Transmittance enhancement at Graphene/Al interfaces

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When two metal films stack together forming “hetero-film”, it has been generally accepted that the effective transparency is lower than the respective metal film as a result of the absorption accumulation. Here, we report a counterintuitive phenomenon where transparency of a hetero-film is significantly higher compared to the original metal film. Specifically, we found that by layering one-atom-thick graphene on an aluminum (Al) film, the transparency of the Al film is dramatically increased from ~60% to 80% under 550 nm wavelength light. In this work, we investigated the optical properties of graphene/aluminum interfaces. CVD grown 1LG was firstly grown and transferred on SiO₂ substrate by a PMMA-assisted approach². Subsequently, an aluminum coating with a thickness of 4-20nm was produced by an e-beam evaporator with 99.99% purity aluminum target. We acquired the transmittance spectra of graphene/aluminum stacks using a UV-vis spectrophotometer. One interesting observation is transmittance increased in samples with graphene, indicating a novel physical or chemical interaction between graphene and aluminum. For 4nm Al film, graphene induced transparency enhancement at UV range of 200 to 300 nm. As film thickness increases to 8nm, the transparency enhancement extends to a wider UV range of 10-660nm. In 12nm sample, we observe an averaged 12% increase in transmittance for the wavelength range of 500-2500 nm in the sample with graphene, comparing with pure Al coating on the substrate. More surprisingly, similar transparency enhancement is captured when Al film was deposited on the graphene film. Due to the counter-intuitive observation, we anticipate this work will benefit the community in fundamental understanding and reliable utilization of graphene and Al interactions.

Figure 1 (A) Image to show the transmittance enhancement at Al/graphene interface; (B) Transmittance in the samples with and without graphene; (C) Surface morphologies of Al/SiO₂, Al/Gr/SiO₂ and Gr/Al/SiO₂ samples (D) XPS depth-profile of Al/Gr/SiO₂ sample.

References:

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2. Fu, Sidan, et al. "Self-Assembled, Ultrahigh Refractive Index Pseudo-Periodic Sn Nanostructures for Broad-Band Infrared Photon Management in Single Layer Graphene." ACS Photonics 6.1 (2018): 50-58.