THE 2nd INTERNATIONAL CONFERENCE ON ADVANCED AND MULTIFUNCTIONAL MATERIALS (ICAMM'26)
Email: icamm26@hcmus.edu.vn
Website : https://icamm26.hcmus.edu.vn/

Multifunctional Bi_2Se_3–TiO_2 Nanostructures for Rapid Photocatalytic Degradation of Anticancer Drugs and Enhanced Photoelectrochemical Water Splitting

Author(s): Nguyen Chi Toan[1,2], Thao Phuong Huynh[3], Tho Chau Minh Vinh Do[3], **Phuoc Huu Le**[1,2*]

Institution: [1]Center for Plasma and Thin Film Technologies, Ming Chi University of Technology, New Taipei City, Taiwan
[2]International Ph.D. Program in Plasma and Thin Film Technology, Ming Chi University of Technology, New Taipei City, Taiwan
[3]Faculty of Pharmacy, Can Tho University of Medicine and Pharmacy, 179 Nguyen Van Cu Street, Can Tho City, Vietnam

E-mail: * **phle@mail.mcut.edu.tw**

Abstract: Anticancer drugs (ACDs) are among the most toxic pharmaceutical pollutants and are increasingly detected in hospital effluents, where they pose a serious risk to aquatic environments. Three-dimensional Bi_2Se_3 topological insulators, with a narrow bulk band gap (~0.3 eV) and an oxidized state band gap of ~0.8 eV, offer strong IR–visible absorption and favorable band alignment for photocatalysis and photoelectrochemistry. In this work, Bi_2Se_3 nanoparticles were prepared by electrochemical exfoliation, while TiO_2 nanotube arrays and TiO_2 nanowires-on-nanotubes films were grown on Ti by anodic oxidation. Bi_2Se_3/TiO_2 nanostructured films with controlled Bi_2Se_3 loading were fabricated and characterized structurally, morphologically, and compositionally. Their photocatalytic activity toward eight representative ACDs (IF, CY, GEM, CAP, MET, DOX, IRI, 5-FU) was quantified by LC–MS/MS, with optimized architectures achieving apparent first-order rate constants up to ~2.4–2.7 × 10^{-1} min^{-1} for 5-FU and ~1.5–3.5 × 10^{-1} min^{-1} for several other drugs, enabling rapid removal in both model solutions and real hospital wastewater, with stable performance over at least five reuse cycles. Additionally, Bi_2Se_3 hexagonal nanosheets–TiO_2 nanoparticle nanocomposites obtained via hydrothermal synthesis showed markedly enhanced photoelectrochemical water-splitting currents under UV–Vis and Vis illumination, owing to improved IR–Vis light harvesting and more efficient separation of photogenerated carriers at Bi_2Se_3–TiO_2 heterointerfaces. These results identify Bi_2Se_3–TiO_2 nanostructures as promising dual-function materials for pharmaceutical wastewater remediation and solar-driven hydrogen production.

Keywords: *Bi_2Se_3–TiO_2, Anticancer Drugs, Photoelectrochemical (PEC) water splitting, LC-MS/MS*