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Controlled electronic properties of graphene via atomic layer deposition

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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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