Contribution ID: **365** Type: **Poster**

Controlled electronic properties of graphene via atomic layer deposition

Wednesday 20 June 2018 17:05 (15 minutes)

As a source material for numerous electrical applications, graphene has received great attention in two-dimensional (2D) materials field. For applications of graphene, it is critical to fine control of the Fermi level and the carrier concentration through a nondestructive doping method. Here, we develop an effective way to fabricate conformal ZnO thin films on graphene via atomic layer deposition through a reactive functional material layer and analysis its electrical behavior. This non-destructive and precise n-doping method provides a finely tunable result in thickness with 1 Å resolution. More importantly, the n-doped graphenes with ZnO thin films have a uniform and conformal morphology and good quality with a low density of pinholes. The electrical properties of graphene transistor including carrier density and doping state are controlled as a function of the thin film thickness. In addition, ZnO thin film barrier characteristics are observed by the extraordinary stability of graphene devices in air condition against air-borne water and oxygen which are an effect on the graphene. To other 2D materials such as MoS2 and WSe2, ZnO thin film ALD was successfully applied and shown enhanced electron mobility.

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Presenter: LEE, Lynn

Session Classification: Poster Session Wednesday

Track Classification: Surface Science & Applied Surface Science