Fabrication and Application of Nanocrystalline Diamond Thin Films and Hybrid Diamond-Silicon Sensor Applications

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Nanocrystalline and ultrananocrystalline diamond combines the remarkable properties of conventional diamond, such as extreme hardness and wear resistance. Here, we report on the correlation between grain size and relevant physical and chemical properties of phase pure NCD and UNCD layers synthesized by chemical vapour deposition on silicon single crystal wafers with diameters up to six inches. The UNCD films consist of ultra-small (ca. 5 nm) equiaxed grains resulting in ultra-smooth surfaces with surface roughness equivalent to the grain size. The mechanical properties show that due to the large number of grain boundaries with highly disordered atomic structure the Young's modulus is decreased from about 1010 GPa to 500-700 GPa and fracture strength is increased from 1 GPa to ca. 5 GPa. The electrically conductive UNCD layers exhibit a piezoresistive effect which makes it useful for sensing applications.

As a step further, by a combination of photolithographic masking and controlled reactive ion etching processes, complex shaped microparts are designed and fabricated. Some applications will be discussed, such as a prototype silicon-diamond hybrid pressure sensor for harsh environments.