Nano-patterning of fluorinated graphene by electron beam

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Transparent organic electronics holds great promise for future applications, for example in smart windows and in photovoltaic cells. The development of transparent organic electronics is reliant on achieving high conductivity materials with a gate tuneable carrier mobility and low contact resistance at the interface with metals. Graphene –a layer of carbon atoms in a honeycomb lattice- offers just such a possibility. Chemically functionalized graphene with hydrogen [1] and fluorine [2, 3] induce the opening of a band gap in the otherwise zero–gap semimetallic graphene. The ability to tune, by functionalization, the conductivity of graphene over the full range from insulator to metal opens the possibility of accessing a conceptually new scenario of transparent graphene based electronic circuits.
Here we demonstrate that fluorinated graphene –a wide gap semiconductor with sp3 electron orbital hybridization- can be selectively reduced to sp2 graphene by electron-beam irradiation [4], see Figure. We employ this functionality to pattern conductive nanostructures in a sheet of fluorinated graphene, realizing transparent graphene-based electronic devices such as nanoribbons without the need for etching of graphene. Electrical transport experiments over a wide range of temperatures (ranging from room temperature to 4K) of the ribbons show a transport gap whose size is inversely proportional to the width of the patterned ribbons. In this gap, electrons are localized, and charge transport is dominated by variable range hopping. Charging effects constitute a significant portion of the activation energy, and we find that the activation energy scales well with the width of the ribbons [4].

References
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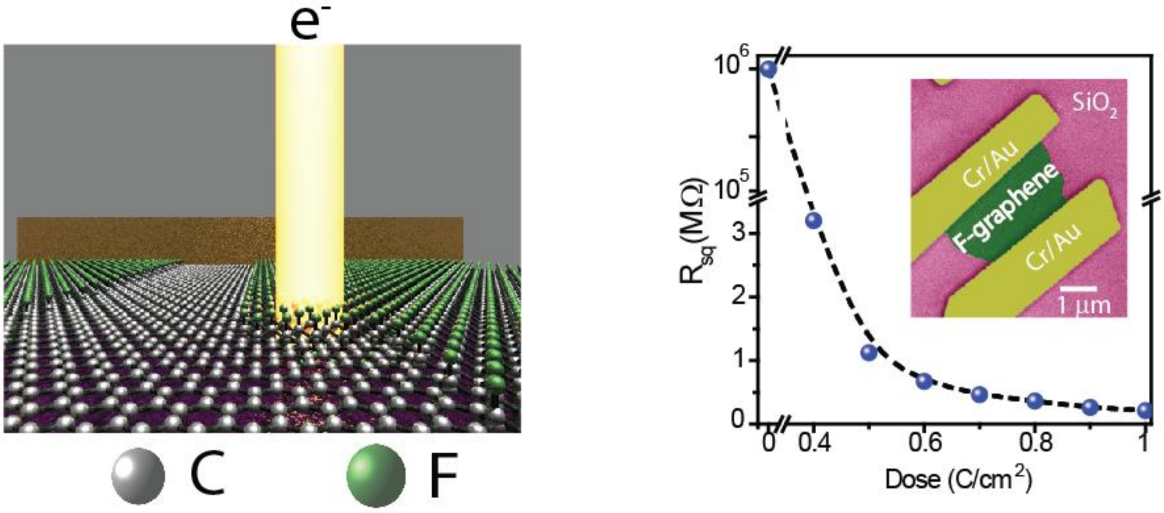
Figures



Left. Illustration of the defluorination process assisted by electron irradiation. Right. Measured sample resistance per square plotted against the electron irradiation dose. The sample displays an insulator to metal transition.