

Growth of diamond films using an enclosed methyl-acetylene and propadiene combustion flame

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Abstract

Diamond growth in low pressure combustion flames was studied using a safer, more economical substitute for acetylene: a mixture of methylacetylene, propadiene, and liquefied petroleum (MAPP gas). A burner-stabilized, low pressure, flat, premixed flame was used to deposit continuous, uniform thickness diamond films on a heated molybdenum substrate. This work identifies the dependence of film growth rate and quality on the fuel to oxygen ratio and the burner-substrate separation distance at two different reactor pressures of 70 and 250 Torr. A single substrate temperature of 800 °C was used to consistently produce well-faceted films. For the MAPP/O₂ premixed flame, it was determined that the optimal fuel to oxygen ratios for diamond growth are 0.53 at 70 Torr and 0.51 at 250 Torr. Typical growth rates at these conditions were on the order of 1 μm/h. However, growth rate and quality are very sensitive to the fuel to oxygen ratio, falling off rapidly in either direction from the optimal value. Increasing the ratio enhances secondary nucleation, and eventually results in graphitic and amorphous material. The growth rate is also very sensitive to the burner-substrate separation distance due to tight coupling between the transport and chemical kinetic time scales in the combustion reactor.

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