DIAMOND CHEMICAL VAPOR DEPOSITION

Nucleation and Early Growth Stages

by

Huimin Liu **David S. Dandy**

Department of Chemical and Bioresource Engineering
Colorado State University

The chemical vapor deposition (CVD) process, one of the most technological developments in the past decade, has made production of high-quality diamond coatings on preshaped parts and synthesis of free-standing shapes of diamond a reality. Epitaxial diamond has been grown on diamond and cubic-BN. Polycrystalline diamond films have been deposited on various non-diamond substrates, including insulators, semiconductors and metals, ranging from single crystals to amorphous materials. However, further technological development in CVD of diamond films, particularly in such challenging areas as single-crystal growth for electronic applications and low-temperature deposition for coating on optic and plastic materials, requires a detailed understanding and effective control of the fundamental phenomena associated with diamond nucleation and growth. These phenomena, especially the nucleation and early growth stages, critically determine film properties, morphology, homogeneity, defect formation, adhesion, and the type of substrates that can be successfully coated.

This book presents an updated, systematic review of the latest developments in diamond CVD processes, with emphasis on the nucleation and early growth stages of diamond CVD. The objective of this book is to familiarize the reader with the scientific and engineering aspects of diamond CVD, and to provide experienced researchers, scientists, and engineers in the academic and industry community with the latest developments and applications of diamond CVD, starting with a brief description of atomic and crystal structures of diamond and review of the various processing techniques used. It is followed by an extensive discussion of fundamental phenomena, principles and processes involved in diamond CVD, with emphasis on the nucleation and early growth stages of diamond during CVD. Diamond nucleation mechanisms, epitaxy and oriented growth are discussed on the basis of experimental observations. The nucleation enhancement methods developed to date are summarized. The effects of surface conditions and deposition parameters on surface nucleation are described. Finally, theoretical and modeling studies on surface nucleation are reviewed.

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