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Formation and functionalization of 2D materials: a molecular approach

Steven De Feyter
KU Leuven, Department of Chemistry, Celestijnenlaan 200F, B-3001 Leuven, Belgium
Steven.DeFeyter@kuleuven.be

In this presentation, I will mainly focus on the functionalization of graphite, graphene, and transition metal dichalcogenides using molecules, though the concepts can be applied to other 2D materials too [1]. Nanostructuring is at the heart of all functionalization protocols that we develop, because it opens new possibilities of control and functionality. A variety of scanning probe microscopy methods are used for visualization, characterization, and manipulation. A first approach is based on molecular self-assembly at the interface between a liquid or air, and graphite or graphene. I will discuss concepts of nanostructuring emphasizing the effect of solvent, solute concentration and temperature, stimulus-driven self-assembly and self-assembly under nanoconfinement conditions [2]. A second approach is based on grafting molecules on 2D materials via covalent chemistry. It will be demonstrated how in addition to bottom-up strategies [3] that provide control on the density and layer thickness, as well as submicron to nanoscale nanostructuring [4,5], also top-down scanning probe microscopy and optical lithography can be used to structure such covalently modified surfaces [2,6]. A third approach does not focus on the functionalization of the surface, but uses the surface as a support for the in-plane covalent stitching of molecules, leading to the formation of on-surface 2D polymers. The (de)polymerization can be controlled by scanning tunneling microscopy [7,8]. Some applications will be given [9].

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