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Calcium and Magnesium Intercalation of Graphene on Silicon Carbide

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Graphene has transformed experimental two-dimensional (2D) physics and has proven itself an indispensable testing-bed for improving our understanding of condensed-matter physics. Recent theoretical and experimental results from literature have suggested that graphene, highly doped with alkaline earths(through intercalation and/or surface decoration), can superconduct at relatively high temperatures, and is a potential platform for electronically mediated superconductivity. Furthermore, highly electron-doped graphene may be useful as a transparent conducting electrode with low workfunction for applications such as photovoltaics.

This work will present recent results from X-ray photoemission spectroscopy (XPS) - conducted at the Soft X-ray (SXR) beamline at the Australian Synchrotron - and scanning tunnelling microscopy (STM)- conducted in the Fuhrer Laboratory at Monash University - which elucidate the structure of calcium and magnesium intercalated graphene on silicon carbide.

We study both epitaxial monolayer graphene (EMLG) and quasi-free standing (hydrogen intercalated) bilayer graphene (QFSBLG) on 6H-SiC(0001) substrates. The former consists of monolayer graphene on a carbon interface layer, which is partially covalently back-bonded to the silicon face on SiC - often termed 'zero layer graphene' or 'the buffer layer'. The latter is formed by hydrogen treatment of the EMLG whereby the hydrogen is able to bond to the silicon on the SiC surface, releasing the interface layer and forming another layer of graphene.

Our XPS and STM data suggests that calcium and magnesium are able to intercalate underneath the graphene and bond with the silicon on the surface of the SiC – forming calcium/magnesium intercalated quasi-free standing bilayer graphene (Ca-QFSBLG/Mg-QFSBLG). Furthermore, the calcium may also intercalate between the graphene layers, which could result in highly n-doped graphene. Secondary electron cut-off (SECO) measurements show the change in workfunction for both intercalated materials. Surprisingly, the Ca-QFSBLG is stable to brief air exposures, indicating it may be useful as a transparent conducting electrode with low workfunction.

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