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Fabrication and Applications of Nanocrystalline Diamond and Engineered Diamond Micro- and Nanocomponents

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Nanocrystalline and ultrananocrystalline diamond combines the remarkable properties of conventional diamond, such as extreme hardness and wear resistance and a coefficient of friction of about 0.01. 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 to 500 -700 GPa and fracture strength is increased from 1 GPa to ca. 5 GPa. This makes the material very attractive for a number of applications.

As a step further, by a sophisticated combination of high-precision photolithographic masking techniques and controlled reactive ion etching processes (RIE) complex shaped microparts are designed and fabricated. A number of different examples and industrial applications will be discussed, such as lubrication-free microcomponents and hybrids for high-precision mechanical devices, sensors for harsh environments, MEMS components and ultra-sharp cutting tools for bio-applications.