Direct Writing of Lateral Fluorographene Nanopatterns with Tunable Bandgaps and Its Application in New Generation of Moiré Superlattice

Hu Li[1], Tianbo Duan[1], Soumyajyoti Haldar[2,3], Biplab Sanyal[2], Olle Eriksson[2], S. Hassan M. Jafri[1], Samar Hajjar-Garreau[4], Laurent Simon[4], and Klaus Leifer[1*]
[1] Department of Engineering Sciences, Uppsala University, 75121 Uppsala, Sweden.
[2] Department of Physics and Astronomy, Uppsala University, 75121 Uppsala, Sweden.
[3] Institute of Theoretical Physics and Astrophysics, University of Kiel, D-24098 Kiel, Germany.
[4] IS2M, CNRS-UMR 7361, Université de Haute Alsace, 68093 Mulhouse, France.
Klaus.Leifer@angstrom.uu.se

Abstract

One of the primary goals for monolayer device fabrications and an ideal model of graphene as an atomic thin "canvas" is one that permits semiconducting/insulating lateral nanopatterns to be freely and directly drawn on the semi-metallic graphene surface [1-2]. Here, we demonstrates a reversible electron-beam-activated technique that allows direct writing of semiconducting/insulating fluorographene lateral nanopatterns with tunable bandgaps directly on the graphene surface with a resolution down to 9–15 nm [3-4]. This approach overcomes the conventional limit of semiconducting C_4F in the single-sided fluorination of supported graphene and achieves the tunability until insulating C_2F. Moreover, applying this technique on bilayer graphene demonstrates, for the first time, a new type of rectangular moiré pattern arising from the generated C_2F boat/graphene superlattice. This novel technique constitutes a new approach to fabricating graphene-based flexible and transparent electronic nanodevices with the C_xF channels utilized as semiconducting or insulating counterparts, and also opens a route toward the tailoring and engineering of electronic properties of such materials in addition to the dominating triangular moiré patterns from a graphene/hBN system.

References

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Figures

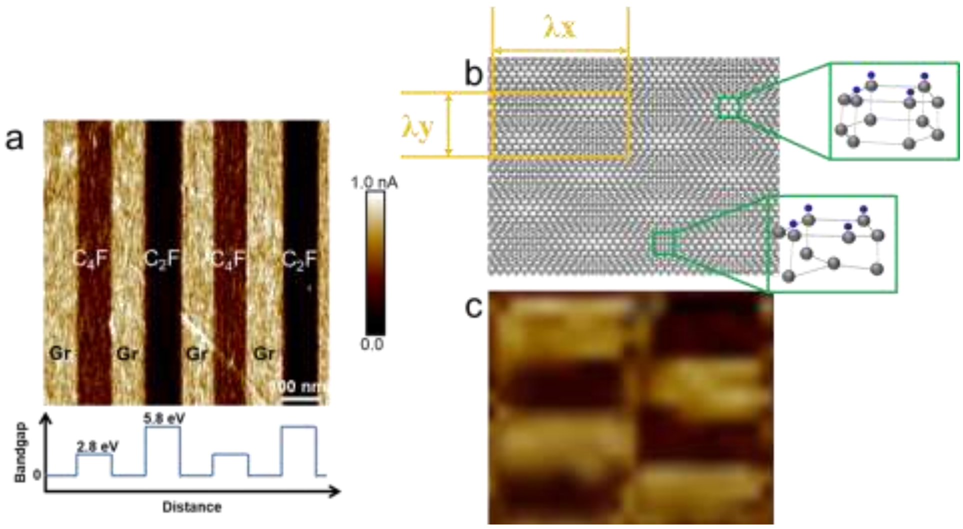

Figure 1: (a) AFM conductive mapping of nanopatterns consisting of graphene, semiconducting C_4F and insulating C_2F stripes directly written on monolayer graphene. The contrast of the mapping indicates the decreasing of the conductivity with the increased fluorine concentration. **(b)** Schematic of the formation of the rectangular moiré patterns for C_2F (boat)/graphene superlattice with a zero misalignment angle and exaggerated lattice mismatches. **(c)** Experimental AFM image of rectangular moiré patterns arising from the C_2F (boat)/graphene superlattice with the length and width of 13.8 nm and 6.8 nm, respectively.