Invited

Stable p-doping in graphene and Terahertz spectroscopy

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In the present work we used CVD grown graphene exposed to deep ultraviolet (DUV) light during different times up to 100 min. [1]. It has been described theoretically that oxygen molecules react with graphene in the presence of UV light to produce oxygen containing groups [2], these oxygen atoms form a stable structure on the sites of pristine graphene and induce p-type doping [3].

We analyzed the samples by Raman spectroscopy and transport measurements. Raman spectroscopy suggest p-doping without a significant increase of defects density.

The p-doping of CVD grown graphene is confirmed by transport measurements [4]. The back gate voltage dependent resistivity for single layer graphene is analyzed as function of DUV light exposure time, the maximum resistivity corresponding to the Dirac point is shifted toward positive gate voltage with increasing the DUV light exposure time. Our work demonstrates by Raman spectroscopy and transport measurements a stable and reversible p-doping in CVD grown graphene film with deep ultraviolet (DUV) light.

Terahertz time-domain spectroscopy (THz-TDS) is a non-destructive testing method based on a coherent detection scheme, implementing a phase-sensitive technique that enables broadband measurements of complex material properties, as refractive index, the absorption coefficient or AC conductivity at THz frequencies, up to 2 THz.

The THz measurements are performed in a THz-TDS spectrometer in transmission setup, based on a commercial THz spectrophotometer TERA K8, from Menlo Systems.

The Broadband THz radiation is generated using a 780 nm wavelength femtosecond laser based on erbium-doped optical fiber and it is detected with a photoconductive antenna. The output of the laser is split into a pump (generating) and a probe (detecting) beams by a polarizing beam splitter, travelling throw two different optical paths to the emitter and the detector antenna, respectively. One path has a variable length, in order to control the pulses delay arriving to the corresponding antenna.

Due to the interaction with the laser pulses electron-hole pairs are generated in the antenna semiconducting material, then a transient photocurrent is induced by applying a bias voltage to the antenna, the accelerated charge carriers emit a THz electrical field proportional to the time-derivative of the photocurrent. This THz radiation is modulated at a 10 kHz and focused on the sample guided through polymer lenses. The transmitted radiation through the sample is focused on a THz detector antenna which is gated by the probe (detection) laser beam. Finally the recorded time trace is transferred into frequency domain by Fourier transform for spectroscopic analysis. The conductance and refraction index of the sample can be deduced.

We analyzed doped and undoped graphene samples on three different substrates: glass, PET and silicon.

References

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