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Damage mitigation of roll-transferred graphene onto arbitrary substrate

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Monolayer graphene, single atomic layer with sp2 bonding, has outstanding physical properties that make it attractive for a lot of applications using extraordinary electrical, thermal, optical, and mechanical properties. Among them, transparent electrode has been a promising candidate of graphene due to its excellent electrical conductivity and high optical transmittance [1]. Especially, monolayer graphene synthesized by chemical vapor deposition (CVD) on copper catalyst has many advantages for commercialization of transparent electrode because of its scalability and high and uniform qualities. For the fabrication of graphene transparent electrode, the CVD graphene is transferred to arbitrary substrate after etching process of copper catalyst. Mass-production of the graphene transparent electrode requires roll-based synthesis, roll-based etching process, roll-based transfer process, and roll-based patterning process [2,3]. However, the roll-based process might be easily damaged by localized contact pressure between graphene and a substrate or a carrier film [4]. In this study, we focused on damage mitigation of graphene in the roll-based transfer process. CVD grown graphene is transferred onto arbitrary substrate such as silicon wafer, polyethylene terephthalate (PET), and silicone adhesive coated films. In the fabrication process of graphene transparent electrode, monolayer graphene transferred on the substrate is torn and wrinkled by adhesion between contact surfaces, and mechanical deformation of substrates and carrier films. These damages might cause a degradation of physical performance of graphene produced by the roll-based process. To minimize mechanical damages, we introduce several types of carrier films, and compare the quality of graphene transparent electrode fabricated with each carrier film. Moreover, nip force control module is adopted in the roll transfer system to minimize contact pressure among graphene, carrier film, and PET and shear force between the roll and the films. With the roll-based transfer process, graphene transparent conductive films with large area were successfully manufactured with a width of 500 mm. Also, we confirmed graphene transparent conductive film with excellent and uniform electrical properties. The researches on roll to roll transfer process might be able to be applicable for other 2-dimensional nanomaterials such as hexagonal boron nitride and molybdenum disulfide, and it will give critical insights on manufacturing of products using these materials.

[1] J. Ryu, et al., ACS Nano 8(1), p.950-056 (2014).

[2] K. S. Kim, et al., Nature 457, p.706-710 (2009).

[3] S. Bae, et al., Nature Nanotech. 5, p.574-578 (2010).

[4] J. Kang, et al., ACS Nano 6, p.5360-5365 (2012)