Enhancement of electrical property of graphene by atomic layer deposition of Ru

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Abstract

Graphene, as a single atomic layer and sp^2 covalent bonding material, has been attracted researchers interest, because of its unique electrical, mechanical, optical properties. Especially, remarkable electrical, such as high carrier mobility as 230,000 cm^2/Vs encourage graphene as a next generation material for transparent and flexible electrode material application. However, despite of these advantages, relatively lower carrier concentration of graphene becomes bottleneck for real application of graphene.

Here, we observed the enhancement of electrical property of graphene by atomic layer deposition of Ru. The deposition of Ru is limited only on graphene defects such as wrinkles, grain boundaries and point defects. These preferential deposition of Ru on graphene defects enables graphene's transparency to maintain over 90 % at 550 nm of visible light even at 50 cycle of Ru ALD. The sheet resistance reduced as the Ru ALD cycle increase, showing 76 % reduction at 50 cycle of Ru ALD, compared with as-prepared graphene. Hall measurement and ultraviolet photoemission spectroscopy reveals that deposition of Ru on graphene is p-typed and increase work function of graphene form 4.6 eV to 5.1 eV. The doping mechanism of Ru ALD on graphene considered to the electron transfer from graphene to Ru increasing the hole carrier concentration of graphene.

Figures

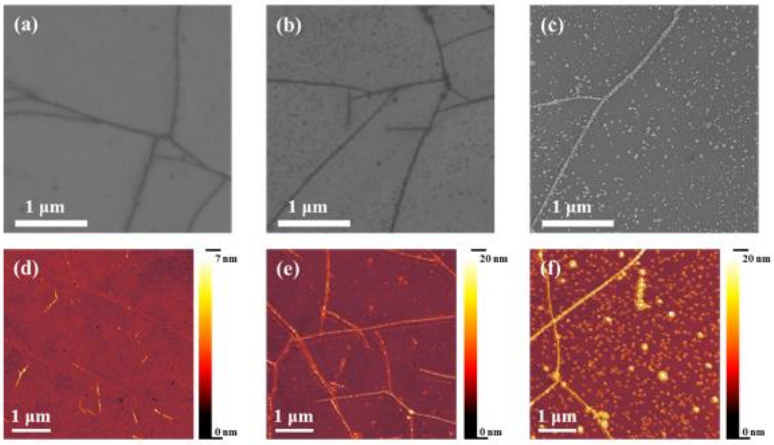

Figure 1. SEM (a~c) and AFM (d~f) images after Ru ALD on graphene. (a, d) As-prepared graphene, (b, e) after 50 cycle of Ru ALD on graphene, (c, f) after 100 cycle of Ru ALD on graphene

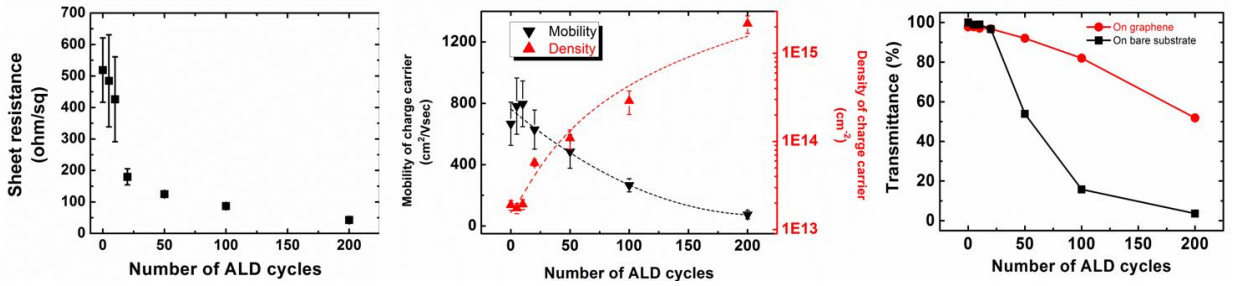

Figure 2. Electrical and optical properties of graphene. (a) sheet resistance of graphene. (b) carrier density and mobility of graphene and (c) Transmittance at 550 nm V.S. the number of ALD cycle.