Millimeter-Scale Graphene Domains: CVD Growth on Pt and Its Nondestructive Transfer

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Graphene, a two-dimensional honeycomb lattice of sp^2-bonded carbon atoms, has attracted the worldwide interests after the experimental isolation from graphite.[1] High-quality graphene can be prepared by micromechanical cleavage method, thermal decomposition of SiC,[2] epitaxial growth and chemical vapor deposition (CVD) on Ru (0001),[3] Pt (111),[4] $Pt_{83}Rh_{17}$ foils,[5] Ni films,[6,7] Cu (111),[8] and Cu foils.[9] Recently, CVD growth of graphene on Cu foils has attracted increasing interests, because of the predominant growth of large area monolayer graphene, easy transfer and cheap substrates. However, the graphene domains grown on Cu foils are small (usually smaller than 10 μm), and no big single crystalline domains were formed even on single crystal Cu substrate. Moreover, the dissolution of Cu during the transfer process unavoidably lead to serious pollution and high cost. Therefore, it still remains great challenges to prepare large area graphene films of high crystalline quality and realize their nondestructive transfer.

Here we present the growth of high quality graphene film with large single crystalline domains on the surface of polycrystalline Pt foils and single crystalline Pt (111) by ambient pressure CVD.[10] Although the solubility of carbon in Pt is high (~ 0.9 at% at 1000 °C), the growth of graphene on Pt follows surface adsorption process, which is similar to that on Cu foils.[11] However, in contrast to Cu foils,[12] a fast graphene growth rate and broad growth window were found for the Pt substrate. The average size of single crystalline graphene domain obtained is up to millimeter size. Its high quality is confirmed by optical microscopy, atomic force microscopy, scanning tunneling microscopy, Raman spectroscopy and transport property measurements. Moreover, we developed a nondestructive method to transfer graphene films from Pt to arbitrary substrates. This unique transfer process does no harm to the graphene films and the metal substrate, which is totally different from the currently used transfer methods for Cu and Ni substrates based on etching, so the Pt foils and single crystalline Pt can be recycled to grow graphene films.

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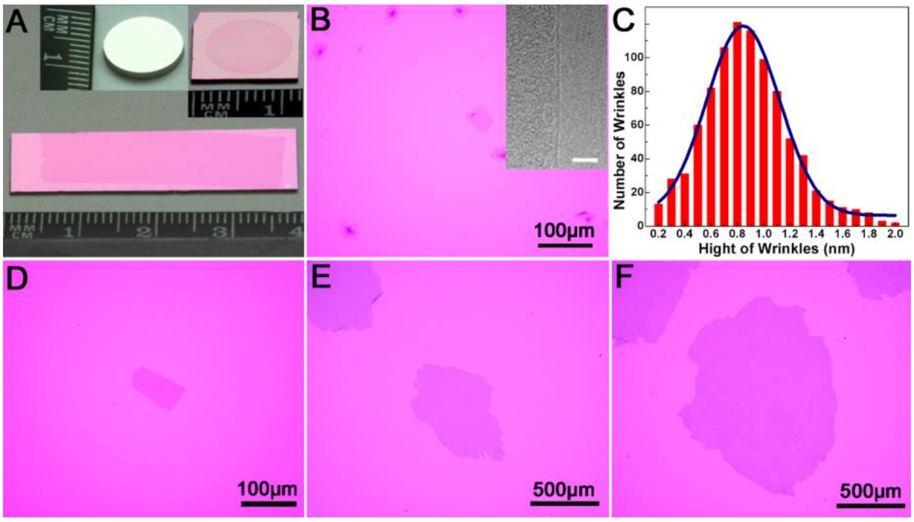

Figure 1. Photograph and optical images of graphene transferred from polycrystalline Pt foils and Pt (111) to Si/SiO_2 substrates.