SIMULATION OF PLASMA DURING ARC DISCHARGE ABLATION FOR THE SYNTHESIS OF CARBON NANOTUBES*

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Carbon nanotubes is one of the rapid growing fields of study, during the past two decades, due to their superior mechanical, thermophysical, and electrical properties[1]. Nanotubes are synthesized using three major techniques: arc discharge ablation, laser ablation, and chemical vapor deposition. Out of these, arc discharge ablation is cheaper, easier and produces nanotubes with fewer topological defects[2,3]. When, an electric arc is generated between the electrodes, placed in a closed chamber filled with a background gas, the catalyst doped carbon anode evaporates to form a web of nanotubes. In order to synthesize the nanotubes of desired properties, the influence of various input parameters (quantity and type of catalyst, background pressure, electromagnetic field, and etc.) on their growth has to be fully understood. Keeping this goal in view, a numerical program is developed to simulate and analyze the arc discharge ablation process.

The numerical program combines various processes such as arc formation, electrode heating, evaporation, expansion, and plasma generation. Navier Stokes equations along with electromagnetic source and energy equation are solved in cylindrical coordinates using SIMPLE algorithm. The hybrid upwind-central differencing scheme suitable for compressible and incompressible flow regimes is used. Electrode heating and ablation rate are coupled with flow expansion to evaluate the instantaneous mass source term self-consistently. Current continuity and magnetic field equations are solved to obtain the electromagnetic source term.

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