NewTimes – New Trends in Materials Science and Engineering
1st International Virtual Conference
14-18 June 2021
UNIVERSITÀ DELLA CALABRIA
CNR NANOTEC
INSTITUTE OF NANOTECHNOLOGY

Variable angle spectroscopic ellipsometry characterization of reduced graphene oxide stabilized with poly(sodium 4-styrenesulfonate)

Grazia Giuseppina Politano[1], Carlo Vena[1], Giovanni Desiderio [2], Carlo Versace[1,2]
1. Department of Physics, University of Calabria 87036 Rende CS, Italy
2. CNR-NANOTEC, 87036 Rende CS, Italy

Abstract

Lately, the optical properties of Graphene Oxide (GO) and Reduced Graphene Oxide (RGO) films have been studied in the ultraviolet and visible spectral range. However, the accurate optical properties in the extended near-infrared and mid-infrared range have not been investigated yet. In this contribution, we report a Variable Angle Spectroscopic Ellipsometry (VASE) characterization of GO thin films dip-coated on SiO_2/Si substrates and thermally reduced GO films in the 0.38-4.1 eV photon energy range, i.e. from the near-infrared up to ultraviolet range of the electromagnetic spectrum. Moreover, we explore the optical properties of RGO stabilized with poly(sodium 4-styrenesulfonate) (PSS) films dip-coated on SiO_2/Si substrates. Definitely, the Lorentz optical models fit well the experimental data. Correspondingly, the morphological properties of all studied samples were characterized by Scanning Electron Microscopy (SEM).

Methods and materials

- Dip-coating process was employed to deposit GO and PSS-functionalized RGO on SiO_2/Si (SiO_2 $\sim 2\ nm$) substrates
- The samples were prepared using commercial dispersions in H_2O of GO (4 mg/mL) and PSS-functionalized RGO (10 mg/mL). The solutions were sonicated for 30 minutes using an ultrasonic bath.
- GO films on SiO_2/Si were eventually heated at 400 °C for 20 min in an Ar atmosphere furnace.
- The optical characterization of the samples was carried out by using VASE. Spectra of the ellipsometric angles ψ and Δ were acquired using a V-Vase (Woollam Co.) ellipsometer in the [0.38 -4.1] eV photon energy range at 65°, 70°, 75° incident angles at room temperature.

SEM measurements

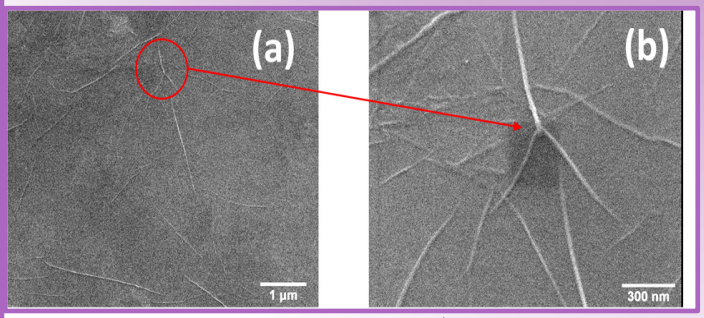

Figure 1. SEM images of (a) graphene oxide films on SiO_2/Si substrates and (b) the related magnification.

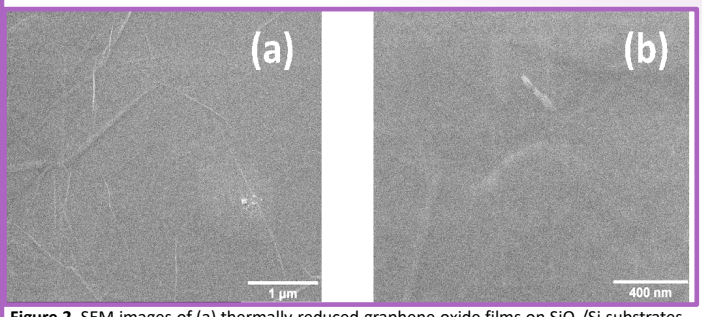

Figure 2. SEM images of (a) thermally reduced graphene oxide films on SiO_2/Si substrates and (b) the related magnification.

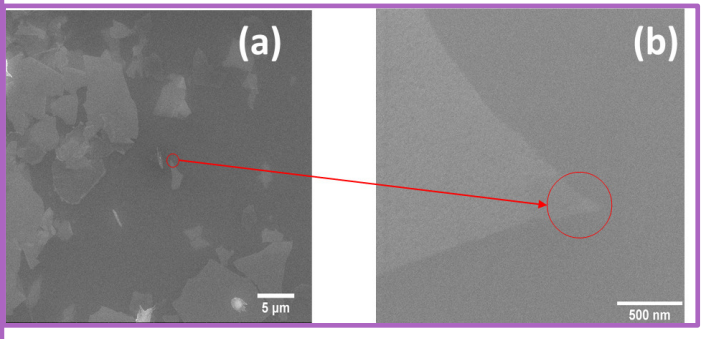

Figure 3. Scanning Electron Microscopy image of (a) reduced graphene oxide films stabilized with PSS on SiO_2/Si substrates and (b) the related magnification.

VASE measurements

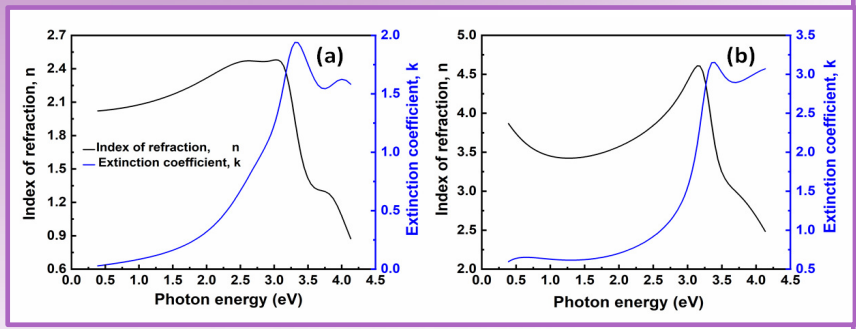

Figure 4. Estimated dispersion laws of (a) graphene oxide and (b) thermally reduced graphene oxide films on SiO_2/Si substrates by ellipsometry characterization

- Dispersion laws of GO and thermally reduced GO films are described by three Lorentz oscillators [1].
- In GO optical model, oscillator 1 at ~ 2.8 eV denotes different coverage of mixed hydroxyl groups and oxygen atoms. Oscillator 2 at ~ 3.2 eV (at ~ 388 nm) represents a transition that is near the shoulder in the absorbance spectrum of GO (at~ 320 nm) and close to the wavelength of blue luminescence detected for partially RGO (at ~ 390 nm). Oscillator 3 at ~ 3.9 eV is assigned to the small shoulder of GO in absorbance spectrum.
- In RGO optical model, oscillator 1 at ~ 2.1 eV denotes different coverage of mixed hydroxyl groups and oxygen atoms. Oscillator 2 at ~ 3.17 eV is related to the narrow photoluminescence peak observed for partially RGO. Oscillator 3 at ~ 4 eV falls in the range of blue photoluminescence [2].

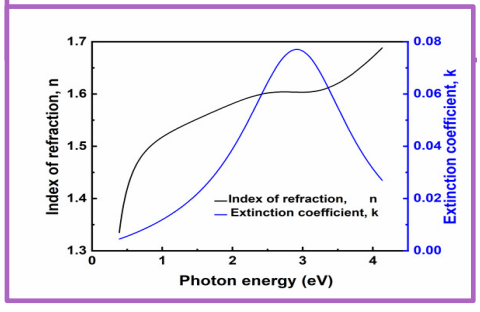

Figure 5. Dispersion laws of reduced GO stabilized with poly(sodium 4-styrenesulfonate) on SiO_2/Si substrates

- The dispersion laws of PSS-functionalized RGO on SiO_2/Si are described by a Lorentz oscillator and a pole [1].
- In PSS-RGO optical model, oscillator 1 at ~ 2.8 eV is assigned to states originated by sp^2 hybridization in the rearrangement due to reduction [3]. Oscillator 2 is outside the ellipsometer's range and the pole function covers its contribution.

CONTACT PERSON

Grazia Giuseppina Politano
Università della Calabria
Dipartimento di Fisica
Email:grazia.politano@unical.it

REFERENCES

1. G. G. Politano et al. *Coatings* 10 (2020) 743
2. G. Eda et al. Adv. Mater. 22 (2010) 505–509
3. H. F. Liang et al. J. Mater. Chem. C. 3 (2015) 12484–12491

NewTimes – New Trends in Materials Science and Engineering
1st International Virtual Conference
14-18 June 2021