

Investigating the Solution Phase Fluorescence Quenching in a Graphene Oxide Derivative in the Presence of Tetracene

Y. K. D. Risini Chathma¹, Neranga Abeyasinghe¹

¹Department of Chemistry, University of Colombo, Sri Lanka

Introduction

- Tetracene has been reported to demonstrate strong performance in organic optoelectronic devices.
- It exhibits both fluorescence and phosphorescence emission, highlighting its unique photophysical processes.
- Fluorescence quenching of graphene oxide (GO) derivative in the vicinity of a tetracene molecule is an intriguing question that we try to address in this study.
- A graphene oxide derivative that possess π -orbitals on adjacent atoms was adopted as the π -conjugated system.

Experimental Procedure

- Modified Hummer's method

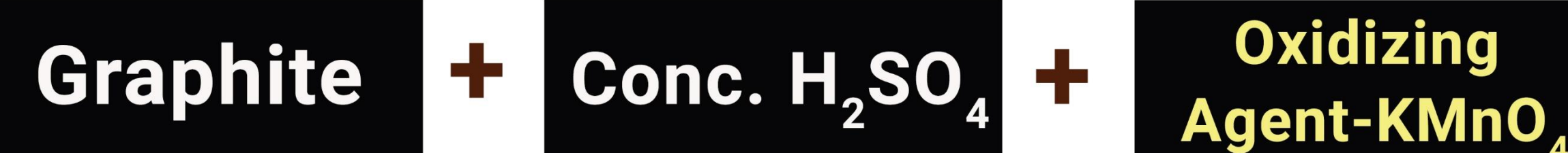


Figure 1.1- $KMnO_4$ added solution

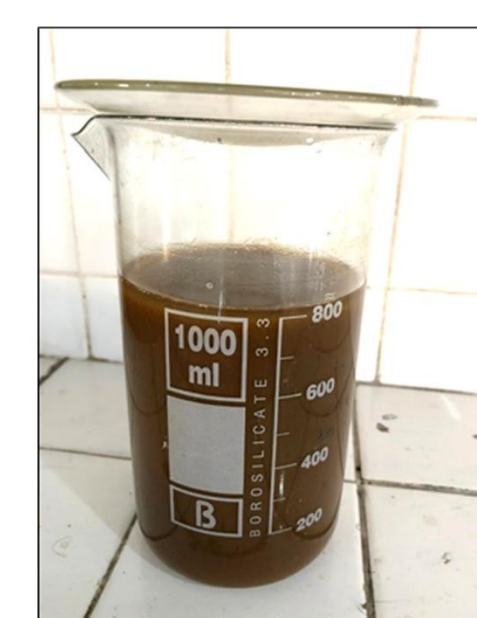
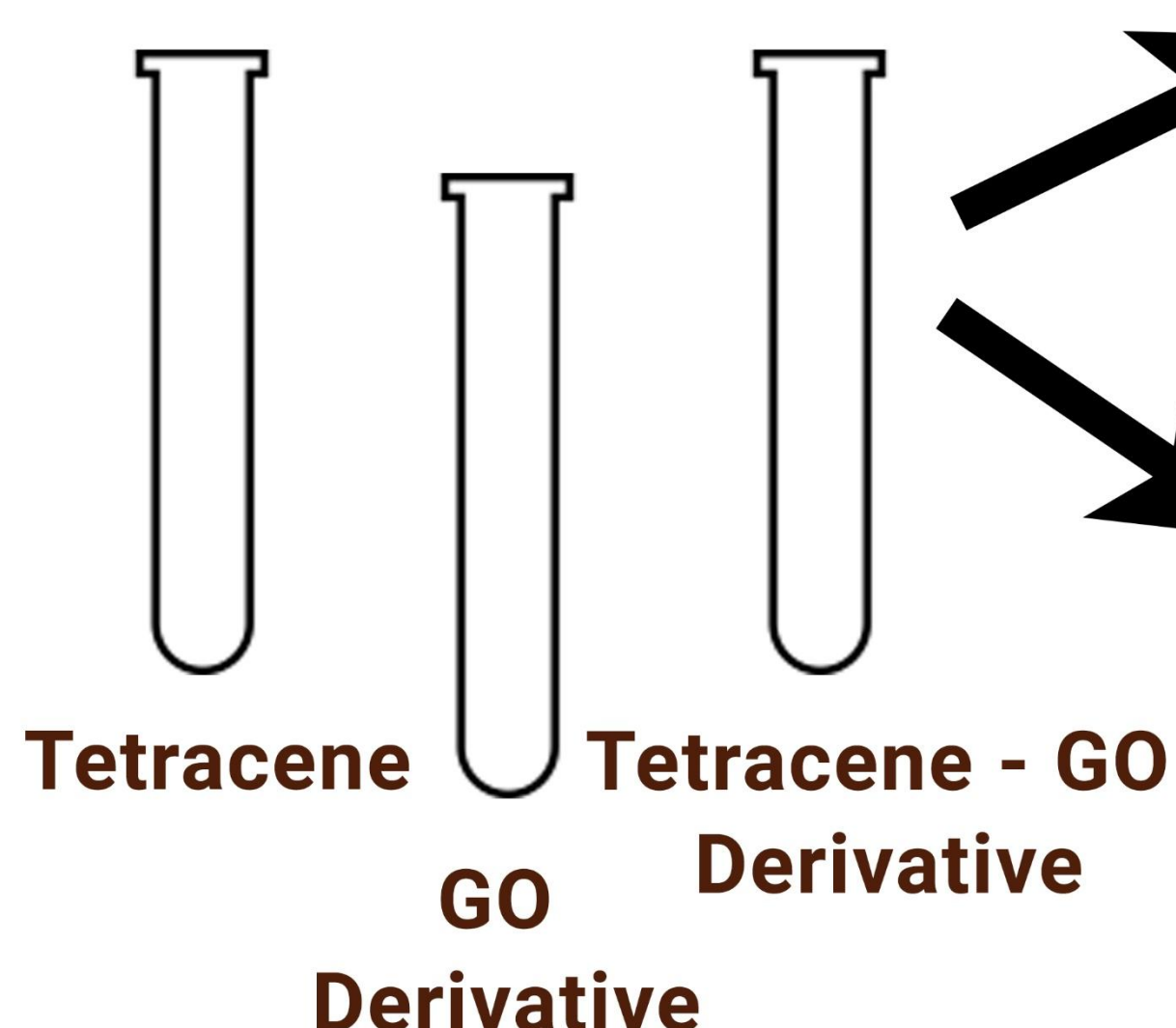


Figure 1.2- Stock solution of GO

GO Derivative



UV/ Visible Soectroscopy
Fluorescence Spectroscopy
Raman Soectroscopy

Relative QY Experiments
Standard - Fluorescein

Solubility Test

- DMF/ THF co-solvent was selected as the solvent system for Tetracene due to its higher solubility in it compared to other solvents.

Table 1.0 - Solubility of Tetracene in different solvents

Solvent	Solubility
Distilled Water	Insoluble
DMF	Less Soluble
THF	Soluble
Toluene	Soluble
DMF/ THF Co-Solvent	Soluble
DMF/ Toluene Co-Solvent	Soluble

Material Characterization

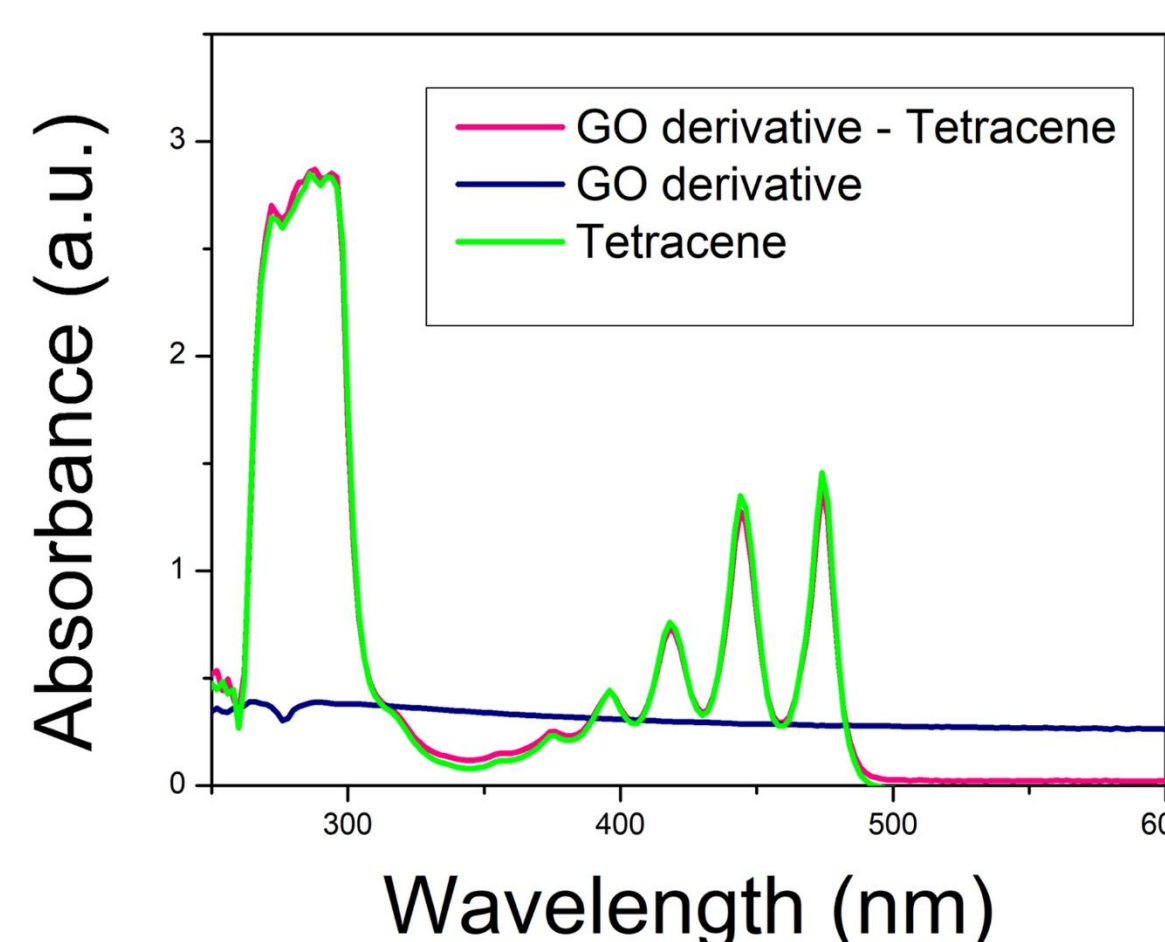


Figure 1.3- UV-Visible spectra of Tetracene, GO derivative, GO derivative- Tetracene mixture

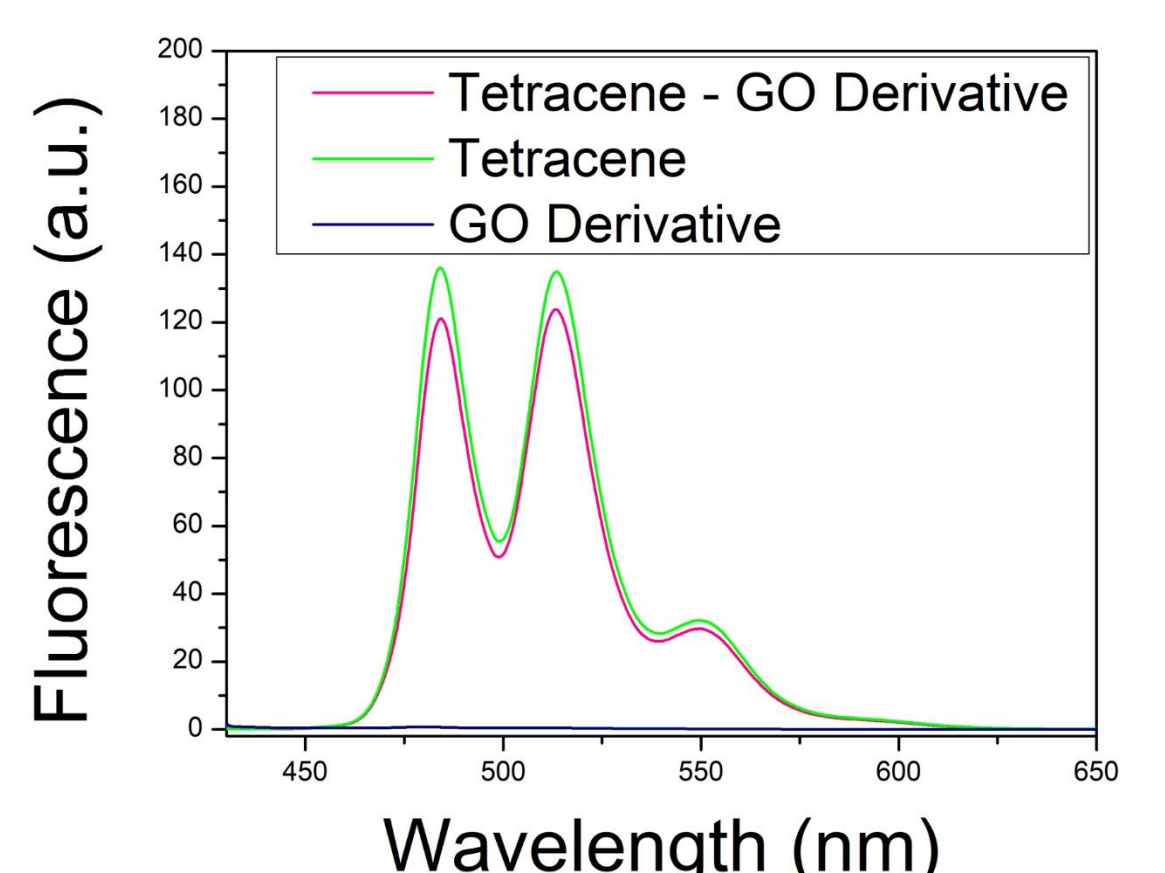


Figure 1.5- Fluorescence spectra of Tetracene, GO derivative, GO derivative- Tetracene mixture at 418 nm excitation wavelength

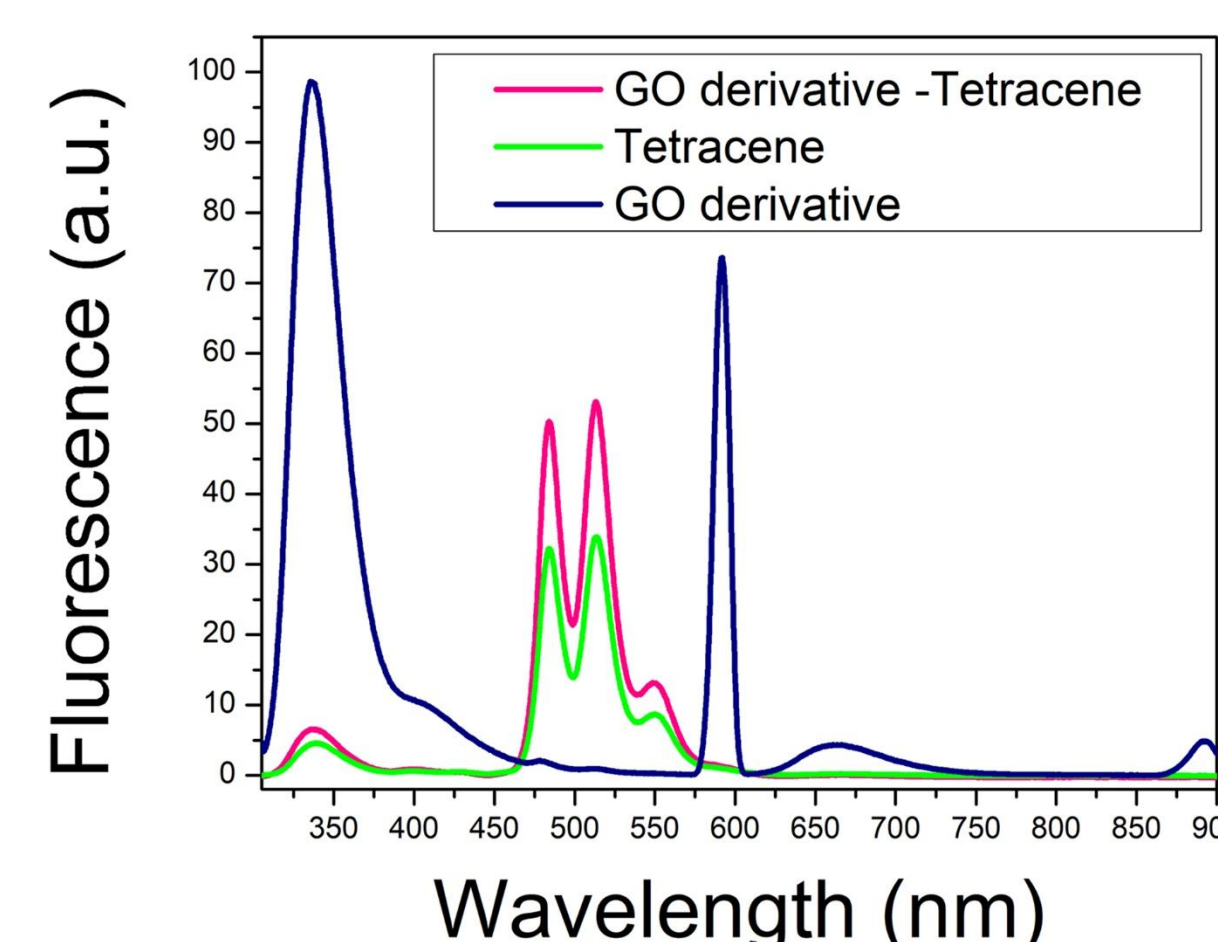


Figure 1.4- Fluorescence spectra of Tetracene, GO derivative, GO derivative- Tetracene mixture at 294 nm excitation wavelength

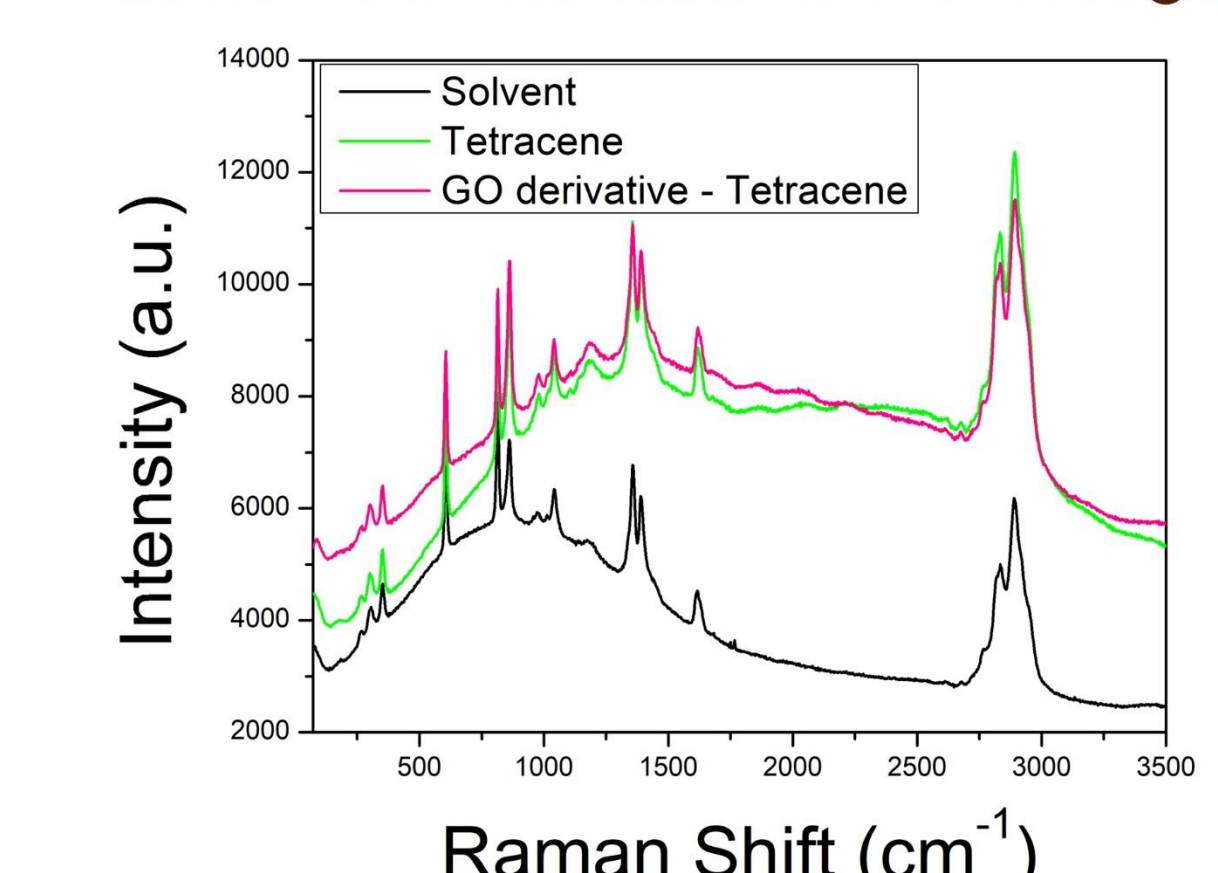


Figure 1.6- Comparison of Raman Spectra of the solvent, Tetracene, GO derivative and GO derivative - Tetracene mixture

Quantum Yield

- Presence of the GO derivative significantly decreased the quantum yield of Tetracene

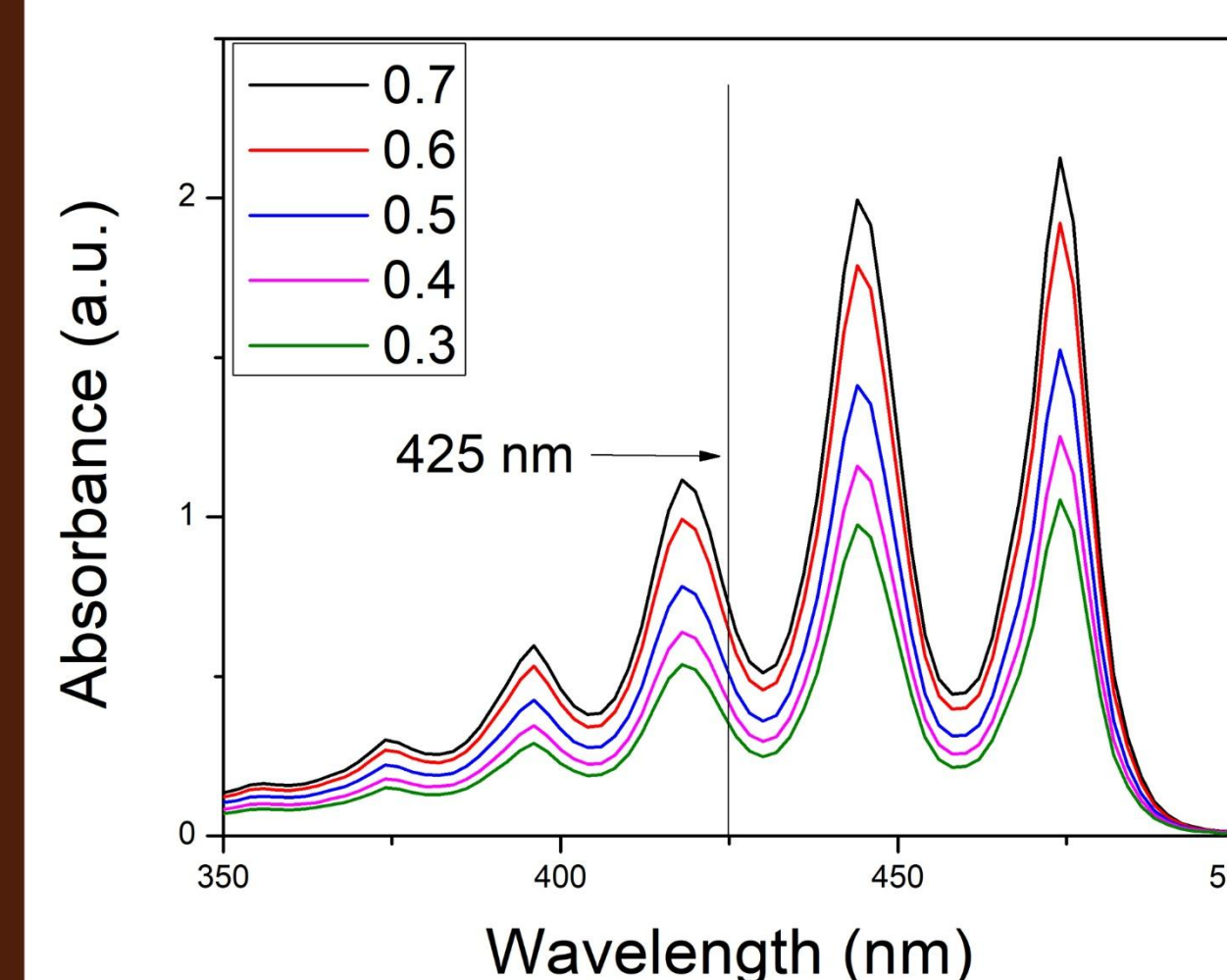


Figure 1.7- UV-Visible spectra of GO derivative- Tetracene

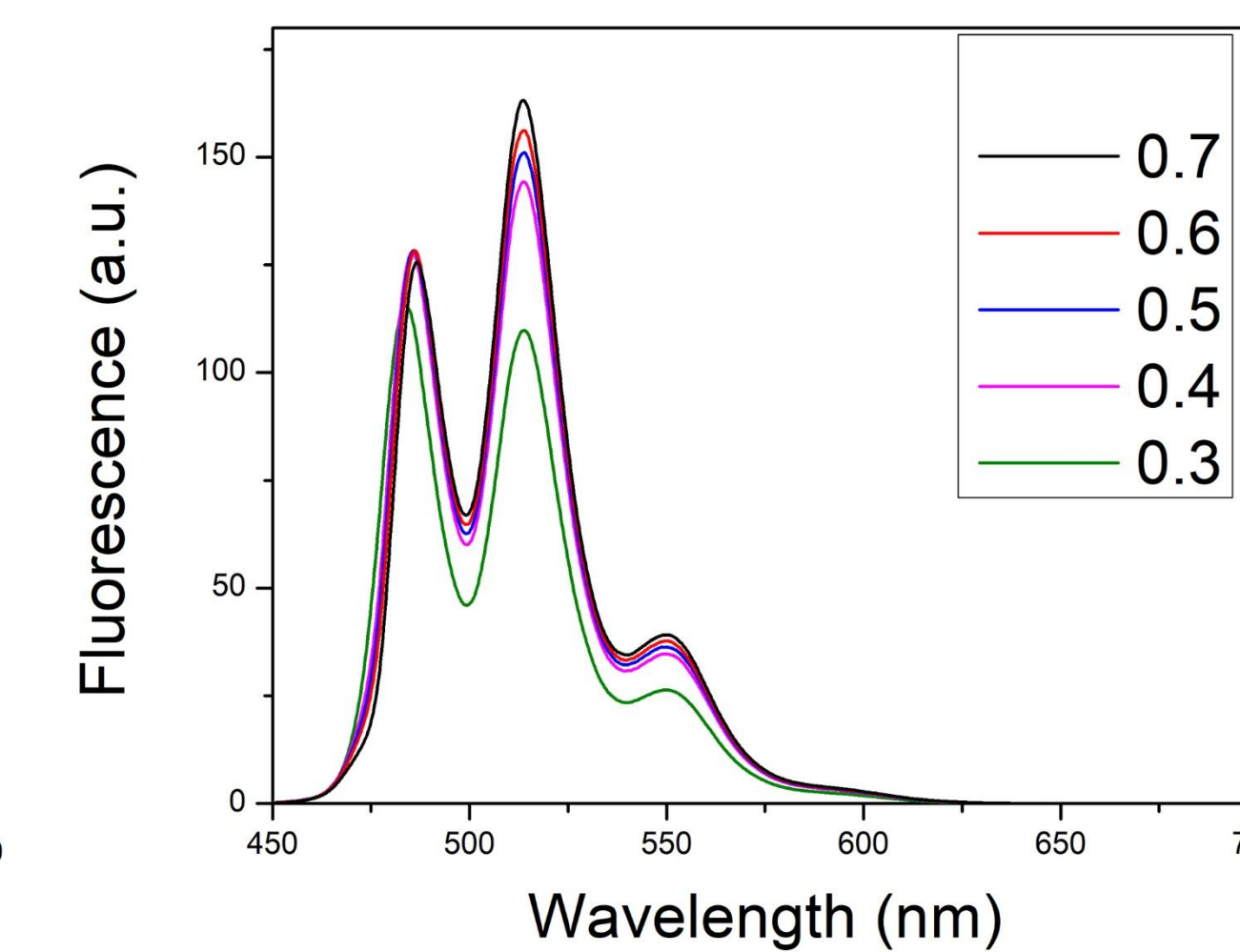


Figure 1.8- Fluorescence spectra of GO derivative- Tetracene at 425 nm excitation wavelength

Table 2.0 - Quantum Yield of Samples

Compound	Gradient of the plot of Integrated Fluorescence vs. Absorbance	Refractive index of the solvent	Quantum Yield for excitation at 425 nm
Fluorescein	53,496	1.3614	0.79
Tetracene	21,582	1.4187	0.35
GO derivative - Tetracene	19,893	1.4187	0.32

Energy Level Diagrams

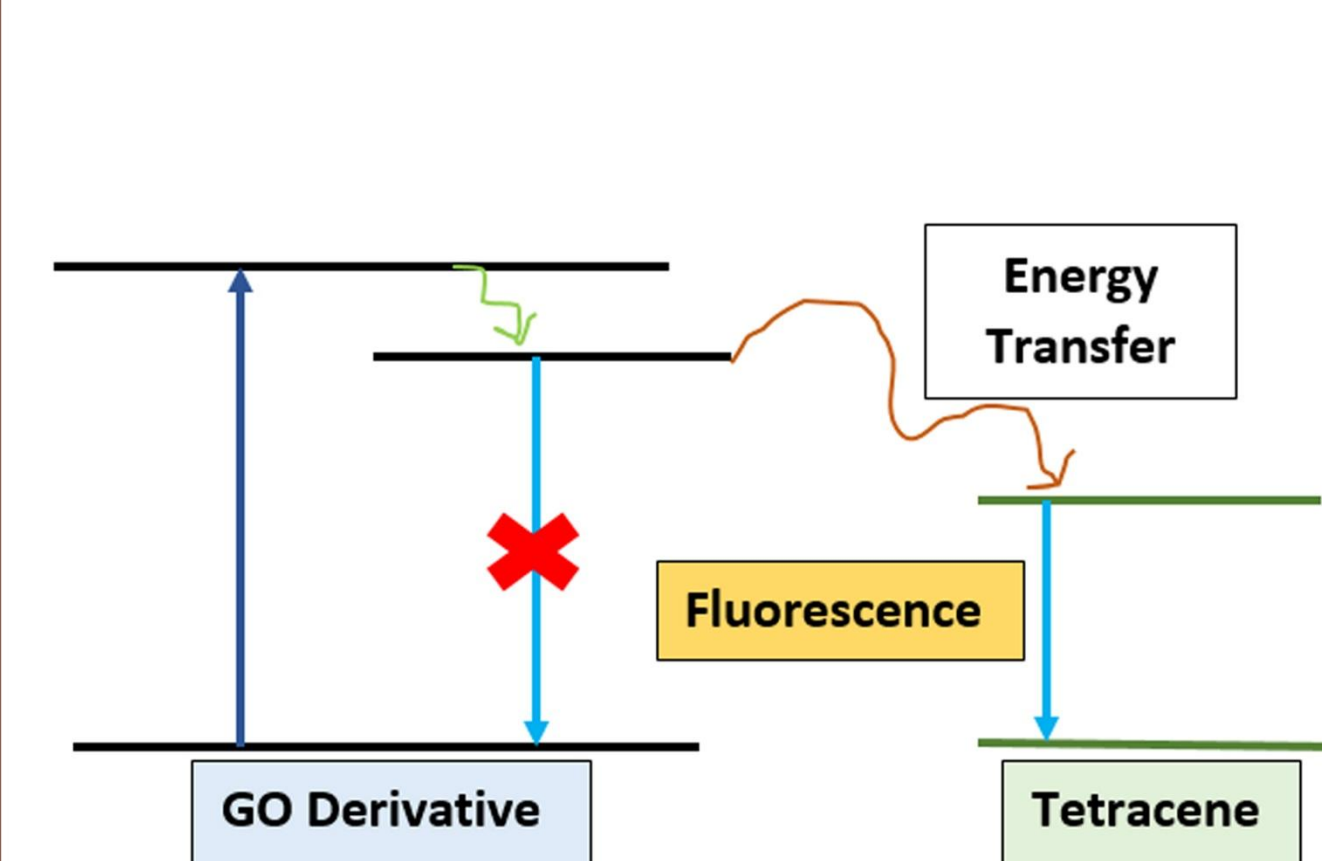


Figure 1.9- Hypothesized Energy Transfer

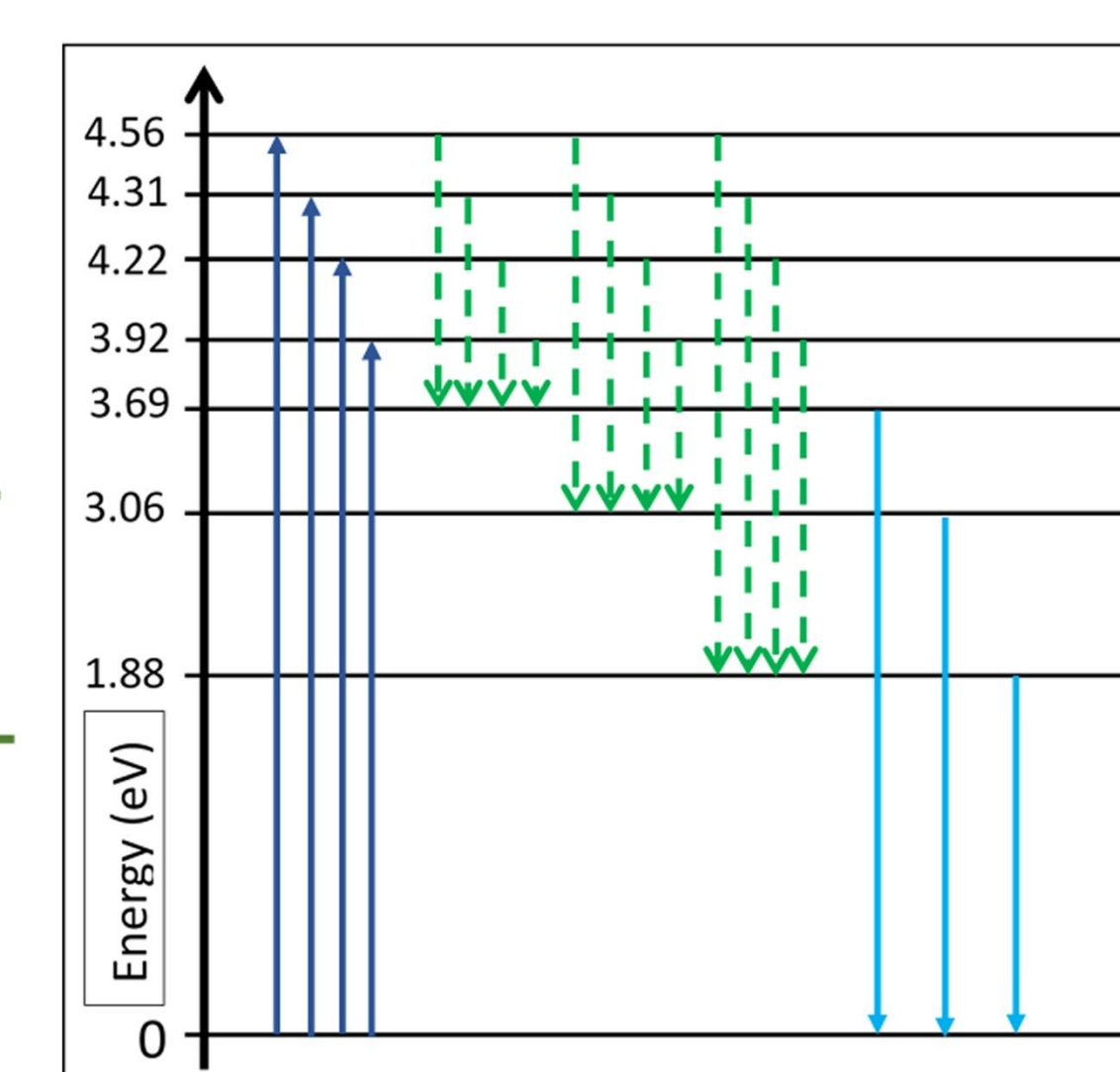


Figure 2.0- Energy Level Diagram of GO Derivative

Conclusion

- The absorption spectrum of the mixture showed no significant deviation from the original spectra of tetracene and the Graphene Oxide derivative.
- Emission spectral analysis revealed a notable quenching effect, while relative fluorescence measurements showed a reduction in quantum yield.
- These findings provide insights into the quenching mechanisms occurring between the two molecular systems.
- Molecular interactions such as reabsorption, vibronic coupling, and energy transfer may explain the spectral variations by suggesting potential applications in energy efficient technologies.
- Such interactions have led to distinct modifications in the optical, electronic, and spectroscopic properties of tetracene and the GO derivative.

Prospective Studies

- Incorporating the component mixture during the fabrication of thin films for optoelectronic devices.
- Investigating further energy transfer mechanisms using advanced spectroscopic techniques.

References

- (1) Kazzaz, A. A.; Zahlan, A. B. Temperature Dependence of Crystalline Tetracene Fluorescence. The Journal of Chemical Physics 1968, 48 (3), 1242–1245.
- (2) Peter, G.; H. Bässler. Fluorescence and Energy Transfer in Disordered Solid Tetracene. Chemical Physics 1980, 49 (1), 9–16.
- (3)Burdett, J. J.; Müller, A. M.; Gosztola, D.; Bardeen, C. J. Excited State Dynamics in Solid and Monomeric Tetracene: The Roles of Superradiance and Exciton Fission. J. Chem. Phys. 2010, 133 (14), 144506.
- (4)Mateo-Alonso, A. π -Conjugated Materials: Here, There, and Everywhere. Chem. Mater. 2023, 35 (4), 1467–1469.