The Graphene/Indium-Oxide Composite as a Next Generation Flexible and Transparent Electrode

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CVD graphene is considered as the most suitable fabrication method to produce large area graphene with low defects, however It also possesses some defects from its synthesis and transfer process, such as grain boundaries, pinholes, or wrinkles. Especially the macroscale cracks on graphene during the transfer process critically degrade the electrical and mechanical property of graphene. With the fact that graphene has 2-Dimensional structure, the detrimental effect from macroscale defects is much more negative on graphene than that of other bulk materials. Accordingly, these macroscale defects could be an absolute factor deciding the performance and reliability of graphene-based devices.
Here, we propose noble graphene/indium oxide (GI) composite as a next generation flexible and transparent conductive material. The bilayer structure of GI is formed by transferring chemical vapor deposition (CVD) graphene on the indium oxide film grown by atomic layer deposition (ALD). The electrical, optical, and mechanical properties is systematically investigated according to the thickness of indium oxide. First, the electrical data shows that GI has uniform electrical properties with 6-inch wafer scale. Underlying Indium oxide layer act as current bypass for damaged graphene. The standard deviation of sheet resistance (R_S) of GI (10 nm thickness of indium oxide) is only 8 Ω/sq within 6-inch-scale large area. This value is only 3 % of average Rs of the GI. The excellent uniformity enables a real application of GI. Second, it is confirmed that the electrical properties of GI is enhanced with compared to pure graphene and indium oxide. Comparison of measured sheet resistance of the graphene/Indium oxide bilayer and calculated sheet resistance as ideal parallel series indicates noticeable enhancement of electrical property of graphene on thin Indium oxide layer. [1] Our method suggests a new way to fabricate flexible and transparent electrode with extreme large-area uniformity for mass production of future electronics

References

[1] Oliver Bierwagen, Soojeong Choi, and James S. Speck, *Phys.Rev.B.*, 85 (2012) 165205

Figures

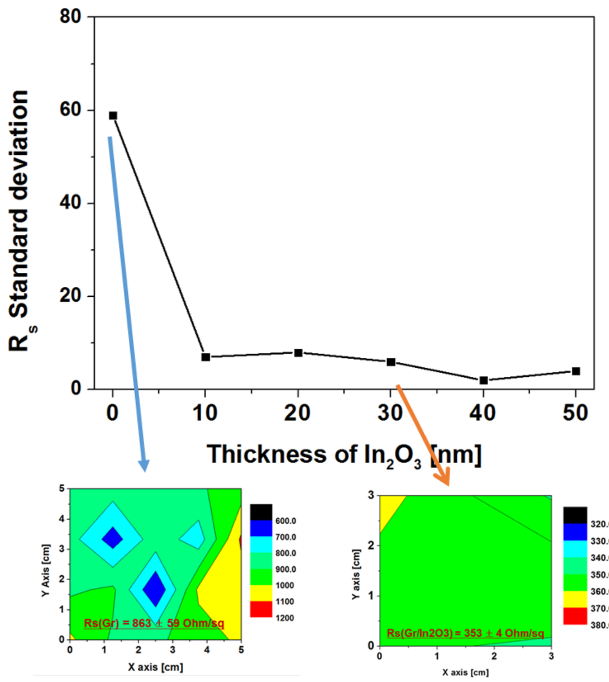

Figure 1: A Standard deviation of Sheet resistance of the transferred graphene on Bare SiO_2 and Indium oxide with different thickness