Property Modulation of Graphene Oxide Incorporated with TiO_2 for Dye-Sensitized Solar Cells

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Supporting Information

Table S1 shows the photovoltaic performance of dye-sensitized solar cells (DSSCs) with GO synthesized by different techniques, as reported in the literature.

Table S1. State of the art of rGO used in TiO_2 layer in DSSC.

Authors	Deposition/ Synthesis process	Photoanode	DSSC parameters	Covered (Positives)	Ref.
Mustafa et. al. (2021)	electrodeposition method	rGO-TiO_2 compact layer	• J_{SC} = 14.07 mA cm^{-2} • V_{OC} = 0.63 V • FF = 32.60% • PCE = 2.89%	• suppressed the dark current • longest electron lifetime • highest charge collection efficiency	1
P. Makal et. al. (2021)	hydrothermal method	rGO-TiO_2-bronze nanowire composites	• J_{SC} = 10.41 mA cm^{-2} • V_{OC} = 0.71 V • FF = 67% • PCE = 4.95%	• lower interfacial resistance against charge transport • improve the specific surface area • enhance visible light absorption capacity	2
M. Dhonde et. al. (2021)	sol–gel-assisted hydrothermal method	Cu-doped TiO_2/graphene (CuTGR) composites	• J_{SC} = 19.93 mA cm^{-2} • V_{OC} = 0.745 V • FF = 66.04% • PCE = 9.81%	• improved current density • faster charge transport	3
Y. He et. al. (2020)	physical mixture process	Optimized Uio-66-rGO/TiO_2	• J_{SC} = 18.6 mA cm^{-2} • V_{OC} = 0.67 V • FF = 60.8% • PCE = 7.67%	• significant enhancement of the BET area • improve incident photon to electron efficiency	4

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Characterizations Techniques. X-ray diffraction (XRD) measurement was performed by XPERT–PRO diffractometer from Panalytical PW3050/60 working with Cu Kα (λ = 1.54060 Å). These films were also investigated by Raman spectroscopy (micro-Raman STR500Airix) using a He-Ne laser of 638 nm wavelength. High-resolution X-ray photoelectron spectroscopy (XPS) analysis was carried out using SCIENTA ECSA 300 equipped with monochromatic Al Kα (photon energy= 1486.6 eV) X-ray source. Soft X-ray absorption spectroscopy (XAS) is a very reliable tool to investigate the electronic structure (unoccupied states above Fermi level) of carbon-based materials. The GO and rGO thin films are probed by near-edge X-ray absorption fine structure (NEXAFS) collected at O K-edge and C K-edge. The NEXAFS measurements were performed at a high-energy spherical grating monochromator (H-SGM) BL20A1 (TEY mode, surface-sensitive up to ~ 5 nm) at the national synchrotron radiation center (NSRRC), Hsinchu, Taiwan and performed at Pohang Accelerator Lab at 2A beamline in Partial electron yield (PEY, sensitive to few atomic layers). The work function and surface morphology of the deposited GO and rGO thin films were recorded by Scanning Kelvin probe microscopy (SKPM) by Bruker (Singapore). The changes in the optical band gap of GO due to reduction were measured by Agilent Cary 5000 UV-Vis-NIR spectrophotometer. Microstructural topography of GO and rGO sample films were observed by field emission scanning electron microscopy (FESEM) from Nova Nano FE-SEM 450. *J-V* curves of assembled DSSCs were measured by illumination of 100 mW cm^{-2} under AM 1.5 G conditions using Oriel Sol 3A, a class AAA solar simulator. The solar simulator was calibrated using NREL-certified Si solar cells before testing of DSSCs.

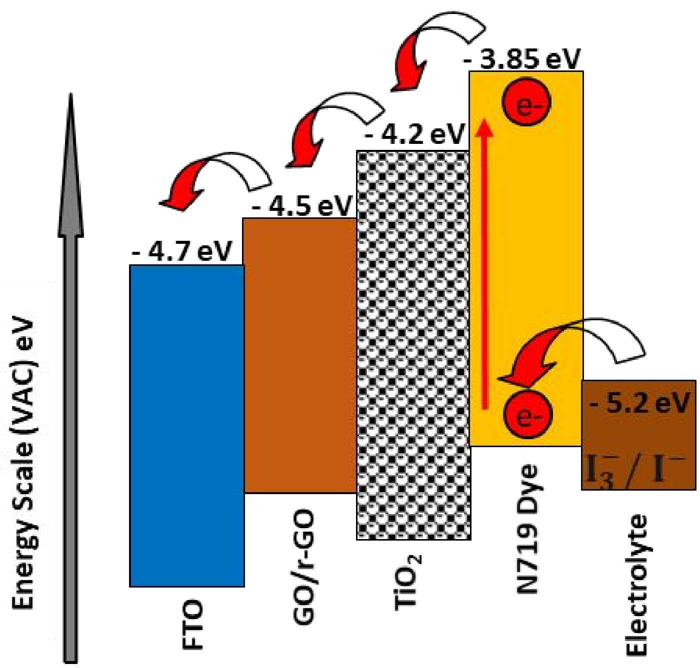

Figure S1. Charge flow in fabricated DSSC [2].

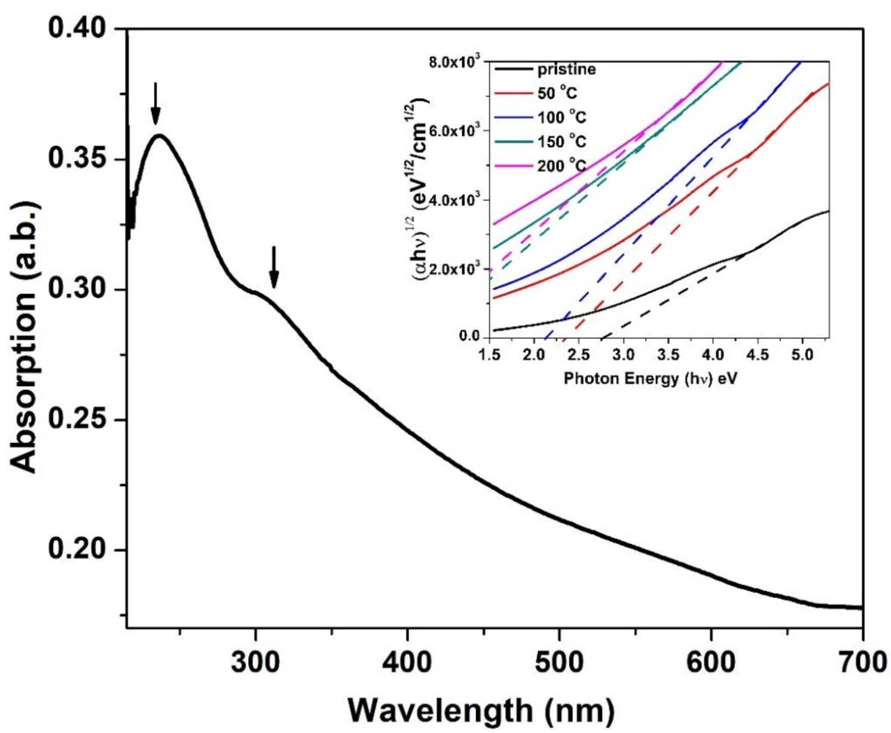

Figure S2. Absorption spectra of aqueous GO dispersion and Tauc plots for the deposited GO and rGO thin films (in the inset).

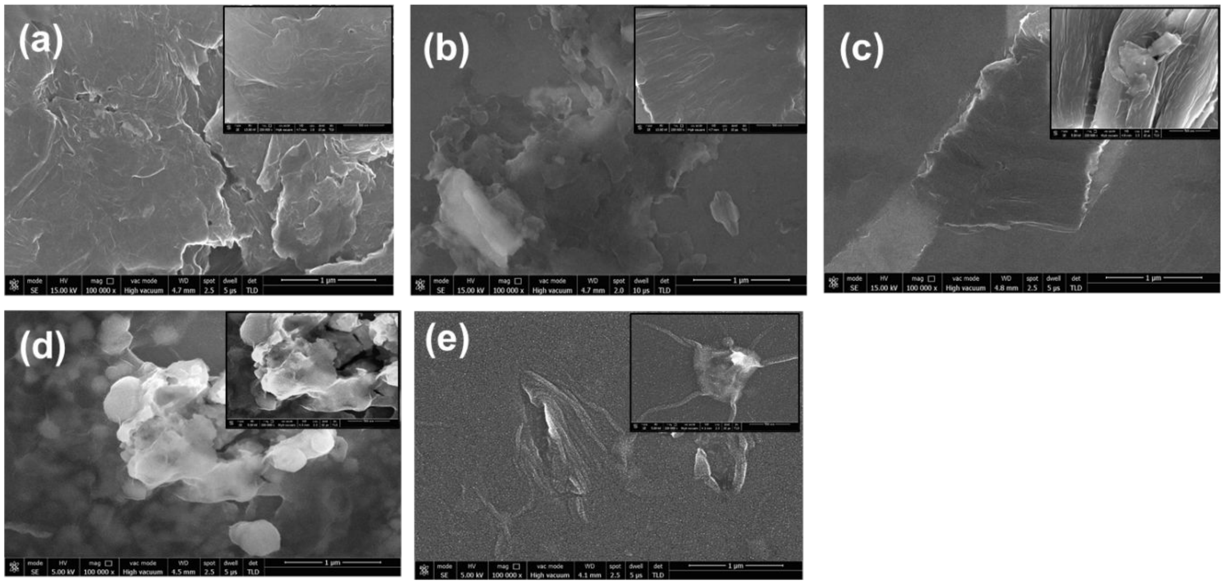

Figure S3. FESEM Images of GO (a) Pristine and reduced at (b) 50 (c) 100, (d) 150, and (e) 200 ºC.

References

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