Modifying the Optical Properties of Graphene Oxide via an Electric Field

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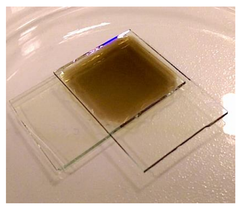
Abstract

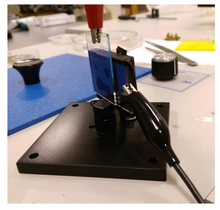
Graphene is a promising material, due to its various inherent properties that will lead to better, smaller, faster, or flexible electronics. Graphene doesn't exhibit optical emission, limiting its potential use in optoelectronics. However, graphene's functional derivative Graphene Oxide (GO) maintains many of graphene's properties and exhibits optical fluorescence emission in the visible/near-infrared, which makes it a candidate for novel applications such as optoelectronic transistors, light emitting diodes (LEDs), and solar cells. Therefore, finding a way to alter optical and electronic properties of GO will lead to more versatility and control among the aforementioned applications.

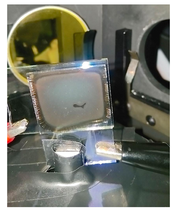
In this work, we studied the potential use of GO for microelectronic applications by observing the fluorescence of this material under the electric field. A dried GO/PVP film was subject up to 1.6 V/µm in between transparent conductive ITO electrodes resulting in observable quenching of fluorescence emission as the field was applied. The emission was further partially restored at 0 field. Additionally, microscopic flakes of graphene oxide deposited onto interdigitated 10 µm electrodes were subject to 100V/µm with no breakdown current detected. The fluorescence of individual flakes, observed via visible fluorescence microscopy, experienced substantial field-dependent quenching. In aqueous suspensions GO flakes exhibited electrophoretic migration signifying of charge separation. As a result of this work we suggest the potential of varying electronic and optical properties of graphene oxide via the electric field for the advancement and control over its optoelectronic device applications.

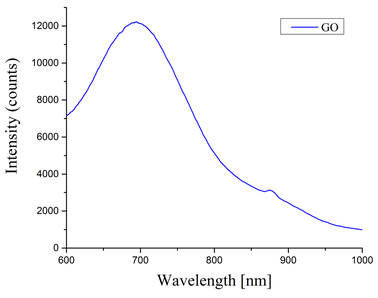
GO Film

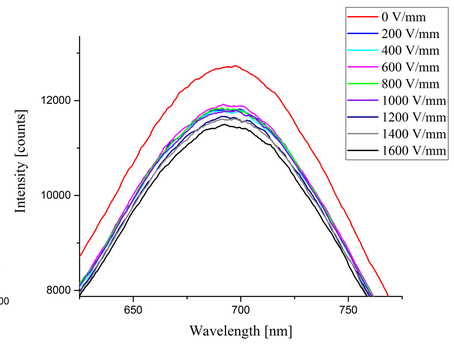
- ITO electrodes used with 1mm spacing.
- ~ 1mm thick GO film in PVP subjected to an electric field inside the fluorescence spectrometer: fluorescence is observed in situ.
- Fluorescence decreases with electric field.





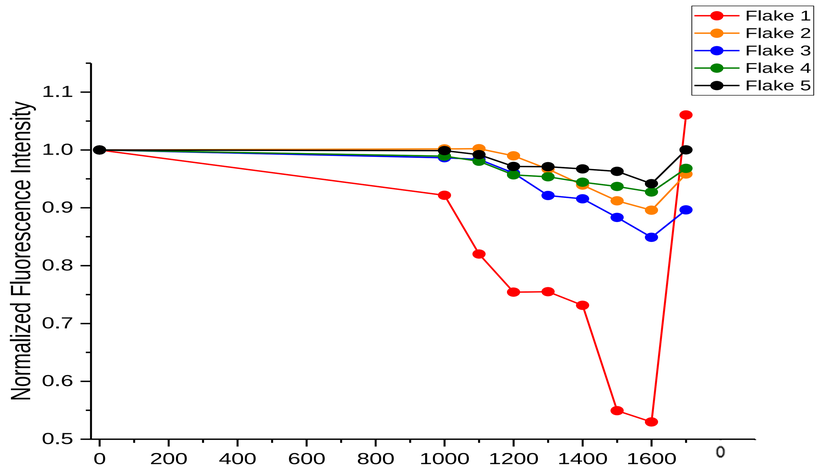


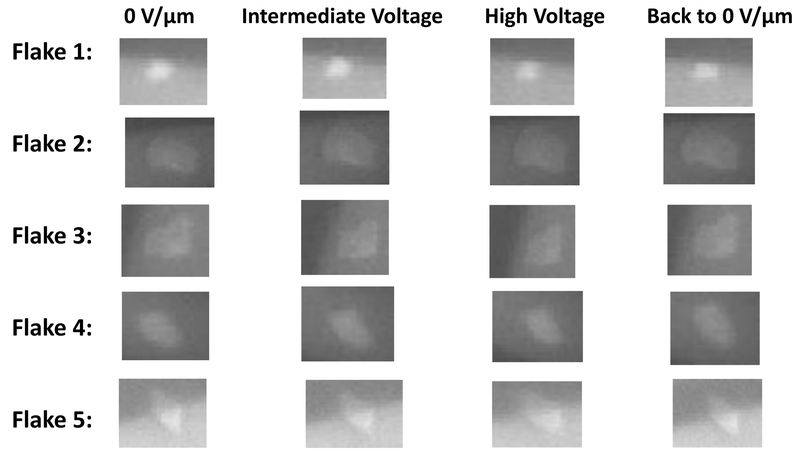




GO Flakes on Electrode

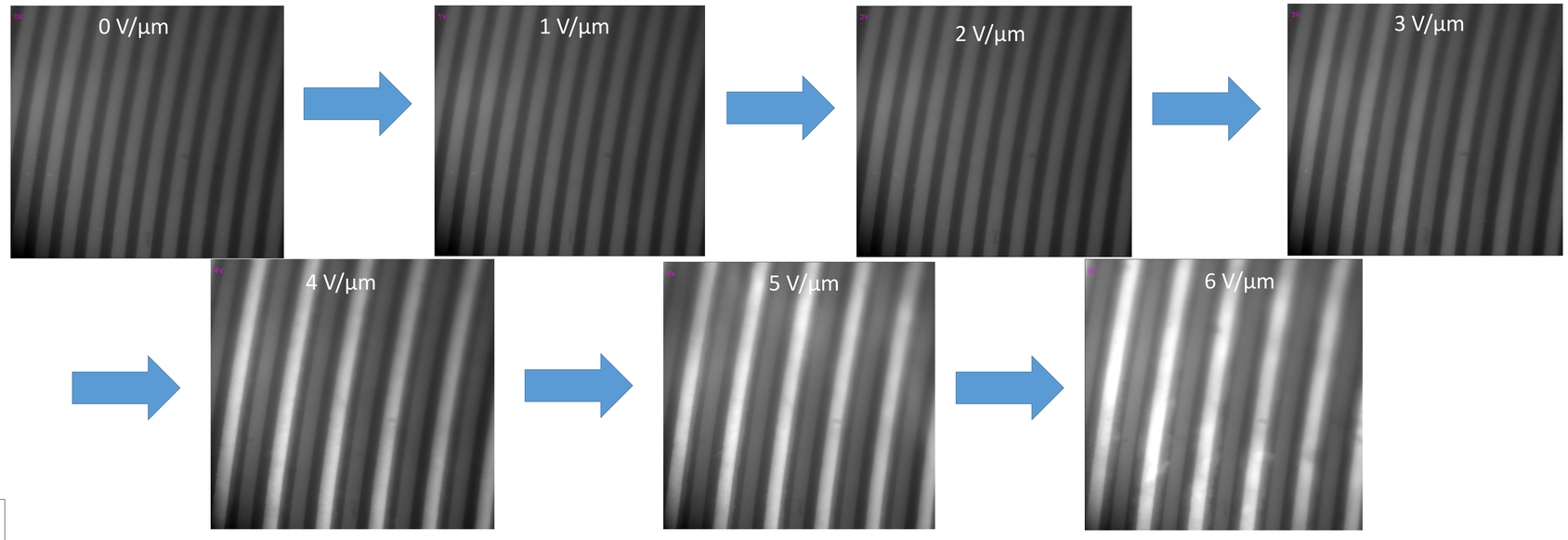
- Interdigitated 10 µm gold electrodes with microscopic GO flakes deposited
- Subjected up to 100V/µm electric field
- Fluorescence observed via fluorescence microscopy
- Fluorescence decrease when subject to field, and recovers when field stopped
- Fluorescence Intensity integrated over entire flake and then normalized





Electrolysis

- GO flakes in aqueous suspension subject to field up to ~6 V/µm
- Observed via fluorescence microcopy
- Evident electrophoretic migration
- Signifies charge separation



Summary

- We can control GO films fluorescent propertied by means of Electric Field
- GO flakes can be applied directly to a microelectrode and additionally controlled via Electric Field
- GO flakes exhibit evidence of charge separation die to electrophoretic migration while being subject to field
- Application: microelectronics, control the emission of optoelectronic transistors made from GO.
- Future experiments: study the photoelectric properties of quantum dots via lamp fluorescence and while being subject to high intensity laser excitation