Preparation of F-diamane-like nanosheets via exfoliation

Marc DUBOIS[1]
Marie Colin[1], Sam Chen[2,3], Silvana Radescu[4], Aditya Rawal[2], Chuan Zhao[2], Dong Jun Kim[1]
[1] *Université Clermont Auvergne, CNRS, Institut de Chimie de Clermont-Ferrand (UMR 6296), BP 10448, F-63000, Clermont-Ferrand, France*
[2] *School of Chemistry, The University of New South Wales, Sydney, New South Wales, 2052, Australia*
[3] *School of Environmental and Life Sciences, The University of Newcastle, Callaghan, New South Wales 2308, Australia*
[4] *Departamento de Física, Universidad de La Laguna, Instituto de Materiales y Nanotecnología, 38200, La Laguna S/C Tenerife, Spain*
Marc.dubois@uca.fr

Atomically thin diamond ("diamane") has recently emerged as a new two-dimensional carbon allotrope. Theoretical studies first predicted the conversion of AB-stacked few-layer graphene into diamane films through sufficient formation of carbon-fluorine (C–F) or carbon-hydrogen (C–H) bonds on the two free surfaces. In the present work, poly(dicarbon monofluoride) $(C_2F)_n$ which is essentially made of stacked layers of "F-diamane" (Fig. 1) has been synthesized and exfoliated in a variety of solvents to yield well-dispersed ultrathin sheets. Microscopic and spectroscopic analyses revealed that the exfoliated nanosheets retained the "F-diamane"-like structure. The experimental results are also supported by density functional theory (DFT) calculations.
To fully exploit the properties of diamane, further advances in the synthesis methods for its large-scale production are required. So, we propose another route for the efficient and high-yield production of fluorinated diamane (F-diamane)-like nanosheets. This is achieved by direct fluorination of expandable graphite or thermally expanded graphite with molecular fluorine to form stage-2 graphite fluoride $(C_2F)_n$ made of stacked layers of F-diamane. Subsequently, mild sonication is implemented to exfoliate the layers into F-diamane-like nanosheets of hundreds of nanometers to a few micrometers in lateral size, with a thickness of mostly < 10 nm.

References

[1] Chen, X.; Dubois, M.; Radescu, S.; Rawal, A.; Zhao, C. Carbon, 175 (2021) 124-130
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Figures

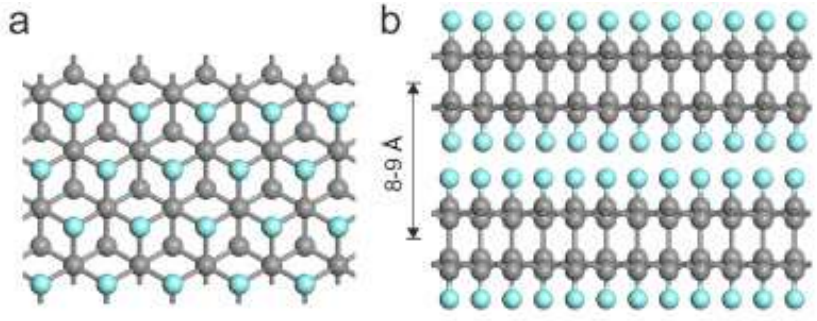

Figure 1: The proposed (a) top-view and (b) side-view crystal structure of (C2F)n type graphite fluoride.