National Institute of Technology Rourkela

Progress Seminar

Seminar Title	: Fabrication of Indium Sulphide-based Hydrogels as a Multifunctional Photocatalyst for Environmental Remediation and Energy Applications
Speaker	: Hritankhi Tripathy (Rollno : 523ch3001)
Supervisor	: Arvind Kumar
Venue	: New Seminar Hall, Department of Chemical Engineering
Date and Time	: 13 Aug 2025 (04:00 PM)
Abstract	: Photocatalysis has emerged as a sustainable and efficient approach for addressing environmental challenges, particularly in wastewater treatment and energy applications. This study reports the fabrication and performance evaluation of In_2S_3-based photocatalytic hydrogels engineered for dual applications in environmental remediation and oxidative energy generation. Three hydrogel systems&mdashIn_2S_3-TA, ICS, and ICB&mdashwere synthesized via hydrothermal and crosslinking methods using biopolymer supports (alginate, pectin or CMC) to improve structural stability, dispersion, and reusability. The In_2S_3-TA hydrogel, exhibiting a flower-like morphology, showed enhanced visible-light absorption and reduced band gap (~1.4 eV) as confirmed by XRD, FTIR, PL, and UV-DRS analysis. It achieved 81% degradation of sulfamethoxazole (SMX, 10 mg/L) in 60 minutes and maintained 63% efficiency after 8 reuse cycles. The binary ICS hydrogel, comprising a type-II heterojunction of In_2S_3 nanorods and CuSe nanoflowers embedded in a 3D CMC matrix, was validated through XRD, FTIR, XPS, FESEM/EDX, and electrochemical studies. It showed strong visible-light activity with a 1.4 eV band gap, achieving 100% SMX degradation in 5 minutes (rate constant 0.989 min^{-1}), 34.5% dark adsorption, and retained 92% activity after 20 cycles. The ternary ICB hydrogel, integrating In_2S_3, CdS, and Bi_2WO_6 into an alginate network, formed a dual Z-scheme heterojunction with spherical, microporous structure confirmed by XRD, FTIR, EDX mapping, PL, Mott-Schottky, and EIS. It achieved 99% SMX degradation in 20 minutes (rate constant 0.191 min^{-1}), generated 455 &muM H_2O_2 with isopropanol, and maintained 87% efficiency over 10 cycles, even under solar irradiation and in real water matrices. Mechanistic studies revealed the formation of reactive species (&bullOH, SO_4&bull$^-$, &bullO_2^-) and complete SMX mineralization. This study highlights the potential of In_2S_3-based hydrogels as multifunctional photocatalysts, capable of addressing wastewater pollution and contributing to energy applications through visible light-driven processes.

Keywords: *Photocatalysis, In_2S_3, Hydrogel, Wastewater treatment, Sulfamethoxazole, Energy applications*.