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Notice for the PhD Viva Voce Examination

Mr Vinay Kumar M, Registration Number: 2270152, PhD Scholar at the Department of Physics and Electronics, School of Sciences, CHRIST (Deemed to be University), will defend his PhD thesis at the public viva-voce examination on Wednesday, 02 September 2026 at 02.00 pm in Room No. 044, Ground Floor, R&D Block, CHRIST (Deemed to be University), Bengaluru - 560029, Karnataka, India.

Title of the Thesis	:	**Integrating Different Strategies to Develop Efficient Photocatalyst for Effective Water Purification and Splitting**
Discipline	:	**Physics**
External Examiner - I	:	**Dr Alagarsamy Pandikumar** Principal Scientist CSIR-Central Electrochemical Research Institute Sekkalakottai, Karaikudi - 630003 Tamil Nadu
External Examiner - II	:	**Dr Neethu Jha** Assistant Professor Department of Physics Institute of Chemical Technology Mumbai - 400019, Maharashtra
Supervisor	:	**Dr Nainesh Kantilal Patel** Associate Professor Department of Physics and Electronics School of Sciences CHRIST (Deemed to be University) Bengaluru - 560029, Karnataka
Co-Supervisor	:	**Dr Rupali Nainesh Patel** Associate Professor Department of Physics and Electronics School of Sciences CHRIST (Deemed to be University) Bengaluru - 560029, Karnataka

The members of the Research Advisory Committee of the Scholar, the faculty members of the Department and the School, interested experts and research scholars of all the branches of research are cordially invited to attend this open viva–voce examination.

Place: Bengaluru
Date: 27 August 2026

Registrar (Academics)

ABSTRACT

The dual challenges of pharmaceutical contamination in water bodies and the growing demand for clean energy could be addressed with the development of highly efficient, visible-light-active, and noble-metal-free photocatalysts. Graphitic carbon nitride (gC3N4) has attracted considerable attention due to its suitable band gap, chemical stability, and earth- abundant composition; however, its widespread application is limited by insufficient visible-light utilization, fast charge carrier recombination, and sluggish surface reaction kinetics. This study focuses on systematic advancement of gC3N4 through elemental doping/co-doping and co-catalysts loading, enabling the photocatalytic activity of gC3N4.

The first study shows a synergistic modification strategy by doping phosphorus into gC3N4 and loading cobalt boride (CoB) nanoparticles onto gC3N4 (CoB/P-gC3N4). Phosphorus incorporation effectively tailors the electronic structure by narrowing the bandgap and extending visible-light absorption, while uniformly distributed CoB nanoparticles create interfacial Schottky junctions that promote directional electron transfer and suppress recombination of charge carriers. The optimized CoB/P-gC3N4 photocatalyst shows a 35-fold enhancement in the tetracycline (TC) degradation reaction rate compared to pristine gC3N4 under visible-light irradiation, highlighting the effectiveness of P-doping and CoB- loading onto gC3N4.

To further enhance the TC degradation, in the second work, simultaneous doping of phosphorus and potassium along with CoB-loading was done to gC3N4 (CoB/P-K-gC3N4). The P-K co-doping induces bandgap narrowing, shallow impurity states, and pronounced charge redistribution, while the ultrasmall CoB nanoparticles not only form Schottky barriers but also generate localized surface plasmon resonance (LSPR), which improves the light absorption and charge separation. As a result, CoB/P-K-gC3N4 shows a 21-fold increase in TC degradation kinetics, achieving 84.8% degradation of 100 ppm TC within 60 min by using only 10 mg of catalyst, corresponding to a high removal efficiency of 7.1 mg g-1 min-1, along with excellent structural stability and reusability. Previously, CoB/P-gC3N4 activity was tested in a 20 ppm TC concentration. To compare CoB/P-gC3N4 with CoB/P-K-gC3N4, CoB/P-gC3N4 activity was also tested under 100 ppm TC concentration. Where the reaction kinetics of CoB/P-gC3N4 was just ~6.5 times higher than pristine gC3N4, clearly indicating the superior activity of CoB/P-K-gC3N4 compared to CoB/P-gC3N4 under high concentration of TC.

The third and fourth studies focus on sustainable hydrogen production. In the third work, we have introduced a phosphorus-incorporated cobalt boride (CoPB) co-catalyst onto gC3N4 (CoPB/gC3N4). The presence of electronegative phosphorus enhances proton (H+) adsorption, while the CoPB co-catalyst functions as an efficient electron acceptor due to a Schottky junction formation, thereby accelerating interfacial charge transfer and surface reaction kinetics. The CoPB/gC3N4 photocatalyst gave a hydrogen yield of 181.6 μ-mol g-1 with a hydrogen evolution rate of 102 μ-mol g-1 h-1, giving a five-fold improvement compared to pristine gC3N4, and exhibits excellent photocatalytic reusability over repeated cycles.

In the final study, a bimetallic cobalt-molybdenum phospho-boride (CoMoPB) co-catalyst is loaded onto gC3N4 (CoMoPB/gC3N4) to further enhance the hydrogen evolution. The synergistic interaction between Co and Mo centers, combined with phosphorus-induced sites, increases charge carrier density and minimizes recombination losses. The optimized CoMoPB/gC3N4 system achieves a hydrogen production of 294.4 μ-mol g-1 with an evolution rate of 146.8 μ-mol g-1 h-1. Overall, this work focuses on gC3N4-based photocatalysts for environmental remediation and hydrogen production.

Keywords: *gC3N4, Doping, Co-Doping, Co-Catalyst Loading, Tetracycline Degradation, Photocatalytic Hydrogen evolution.*

Publications:

1. **Kumar, M. V.**, Fendrich, M., Orlandi, M., Miotello, A., Gupta, S., Patel, R., Fernandes, R., & Patel, N. (2025). Dual strategy for enhanced photocatalytic degradation of tetracycline: Phosphorus doping and cobalt boride co-catalyst loading on g-C3N4. *Journal of Water Process Engineering, 70*, 107036. https://doi.org/10.1016/j.jwpe.2025.107036
2. **Kumar, M. V.**, Hamsaveena, D., Samartha, M. D., Bhagat, B. R., Orlandi, M., Miotello, A., Gupta, S., Patel, R., Fernandes, R., & Patel, N. (2026). Ultrasmall cobalt boride-decorated P, K-doped gC3N4 for plasmon-driven degradation of high concentration tetracycline. *Applied Surface Science*. https://doi.org/10.1016/j.apsusc.2025.165683