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Ultra smooth surface of diamonds, towards Å scale roughness for the (111) orientation

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Synthetic diamond of exceptional quality is required for many high technology applications. An example from high performance electronics is the so-called δ-doped diamond envisaged as an electrical switch in FETs, operating at high power and high frequencies. Another example is 111-oriented diamond plates that are needed at synchrotrons such as the ESRF to serve as a beam splitter monochromator working in reflection geometry (Bragg case).

In these applications, the surface is of special interest. It should be smooth, flat and defect free. For the diffraction application, the requirements is in addition a low miscut for the 111 surface. The various communities for the high tech applications of diamond are therefore seeking a surface processing step to remove the scaife polishing damage (200nm depth), improve roughess (few Å) and flatness (1m) and to also process the diamond 111 surface, the hardest known surface (˜0.20 miscut).

We present a summary of the different polishing techniques as well as their advantages and limits:

* Mechanical polishing with nano diamond powder.
* Oxygen electron cyclotron resonance (ECR) etching, oxygen radio frequency etching or microwave etching (ICP) in a O₂+SF₆+Ar gas mixture.
* Oxygen implantation, followed by annealing in vacuum at 950℃. ‘‘Lift-off’’ resulted from either a hydrogen plasma or an acid etch, and the final anneal in air at 500℃ provided an additional soft isotropic etch.
* Hot metalling 1: The diamond is moved with low speeds over a surface of pure Fe at 1000℃ in vacuum for at least 3 hours
* Hot metalling 2: Mechanical diamond-grit-less sciafe polishing at high speeds, high temperatures and high loads

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