Electrical Properties of Graphene Conductive Thin Films Fabricated with Different Parameters

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Over the past few years, graphene has become a hot topic within the scientific and engineering communities. Recent research has shown that environmentally friendly and low cost graphene-based thin film has a promising future as a conductive electrode for applications in solar cells and super-capacitors due to its high carrier mobility, high optical transparency, high chemical stability, low coefficiency of thermal expansion, and good flexibility [1]. However, there are still some challenges for its practical applications, such as the poor adhesion between graphene and substrates, the dispersion of graphene in common solvents and the functionalization of graphene. Therefore, it is critically important to develop a simple and efficient process to fabricate graphene conducting films.

In this report, we explored a blade coating process to fabricate graphene thin films on glass substrates and investigated effects of process parameters on electrical properties of the films, such as graphene concentrations and annealing temperatures. Sodium dodecyl sulfate [$CH3(CH_2)_{11}OSO_3Na$] was employed as a surfactant for aqueous graphene dispersion, and acrylic resin and silane coupling agent were used to strengthen the connection among graphene sheets and the adhesion of graphene onto the substrate, respectively.

Fig. 1 demonstrate that surface resistances of graphene thin films decrease with the increase of annealing temperature from 70°C to 400°C, but increase at a temperature of 450°C or 500°C. Consequently, we investigated effects of graphene concentrations on electrical properties of the films after thermal annealing at 400°C. As shown in Fig. 2, the resistance decrease with the increase of graphene concentration from 3% to 6%. It was difficult to fabricate a uniform thin film while the graphene concentration was less than 3% or larger than 6%.

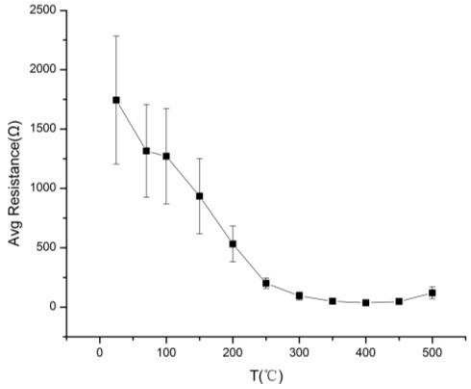

Fig. 1. Effects of annealing temperatures on surface resistances of graphene thin films with 5% graphene.

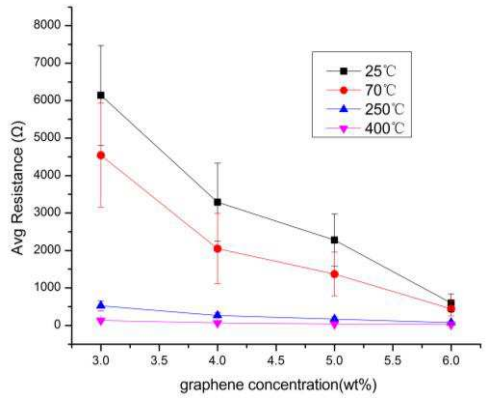

Fig. 2. Effects of graphene concentration (3%, 4%, 5%, and 6%) and annealing temperature (25°C, 70°C, 250°C, and 400°C) on surface resistances of graphene thin films.

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