INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Programme of Study	:	**Ph.D.**

Thesis Title: **Integrated Photocatalytic-Biological Treatment of Pharmaceutical Wastewater and Catalyst Recovery**

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Thesis Submitted to the Academic Division	:	**Centre for the Environment**
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Key words for description of Thesis Work	:	**Bio-based metal-doped TiO_2; Pharmaceutical Wastewater; Pilot-scale Treatment, Photocatalytic Degradation; Photocatalyst Recovery and Reusability; Membrane Separation; Biological Degradation**

SHORT ABSTRACT

Escalating water pollution, containing pharmaceutically active compounds (PhACs), contributes to the development of antibiotic-resistant microbes. This doctoral work develops bio-based metal-doped TiO_2 photocatalysts and an integrated photocatalytic and biological system coupled with a membrane system to achieve efficient PhAC mineralization with catalyst recovery.

Herein, Pt-, Au-, Pd-, and Ni-doped TiO_2 photocatalysts were synthesized using various vegetal extracts. Metal doping significantly reduced the bandgap, delayed recombination, and increased oxygen vacancies, Ti^{3+} defects, and hydrophilicity, leading to enhanced photocatalytic degradation efficiency. Pt-, Au-, Pd-, and Ni-doped TiO_2 could degrade ~85.5% ciprofloxacin, 94.6% chloroquine, more than 98% amoxicillin, and 90.4% furazolidone, respectively. The photocatalytic process significantly reduced the aquatic toxicity and neutralized the antimicrobial activity of all the PhACs.

A pilot-scale integrated photocatalytic and biological degradation process, coupled with a membrane separation process, was designed and installed for the complete degradation of PhACs and the recycling of the catalyst. The pilot-scale crossflow ultrafiltration system achieved >99% recovery of bare and metal-doped TiO_2, while retaining their photocatalytic efficiency. The integrated photocatalytic (Au-doped TiO_2) and biological degradation (*Pseudomonas spp.* PDC11) processes achieved greater than 99% degradation of individual and mixed PhACs in DI water and hospital wastewater, with more than 80% reduction in TOC and COD, along with almost complete recovery of used photocatalysts. Overall, the system demonstrates scalable, sustainable, and highly effective treatment of complex pharmaceutical wastewater with complete catalyst recyclability.