AFM studies of polished surfaces of CVD diamond films

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Commonly CVD diamond films must be polished to be used for many applications (windows, heat spreaders, surface acoustic wave devices, etc). The polishing of diamond is specific as the diamond crystals show highly anisotropic removal rate depending of the crystallographic orientation with respect to the velocity of grinding wheel. Since the polycrystalline CVD diamond typically has a random grain orientation its polishing is more difficult compared to single crystals. Here we studied with atomic force microscopy the topograpy of mechanically polished surfaces of microwave plasma CVD diamond films of of 0.3-0.5 mm thickness. While the surface roughness within the single grain can be as low as 0.1 nm, steps a few nm high are revealed at grain boundaries, this being ascribed to anisotropy of polishing rate of diamond with random orientation of crystallites.

The nucleation side of free-standing films grown on mirror polished Si wafers is found to be composed of diamond grains sized from 30-70 nm to 3 microns depending on growth conditions. The grain surface is concave rather than flat as a result of Si substrate etching in hydrogen plasma at early stages of the diamond deposition. The Si atoms incorporate from the plasma into first layers of growing diamond. The depth profiles of Si impurity determined from spatially resolved photoluminescence spectra revealed a strong dependence on nucleation density. It is shown that an ion implantation, followed by annealing and oxidation of the graphitized material can be used for precise removal of thin fine-grained diamond layers.