Diamond Crystallites Induced by Ion Beams

I. Bello[1], Q. Li[2], S. T. Lee[1]

[1]Center of Super-Diamond and Advanced Films and Department of Physics and Materials Science, City University of Hong Kong, Kowloon, Hong Kong
[2]On leave from: Northwestern University, Evanson, IL 602 08, USA

The presentation shows progress in diamond nucleation, elucidates diamond nucleation sites and discusses the structure of diamond crystallites induced on silicon surfaces using an ion beam method. Broad ion beams were extracted from methane/hydrogen/argon plasma in a Kaufman ion source. Diamond nuclei were induced on silicon surfaces by ion beam bombardment. High-resolution scanning electron microscopic images of samples exposed to ion beam doses on the order of 10^{19} cm^{-2} showed uneven, granular morphology, with a typical grain size of about 200 nm. Raman spectra indicated graphitic structures with absence of diamond peaks at 1330 cm^{-1}. The graphitic structures confined 'nanodiamond precursor' as identified by a small peak at a Raman shift of approximately 1100 cm^{-1}. The cross sectional high-resolution transmission microscopy (HRTEM) indicated predominant an amorphous carbon structure with small diamond crystallites elucidating the Raman spectra. The diamond crystallites were from approximately 2 to 6 nm in diameter. They were either embedded in the amorphous carbon matrix or attached to different sites of the silicon substrate. The crystallites grew randomly, partially epitaxially or perfectly heteroepitaxially with respect to the silicon surface. Heteroepitaxial growth of nuclei was revealed on stepped areas of the silicon. The diamond crystallites were identified by measuring the spacings of the lattice and the angle of the intersecting lattice planes with the reference to the Si (111) lattice in the same image. In addition to the well-known carbon configurations, cubic and hexagonal diamond, the article presents the conclusive evidence for the diamond polymorph designated 9R with a periodicity of 9 layers and a rhombohedral structure formation. The sizes of the 9R diamonds were from 6 to 20 nm. The 9R diamond crystals were produced by the described ion beam method. The article demonstrates the ion beam capability for nanostructuring new materials.

M1-Seventh International Symphosium on Diamond Materials
2001 Joint International Meeting San Francisco, September 2-7, 2001
Corresponding Author: I. Bello, e-mail:apibello@cityu.edu.hk