SnO_2 Thin Films as Photocatalysts: From Fundamental Properties to Environmental Applications

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Abstract

Water pollution remains one of the most critical environmental challenges today, driven by industrial waste, agriculture runoff and urban development. These activities introduce persistent organic and inorganic pollutants, such as synthetic dyes into natural water sources. Conventional water treatment methods are often costly, energy-intensive, and ineffective against many of these contaminants. As a result, photocatalysis has emerged as a promising, sustainable and efficient method for water purification.

While materials like ZnO and TiO_2 have been extensively investigated for photocatalytic use, tin (IV) oxide (SnO_2) is emerging as a promising alternative. SnO_2 is an n-type semiconductor with a wide band gap (~3.6 eV), that possesses high chemical and thermal stability, and excellent optical and electrical properties. In thin-film form, SnO_2 offers additional advantages: films can be easily removed from solution after photocatalytic testing, especially when deposited on flat or porous substrates.

This seminar will provide a brief overview of recent research studies involving SnO_2 for photocatalytic applications, highlighting synthesis methods and performance optimization. In particular, the deposition of SnO_2 thin films using Atomic Layer Deposition (ALD) technique will be explained. In recent years, ALD method has attracted great interest for the synthesis of thin films, as it provides exceptional precision, conformality, and control over film properties at the atomic level.

The seminar will conclude with an outline of my PhD research, which involves synthesizing SnO_2 thin films via ALD technique to study how different growth conditions affect the photocatalytic behavior of SnO_2. Subsequent research will include the formation of heterostructures consisting of ZnO (TiO_2) films with SnO_2 to explore synergistic effects on photocatalytic and antibacterial activity, and the deposition of photocatalysts on porous substrates to further enhance their functional properties. All the samples will be characterized with a range of techniques, including scanning electron microscopy (SEM), transmission electron microscopy (TEM), energy-dispersive

X-ray spectroscopy (EDS), X-ray photoelectron spectroscopy (XPS), atomic force microscopy (AFM) and X-ray diffraction (XRD).

Keywords: photocatalysis, tin (IV) oxide (SnO_2), thin films, Atomic Layer Deposition, water purification