

Diamond film and Surface Techniques

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By virtue of its excellent properties, diamond films have obtained its extensive applications in the field of surface coating, cutting tools, thermo-management, optical window and electronic devices, and thus more and more attention on diamond R & D were attracted recently. A diamond "fever" appeared. However, some troubles emerged : high quality diamond films can not be grown and controled perfectly, even now heteroepitaxy of large area diamond has not been obtained yet. As a result, it would limit people to extend the application area.

The trouble is due mainly to the less understanding of the growth mechanism of diamond under low pressure.

Diamond nucleation and growth begin from surface, so surface science and techniques will be very useful for their mechanism study.

We used surface techniques including high resolution electron energy loss spectroscopy to investigate the mechanism of diamond growth and nucleation, and found out that the growth in (111) face of diamond starts from CH₃ adsorption on the surface, catenation each other, and islands and steps on the surface were formed, then completes with adsorption of C₂H₂, which spreads out on the surface ; growth in (111) face becomes two layers by two layers mode ; the growth rate in (111) face was determined by the amount of C₂H₂ near the substrate, instead of the quantity of steps ; atomic hydrogens are necessary not only for growth but also for nucleation, they open the dimer bonds of Si on the Si (100) surface, and then saturate the dangling bond with hydrogen. Because of the catenation of CH₃, the cluster which size was big enough, will be survived from thermo-description and becomes nucleus for diamond growth.

Surface techniques can also be used in surface treatment of substrate, because surface treatment is essential requirement for diamond nucleation. We have developed four methods for high density nucleation of diamond on mirror-polished Si substrate. Nucleation density reaches as high as 10^8 -- 10^{11} /cm².

On the base of these techniques we grew epitaxially diamond directly on Si substrate, without any buffer layer like SiC in the between, the area of epitaxial layer is about 20-30 square micrometer. Due to the misfit of lattic constant between diamond and silicon, epitaxial layer was tilted and rotated with an angle against Si substrate. We used theory of dislocation to discuss and culcuate these angles.

In addition, Surface techniques also be used in diamond characterization.

One word, surface techniques are very useful for the study of diamond film, and the same for that of other films.