Spectroscopic ellipsometry measurements of doped graphene

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Graphene, a single layer of carbon atoms packed tightly into a honeycomb lattice, has been attracting wide attention due to its unique electronic properties [1]. Through its optical response in the visible and ultraviolet (UV) ranges, we can obtain information on the electronic structure in the nonlinear part of its dispersion relation.

We investigate the optical response of graphene via spectroscopic ellipsometry [2,3] in the UV and visible ranges. Graphene samples are obtained by micromechanical exfoliation of natural graphite on the Si/SiO2 substrate. One of the samples is shown in figure 1. Furthermore, gold contacts are made by a UV photolithography process on some of the samples. These contacts allow us to externally control the doping level of the sample during the measurements. The optical conductance of graphene is described by a Fano model [4-6]. The parameters of this model are extracted from our spectroscopic ellipsometry measurements (figure 2), and the complex refractive index of graphene is obtained (figure 3). Graphene's dispersion relation shows that the density of states function has a logarithmic van Hove singularity corresponding to the M point of the Brillouin zone. The exciton binding energy is calculated as the difference between the resonant and the saddle point energies [4-7]. Afterwards, measurements are carried out with different doping levels. The influence of doping [8] on the extracted optical parameters is estimated.

References

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Figures

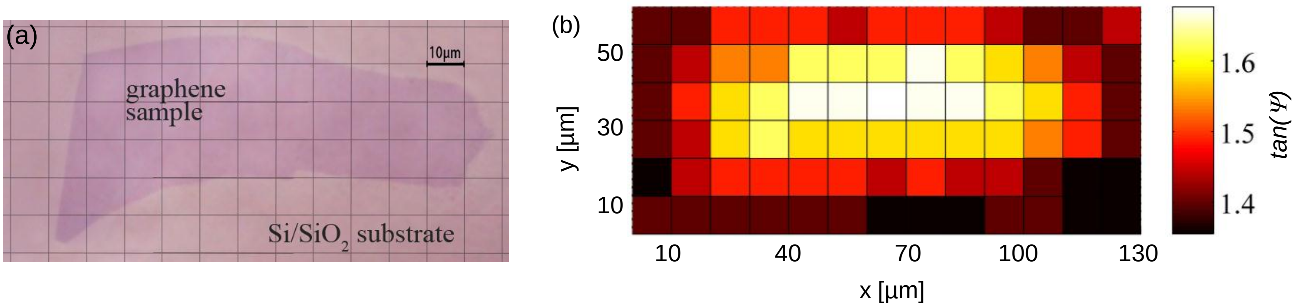

Figure 1: (a) Single layer graphene sample used for extraction of the model parameters (presented in figure 3)
(b) tan(Ψ) map of the sample measured at fixed incident light wavelength of 290nm and fixed incident angle of 60°; spectroscopic measurements (shown in figure 2) were carried out in the center of the flake (where tan(Ψ) has a maximal value).

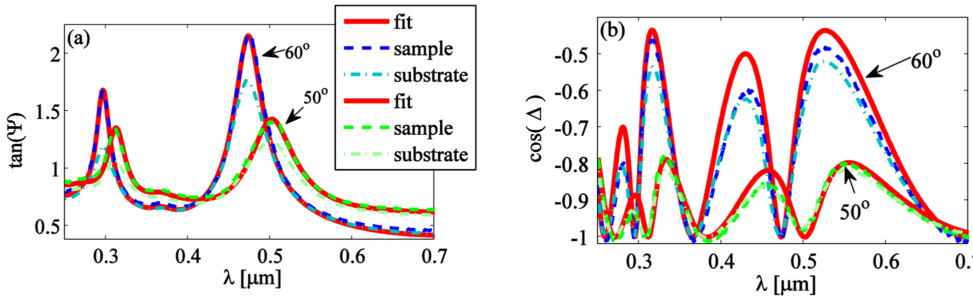

Figure 2: (a) tan(Ψ) and (b) cos(Δ) of the graphene sample (dashed line) and the bare substrate (dot-dashed line) for two different incident angles of 60° and 50°. Filled lines represent fitted sample data.

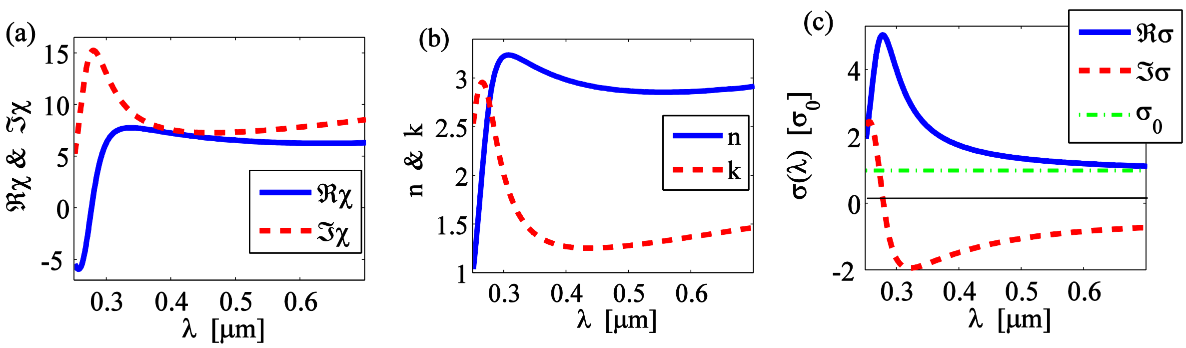

Figure 3: (a) Complex dielectric susceptibility, (b) complex refractive index and (c) complex optical conductivity of graphene modeled by the Fano resonance with the best fit to measured data set of parameters.