Thermal annealing of chemical vapor deposited graphene studied with spectroscopic ellipsometry

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Abstract

Spectroscopic ellipsometry (SE) is a powerful tool to investigate the optical properties of graphene [1]. In the last few years, several groups have calculated the optical constants (*n* and *k*) of graphene via SE [2-8]; their diverse results show that the optical response of graphene is affected by parameters such as flakes dimensions, roughness, and defects. These parameters strongly depend on the method used to prepare the sample. Currently, chemical vapor deposition (CVD) is one of the most convenient ways to create large-area, high quality graphene.

We report an ellipsometric study of millimeter-sized, CVD graphene deposited on a SiO2/Si chip. This sample was heated to 360 °C in high vacuum; SE measurements were acquired before, during and after the thermal treatment. This was achieved using a small, high vacuum chamber inserted between the arms of our ellipsometer. We developed an optical model that fits well the experimental data; through this model, we calculated the optical constants of our graphene. The data show that the optical response of the sample was modified as a result of the thermal annealing in high vacuum; the modification was continuous during the treatment, thus revealing a dependence both on the temperature and on the high vacuum environment. Our model indicates that the change in the optical response of the sample can be modelled as a significant reduction of an ultrathin dielectric layer inserted between graphene and the substrate. The dielectric constants of this layer are compatible with water, suggesting that nanometric amounts of this liquid might have remained trapped during the graphene transfer procedure. AFM and XPS measurements acquired before and after the treatment support this conclusion and add complementary information, such as the shape of the water pockets trapped under graphene.

References

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Figures

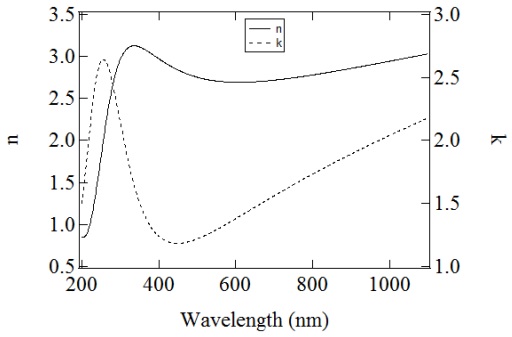

Fig. 1: Optical constants of graphene layer calculated with our model.