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Electron Transport properties of Reduced Graphene Oxide Sheets

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Reduced graphene oxide (RGO), a chemically functionalized atomically thin carbon sheet, provides a convenient pathway for producing large quantities of graphene via solution processing. The easy processibility of RGO sheet and its composites offer interesting electronic, chemical and mechanical properties that are currently being explored for advanced electronics and energy based materials. However, a clear understanding of electron transport properties of RGO sheet is lacking which is of great significance for determining its potential applications. In this talk, we will present fabrication of high-yield solution based graphene field effects transistor (FET) using AC dielectrophoreis (DEP) and investigate the detailed electronic transport properties of the fabricated devices. The majority of the devices show ambipolar FET properties at room temperature. However, the mobility values are found to be lower than pristine graphene due to a large amount of residual defects in RGO sheets. We calculated the density of these defects by analyzing the low temperature (300 to 77K) charge transport data using space charge limited conduction (SCLC) with exponential trap distribution. At very low temperature (down to 4.2 K), we observe Coulomb blockade (CB) and Efros-Shklovskii variable range hopping (ES-VRH) conduction in RGO implying that RGO can be considered as a graphene quantum dots array (GQD), where graphene domains act like QDs while oxidized domains behave like tunnel barriers between QDs. This was further confirmed by studying RGO sheets of varying carbon sp^2 fraction from 55%-80% and found that both the localization length and CB can be tuned. From the localization length and using confinement effect, we estimate tunable band gap of RGO sheets with varying carbon sp^2 fraction.