

國立臺北科技大學化學工程與生物科技系國際專題演講

題目：Avoiding Misinterpretation: A Multi-Step Methodology for Validating Visible-Light Photocatalysis Using Dyes

講者：Professor Sandra E. Rodil

National Autonomous University of Mexico (UNAM)

時間：2025 年 10 月 27 日(星期一) PM 13:30~16:00

地點：化學工程館 101 電化教室



Abstract:

Photocatalysis is a vital field for sustainable development, but many published reports produce unreliable results because they often fail to thoroughly consider all competing processes. Correctly assessing a semiconductor's activity requires separating the effects of photodiscoloration (adsorption/photolysis), dye self-sensitization, photodegradation, and mineralization. The common practice of using dyes as model pollutants is problematic, especially under visible light, because dyes can sensitize wide-bandgap photocatalysts, undergo photobleaching, or form leuco-dyes, making simple photodiscoloration an unreliable measure. While colorless compounds offer better analysis, they require costly techniques like chromatography instead of standard spectrophotometry.

This investigation proposes and validates a multi-step methodology for more accurate photocatalytic interpretation using dyes and visible light. We used the Bi_2O_3 semiconductor, which has a band gap below 2.7 eV, along with three model dyes: Rhodamine-B (RhB), Acid Blue 113 (AB), and Indigo Carmine (IC). The methodology involved theoretical absorbance calculations, spectrophotometric degradation experiments that explicitly account for competing processes, and Total Organic Carbon (TOC) analysis for mineralization. Importantly, we highlight the significance of analyzing the entire dye absorption spectrum over the course of irradiation to effectively monitor the process.

Results showed that much of the observed photodiscoloration and mineralization was mainly caused by photolysis or adsorption onto the Bi_2O_3 surface, rather than complete degradation. This emphasizes the need to measure each contribution separately. A simple test effectively identified dye sensitization with the AB dye. RhB and IC were used as models to detect photobleaching or leuco-dye formation. We propose that IC can serve as a universal probe molecule for analysis, as its degradation can be monitored through distinct absorption signals from its intermediates. Therefore, by following the steps outlined in the methodology and using the IC dye, we concluded that the visible-light activity of semiconductors can be accurately assessed.

Bio:

Dr. Sandra E. Rodil is the Coordinator of the Materials Science and Engineering Graduate Program and a Titular Researcher in Materials's Research Institute at National Autonomous University of Mexico (UNAM). Her research interests are thin film deposition, spectroscopic characterization of materials & thin films, biocompatible and antimicrobial coatings, photocatalysis, surface engineering, mechanical and tribological applications of coatings. She earned her PhD in Engineering at the University of Cambridge, UK in 2001. She is the recipient of "Alfonso Caso" Medal (1997), "Sor Juana Inés de la Cruz" Medal (2009), "Fernando Alba" Medal (2014) at UNAM, Newton Advanced Fellowship from the Royal Society in UK (2017-2019), Women on Science Award from L'Óreal-UNESCO-AMC (2023). She is an editor of Materials Letters and Materials Letters X, ICMCTF Proceedings of Thin Solid Films, Surface and Vacuum Technology, and Vacuum. She is a highly cited scholar with 6300 total citations and average annual citations of 450 for the past 3 years.