

A simplified analytical model of diamond growth in direct current arcjet reactors

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A simplified model of a direct current arcjet-assisted diamond chemical vapor deposition reactor is presented. The model is based upon detailed theoretical analysis of the transport and chemical processes occurring during diamond deposition, and is formulated to yield closed-form solutions for diamond growth rate, defect density, and heat flux to the substrate. In a direct current arcjet reactor there is a natural division of the physical system into four characteristic domains: plasma torch, free stream, boundary layer, and surface, leading to the development of simplified thermodynamic, transport, and chemical kinetic models for each of the four regions. The models for these four regions are linked to form a single unified model. For a relatively wide range of reactor operating conditions, this simplified model yields results that are in good quantitative agreement with stagnation flow models containing detailed multicomponent transport and chemical kinetics. However, in contrast to the detailed reactor models, the model presented here executes in near real-time on a computer of modest size, and can therefore be readily incorporated into process control models or global dynamic loop simulations.

Keywords: Chemical vapor deposition (CVD); Coating; Computer simulation

Materials: C(diamond)

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