Controlled oxidation of epitaxial graphene on Si-face SiC substrate

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Recently oxidation of graphene have received enormous interest as a prominent route to chemically modify its extreme properties and make the graphene suitable for application in various modern day technologies, such as high-performance electronics, sensor, renewable energy, optics, etc.[1,2]. In parallel to the studies on exfoliated graphene, the epitaxial graphene (EG) on SiC has also drawn much attention because of the advantage of producing in wafer scale that can be used for high performance device fabrication[3]. We have employed controlled gas and aqueous phase oxidation procedure on EG on Si-face SiC surface. For the gas phase oxidation, EG on SiC was exposed to atomic oxygen in an ultrahigh vacuum (UHV) chamber. The strong oxidizing agent known as Hummers solution (mixture of KMnO₄, H₂SO₄ and NaNO₃) was used for aqueous phase oxidation under different reaction conditions. The chemically modified surfaces have been characterized by Raman, scanning tunneling microscope (STM), and x-ray photoelectron spectroscopy (XPS) and two-probe surface conductivity measurements.

UHV oxidation of graphene results a chemically homogeneous surface with only epoxy functional groups, and the pristine graphene can be regenerated simply by annealing at 260 °C[4]. On the other hand, the EG oxidized using Hummers solution in both ‘dipped-in’ and ‘drop-casting’ procedures results an inhomogeneous surface with various functional groups such as epoxy, hydroxyl, carbonyl and carboxylic groups. Both the ‘drop-casting’ and ‘dipped-in’ procedures are found to be equally effective for oxidizing the graphene. Drastic change of surface resistivity (~ 100x) by aqueous phase oxidation of graphene reflects the significant changes in electronic states. The detailed results obtained by different techniques will be discussed.