Accurate *in situ* measurements of dielectric constants obtained in THz range

Dielectric constants give significant information on how materials behave and relax under the influence of electromagnetic fields. N. Matsumoto and T. Hosokura from the Murata Manufacturing Co. Ltd. and T. Nagashima and M. Hangyo from Osaka University have developed reflection-type time-domain terahertz spectrosopic ellipsometry (THz-TDSE). Reflection-type spectroscopy is a contactless technique used for high-absorption materials and thin films deposited on opaque substrates, and time-domain spectroscopy provides transmittance/reflectance as well as phase shift information. The accuracy of time-domain spectroscopy is limited by phase shift phenomena. The researchers implemented THz-TDSE, eliminating previous reference and phase shift problems, thus allowing for accurate, contactless, and nondestructive *in situ* measurements of complex dielectric constants in the THz range.

In the January 15th issue of *Optics Letters* (DOI: 10.1364/OL.36.000265; p. 265), the researchers report development of a setup that allows accurate measurements of the dielectric constants in the THz range of different materials, namely GaAs thin films and $SrTiO_3$ on Pt substrate. In the setup, THz waves are generated by irradiation of a photoconductive antenna (on low-*T* grown GaAs) by a pulsed 800 nm laser, and focused on the sample on a ~20 mm^2 area.

The polarizations of incident and emerging THz waves are controlled precisely in order to detect *p*- and *s*-waves independently. The detection of the reflected wave is done by another photoconductive antenna irradiated by the delayed probe laser beam. The photocurrent of the antenna is measured through a lock-in amplifier. The time domain waveforms of *p*- and *s*-polarized reflected waves are measured independently, and Fourier-transformed into complex reflection coefficients.

Since the optical path lengths of the *s*- and *p*-polarized waves are strictly equal, the phase shift information between the *p*- and *s*-polarization can be obtained precisely. Reflection coefficients are used to compute real and imaginary parts of the dielectric constant. Interferences arising from the different interfaces were taken into account and this technique permitted measurement of the dielectric constant for GaAs thin film, as well as soft-mode phonon dispersion spectra in $SrTiO_3$ thin films.

Elsa Couderc

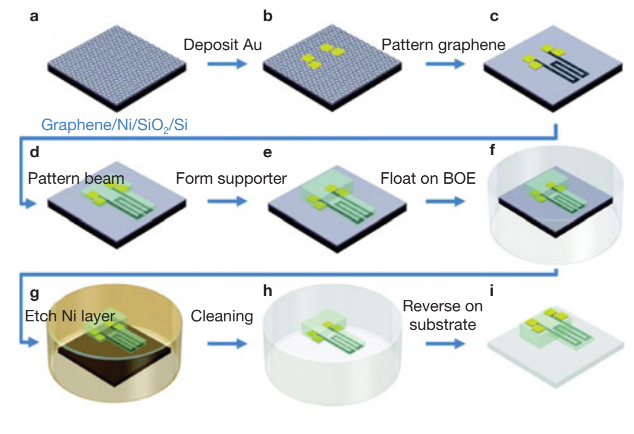
Nano Focus

Novel method developed to fabricate graphene-on-organic film

Researchers H.J. Cho of the University of Central Florida, J.H.Ahn of Sungkyunkwan University, and their colleagues have developed a method to fabricate graphene-on-organic film. This method stems out of the significant challenges in developing a compatible fabrication method of actuator materials for a large displacement and a rapid response at low voltages. Most work on actuators has focused on shape memory alloys, piezoelectric ceramics, and polymer-based materials; however, these materials require postprocessing steps that are not compatible with conventional batch microfabrication steps. The graphene-based organic film is compatible with microfabrication processes and used for electromechanically driven micro-actuators.

As reported in the January 31st online edition of *Nano Letters* (DOI: 10.1021/nl103618e), the researchers used a hybrid material of graphene/epoxy to fabricate the actuator using a series of steps as shown in the Figure. In the first steps (a, b), graphene films are grown by chemical vapor deposition (CVD) on a 4 in. SiO_2/Si wafer coated with a Ni catalyst. The photolithography process is used to fabricate gold contact pads; additionally the process is coupled with O_2 plasma reactive ion etching (RIE) to produce a serpentine micro heater pattern. A sequential photolithography two-step process is used to fabricate a thin graphene/epoxy cantilever beam and support body. The researchers used a buffer echant oxide and Fe_3Cl to remove the nickel and SiO_2 layer and used deionized water to clean the cantilever to be used for testing.

After the fabrication process, the researchers used four arrays of the graphene-epoxy hybrid and a field emission scanning electron microscope (FE-SEM) to confirm the structure of the graphene seropentine pattern. For biomorph actuation, graphene films were directly heated, and the organic epoxy film was warmed up by the diffused heat upon applying the electric power. The researchers report a resistance of graphene ranging 50–60 kΩ



Schematic diagram of the fabrication process for graphene and epoxy hybrid cantilever system. Reproduced with permission from *Nano Lett.* (DOI: 10.1021/nl103618e). © 2011 American Chemical Society.

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