Fabrication of Graphene-Encapsulated Photocathodes

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Primary CNF Tools Used: SC4500 odd-hour evaporator

Abstract:

A new technique for the fabrication of graphene-encapsulated photocathodes is being developed. The monolayer-thick graphene film will protect the photocathode from oxidation by residual gases or the atmosphere while having only a small effect on the intensity and brightness of the generated electron beam.

Summary of Research:

Photocathodes are materials that eject electrons under illumination. By their very nature, high-performance photocathodes must be made from materials that lose electrons easily — in other words, materials that are easily oxidized. For example, many photocathodes are either coated with alkali metals (e.g., Cs/GaAs) or comprised of alkali metals (e.g., Cs_3Sb). This presents a technical challenge, as exposure to even trace amounts of O_2 or H_2O will destroy or degrade the photocathode. For highest performance, the photocathodes must also be atomically flat and extremely homogeneous.

To meet these challenges, we are developing a technique to produce a graphene-encapsulated photocathodes. The key challenge in this project is ensuring that every step of the fabrication leaves no residue on the surface, as even monolayer levels of contamination could significantly reduce photoelectron transmission and beam brightness.

In the first step of fabrication, commercial graphene monolayers, which are grown on a copper foil, are coated with a thin gold layer in the SC4500 evaporator. The copper foil is then removed with an aqueous etchant, allowing the graphene side of the gold-coated graphene to be adhered to a low energy substrate. The gold film is then removed by a second aqueous etch. As shown in Figure 1, we have successfully transferred intact, single-layer-thick graphene films to cm-size substrates as confirmed by both optical microscopy and Raman analysis. The near-atomic cleanliness of the transferred films has been quantified using photoelectron spectroscopy.

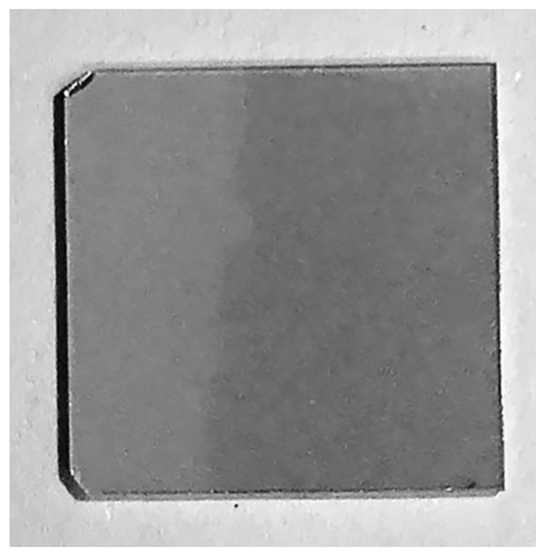

Figure 1: Optical image of a transparent substrate with a graphene monolayer deposited on the right half of the substrate. The graphene monolayer causes a small decrease in the transmission of visible light.