Multi-layered Graphene Quantum Dots derived Photodegradation mechanism of Methylene Blue

Sima Umrao†, Poornima Sharma†, Anushka Bansal‡, Ranjna Sinha‡, Ranjan Kumar Singh†,
Anchal Srivastva†

†Department of Physics, Banaras Hindu University, Varanasi-221005, India.
‡ Department of Metallurgical Engineering, Indian Institute of Technology-B. H. U., Varanasi, 221005, India
§National Bureau of Fish Genetic Resources, Lucknow, India

*Corresponding author

Phone: (+091) 542 2307 308, e-mail: anchalbhu@gmail.com
Figure S 1. Schematic for synthesis of MLGQDs by hydrothermal disintegration of GO in water solution at 200 °C.

Figure S 2. (a) XPS spectra of MLGQDs, (b) FTIR spectra of MLGQDs, (c) Raman spectrum of MLGQDs, and (d) X-ray diffraction pattern of the MLGQDs.

AC impedance Spectrum:
To study about the separation of electrons and holes, the AC impedance measurement of ITO and MLGQDs electrodes in PBS solution (pH 7) containing 5 mM of $[\text{Fe(CN)}_6]^{3-/4-}$ was done using three electrode system with Ag/AgCl as reference, platinum as counter and MLGQDs/ITO as working electrode at the frequency range varying from 0.01 Hz to 10 kiloHz as shown in Figure S2 (see in supplementary information). The values of charge transfer resistance ($R_{CT}$) were recorded 133.5 ohm at open circuit voltage. A single semicircle at the high frequency region and a straight line at the low frequency region indicate a mixed charge transfer and charge diffusion process. The $R_{CT}$ values of the MLGQDs electrode was much smaller than that of the ITO electrode, which illustrates that MLGQDs lead to a much lower charge transport resistance and much higher separation efficiency of electrons and holes. The high separations of charge promote the enhancement of photocatalytic activity of MLGQDs.

![Figure S 3. AC impedance Spectra of as synthesized MLGQDs, the EIS measurements were performed in the presence of a PBS solution (pH 7) containing 5 mM [Fe(CN)6]3-/4-.](image)
Figure S4. Photographic image of MLGQDs-MB mixture before and after light exposure shows the color change from blue into colorless during the photodegradation of MB.

Time dependent absorbance spectrum of MB under Green and Blue light:

Figure S5. Time dependent absorbance of MB under green light (a) and blue light (b).
Figure S 6. Chemical structures and distribution of HOMO and LUMO for MLGQDs-MB complex in first energy band where minimal charge transfer within MLGQDs.

Optimize structure of MLGQDs:
Optimize spectrum of MB:

Optimize structure of LMB: