge with magnetic field as compared with the discharge without magnetic field, and an amount of long nanotubes with the length above 5 micron also increases. Electric and magnetic fields allow effective SWNT transport to the collection area, in-situ SWNT filtration from the soot and SWNT separation by their characteristics (e.g. by chirality, length, structural properties).