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Surface structure and spectroscopic properties of fluorinated diamond materials

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Depending on the surface termination the electronic properties of diamond materials can be varied over a wide range. Besides the usual hydrogenated and oxygenated diamond surface – typically achieved upon plasma treatment in a suitable gas atmosphere – the termination with fluorine is of special interest. It is well known that fluorination generates a highly hydrophobic and lubricating surface. Also the strong electron-withdrawing nature of fluorine bound to carbon atoms plays a role when considering the effect of surface fluorination of diamond as a means to tune its optical and electronic properties. Fluorination of bulk diamond has been achieved in the past using different plasma techniques e.g. with XeF₂ or CF₄ as the fluorine source, electrochemical fluorination or with thermal fluorination techniques.¹

For submicron diamond particles, several methods including the thermal gas phase fluorination,² the fluorination using XeF₂³ and the grafting of perfluorinated alkyl moieties⁴ have been reported. The resulting diamond materials have been characterized using infrared, Raman and XPS analysis to prove the efficient grafting of fluorine to the diamond surface and the modified materials properties.

Additionally, the fluorinated diamond was investigated using advanced solid-state NMR techniques enabling the structural characterization of the existing fluorinated surface structures. The results were supported by theoretical calculations.

Using the reported wet-chemical fluorination technique it is now possible to fluorinate all kinds of diamond materials in a mild and highly efficient way enabling the production of functional diamond materials for applications in catalysis, tribology or medicine.

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