# Bandgap tailoring of graphene oxide by electric field induced reduction: Applications to photonic micro devices

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Graphene oxide (GO) being a very large bandgap (~3 eV) material behaves as an insulator, that restricts its application in various electronic as well as opto-electronic devices. Reduction of GO leads to removal of oxide functional groups from the graphene layer resulting in reduction of its bandgap with enhancement in its conductivity. There are various techniques adopted for reduction of GO such as chemical, thermal, photo-thermal, photo-catalytic, Laser irradiation etc[1]. All these methods have their own advantages as well as limitations. Recently, voltage induced reduction has been studied to investigate the moisture dependent reduction mechanism[2].

In view of the above, step-wise controlled reduction process of GO and its mechanism need thorough investigation as it has wide applications in the industry of electronics, photonics, biomedical to name a few. In the present work, we have investigated the electric field induced reduction of GO drop-casted film on $SiO_2$/Si substrate. Time- dependent current-voltage characteristics has been studied and it was observed that on applying constant voltage, the sheet resistance of the film decreases with time. Using this, various reduced GO films have been studied using Scanning tunnelling spectroscopy. It is observed that as time progresses, due to the reduction, the bandgap changes from 3 eV to 0.3 eV. Whereas, the resistance decreases from 10 M Ω to 100 Ω as shown in figure 1 (a). To understand the mechanism, an in-situ absorption of the film was investigated during the reduction process using an indigenously developed diffused reflectance spectroscopy set-up. The differential absorption (ΔA), as shown in fig 1 (b) shows development of a 460 nm band as reduction progresses. The photo response of this partially reduced film has been investigated. A typical photo-response under the illumination of visible light of different intensities are shown in figure 2. The elaborated discussion on the correlation of our observation will be presented.

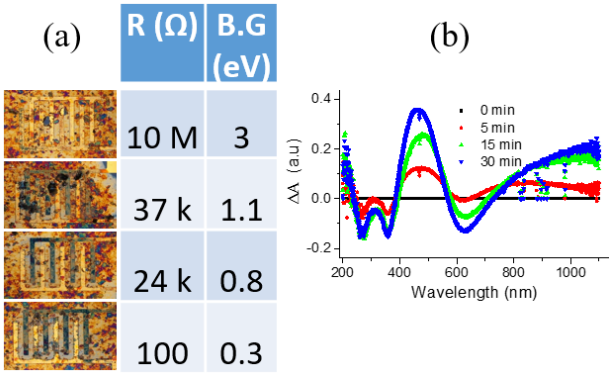


**Figure 1:** (a) in-situ transient absorption (b) optical images & corresponding B.G of GO at different stages of E.F induced reduction process

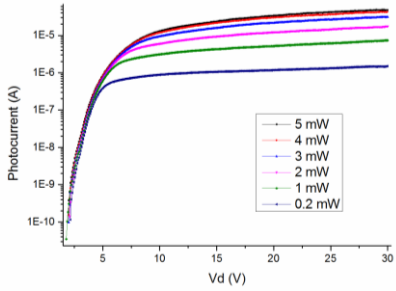


**Figure 2:** Photo-response of partially reduced GO under broad band visible light at different power.

References

[1] Y. Shang, D. Zhang, Y. Liu, and C. Guo, *Bulletin of Materials Science*, vol. 38, pp. 7-12, 2015.

[2] A. C. Faucett, J. N. Flournoy, J. S. Mehta, and J. M. Mativetsky, *FlatChem*, vol. 1, pp. 42-51, 2017.