Chemical Modification of graphene

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Abstract

In this thesis investigations into chemically modified graphene structures are presented. Chemical functionalization of graphene is the chemical attachment of molecules or atoms to the graphene surface via covalent or Van der Waals bonds, this process offers a unique way to tailor the properties of graphene to make it useful for a wide range of device applications. One type of chemical functionalization presented in this thesis is fluorination of graphene which is the covalent attachment of fluorine to the carbon atoms of graphene and the resultant material is fluorographene which is a wide band-gap semiconductor. For low fluorine coverage the low temperature electron transport is through localized states due to the presence of disorder induced sub-gap states. For high fluorine coverage the electron transport can be explained by a lightly doped semiconductor model where transport is through thermal activation across an energy gap between an impurity and conduction bands. On the other hand, at low temperatures the disorder induced sub-gap density of states dominates the electrical properties, and the conduction takes place via hopping through these localized states. In this thesis it is also shown that electron beam irradiation can be used to tune the coverage of fluorine adatoms and therefore control energy gap between the impurity and conduction bands. Futhermore, electron beam irradiation also offers a valuable way to pattern conductive structures in fluorinated graphene *via* the irradiation-induced dissociation of fluorine from the fluorinated graphene. This technique can be extended to the patterning of semiconducting nano-ribbons in fluorinated graphene where the spatial localization of electrons is just a few nm. The second type of chemical functionalization presented in this thesis is the intercalation of few layer graphene with ferric chloride which greatly enhances the electrical conductivity of few layer graphene materials making them the best known transparent conductors.

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