chem2Dmat
August 31 - September 03, 2021 • Bologna, Italy
European Conference on Chemistry of Two-Dimensional Materials

Multicomponent Covalent Chemical Patterning of Graphene

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The chemical patterning of graphene is being pursued due to exciting possibilities in electronics, catalysis, sensing, and photonics applications. Despite the intense efforts, spatially controlled, multifunctional covalent patterning of graphene is not straightforward. [1] The intrinsically poor reactivity of the basal plane of graphene implies the use of harsh chemistries to obtain the desired surface modification. However, chemical protocols to promote the reduction of aryl diazonium ions and the consequent functionalization of carbon-based surfaces have been recently reported. [2] These chemical protocols and conventional lithographic methods could provide the perfect combination to achieve well-defined covalent chemical patterning of graphene.

Here, we demonstrate spatially resolved multicomponent covalent chemical patterning of single layer graphene using a facile and efficient method. [3] Three different functional groups were covalently attached in dense, well-defined patterns. The fidelity of the pattern transfer was found to be exceptional, and the layer thickness of the covalent films was controlled down to 1 nm. The chemically patterned surfaces were characterized using Raman mapping, atomic force microscopy (AFM), and X-ray photoelectron spectroscopy (XPS). The chemical composition of the covalent films was mapped at the nanoscale using AFM-IR measurements, showing the precise compartmentalization of the functional groups along the basal plane. Finally, Kelvin probe force microscopy (KPFM) indicated that such precise multicomponent patterning leads to changes on the graphene surface potential.

References

[1] T. Wei; L. Bao; F. Hauke; A. Hirsch, ChemPlusChem, 85 (2020) 1655-1668
[2] M. C. Rodríguez González; A. Brown; S. Eyley; W. Thielemans; K. S. Mali; S. De Feyter, Nanoscale, 12 (2020) 18782-18789
[3] M. C. Rodríguez González; A. Leonhardt; H. Stadler; S. Eyley; W. Thielemans; S. De Gendt; K. S. Mali; S. De Feyter, ACS Nano, DOI: 10.1021/acsnano.1c03373

Figures

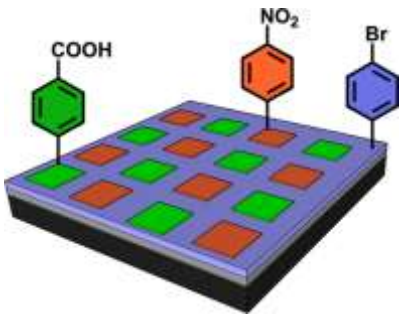

Figure 1: Scheme of the multicomponent covalent chemical patterning of graphene achieved in this work.