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Functional Diamond Thin Films Prepared by LPMP-CVD

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Chemically vapor deposited diamond films are well known for their promising applications in electronics, e.g. field emission display, owing to their high chemical stability and negative electron affinity. Furthermore, diamond has unique optical properties such as large refractive index and high transmittance from UV to infrared light. Highly boron-doped diamond films have received attention from several electrochemists owing to their superior electrochemical properties that are significantly different from those of the other allotropes, e.g. glassy carbon (GC) and highly oriented pyrolytic graphite (HOPG), which have been widely used as electrode materials for many years.[1,2] In the present study, diamond films with various kinds of electrical conductive structures were prepared and their application possibilities were examined.

Diamond films were deposited on Si wafers using low pressure microwave plasma (LPMP)-assisted chemical vapor deposition (CVD). A mixture of acetone and methanol was used as the carbon source, with dissolved B_2O_3 as the electrical conductive boron source, at a B/C weight ratio of $10^1 \sim 10^4$ ppm.

Firstly, graded-morphology diamond thin films were prepared in a single experimental run by use of a simple technique during the chemical vapor deposition (CVD) process: one end of the substrate was elevated, in order to achieve temperature gradient along the Si substrate. We will show that the substrate temperature has a profound effect on the morphology and grain size of the as-deposited lightly boron-doped diamond films. The morphology dependence of electrochemical properties was also observed.

Secondly, the fine particles of SiO_2 with size of visible light wavelength were arranged three-dimensionally. After deposition of diamond on the SiO_2 particles by CVD process, the SiO_2 particles and the substrate were removed by chemical etching to obtain the diamond inverse opals. As a result, the diffraction peak which reflected the particle size was observed, and the diffraction peak shift was observed in proportion to the refractive index when the air spheres were filled with silicon oil. Furthermore, by use of various patterns on the silicon substrate produced by lithography technique, diamond films with various kinds of patterns were prepared by taking them as a mold. They can be expected for various applications not only for electronic applications, e.g. electron emission but also electrochemical for application such as micro-array electrode.

Reference

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2. E. Popa, Y. Kubota, D. A. Tryk, A. Fujishima, *Anal. Chem.*, **72**, 1724 (2000).