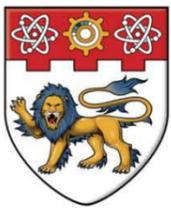


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# Self-cleaning Materials for Sustainable Buildings: Rare-earth Ions Modified Titania Photocatalyst

## Introduction

- ✦ Titania (TiO<sub>2</sub>) is a promising photocatalyst but its large band gap (3.2 eV for anatase) allows only UV radiation to be absorbed (about 5% of sunlight).
- ✦ Pure TiO<sub>2</sub> also has a very fast recombination rate of photogenerated electron-hole pairs, which reduces the lifetime for the hole to migrate to the catalyst surface for redox reactions (Figure 1).
- ✦ Doping of TiO<sub>2</sub> with rare earth (RE) may shift its absorption spectra towards the visible light region and enhance the hole lifetime.

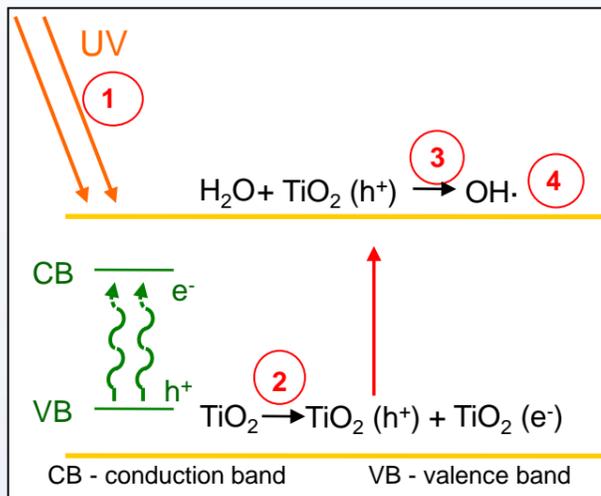
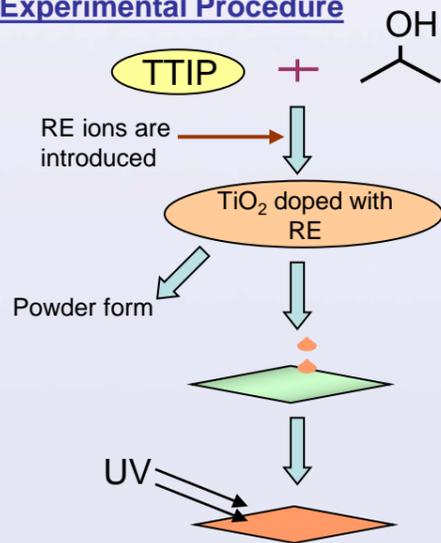


Figure 1: Photoexcitation of TiO<sub>2</sub>

## Objectives

- ✦ To synthesize nanosized TiO<sub>2</sub> via a modified sol-gel method and dope it with 3 different RE ions (terbium Tb<sup>3+</sup>, europium Er<sup>3+</sup>, and erbium Eu<sup>3+</sup>).
- ✦ To spin-coat the doped TiO<sub>2</sub> sol-gel onto glass slides and evaluate its efficiency in degrading salicylic acid in UV light.

## Experimental Procedure

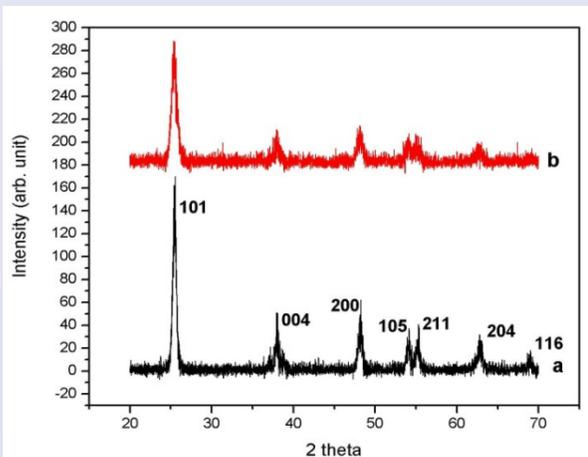


Stage 1: Synthesis of sol-gel with 18 hour oil bath (80°C) and stirring (Main precursors: Titanium tetra isopropoxide TTIP, isopropanol)

Stage 2: Part of synthesized sol-gel is made into powder form for characterization (Xray Diffraction XRD, Absorbance, and Scanning Electron Microscope SEM). The remaining sol-gel is used for spin-coating of glass slides.

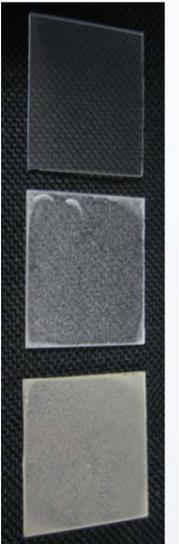
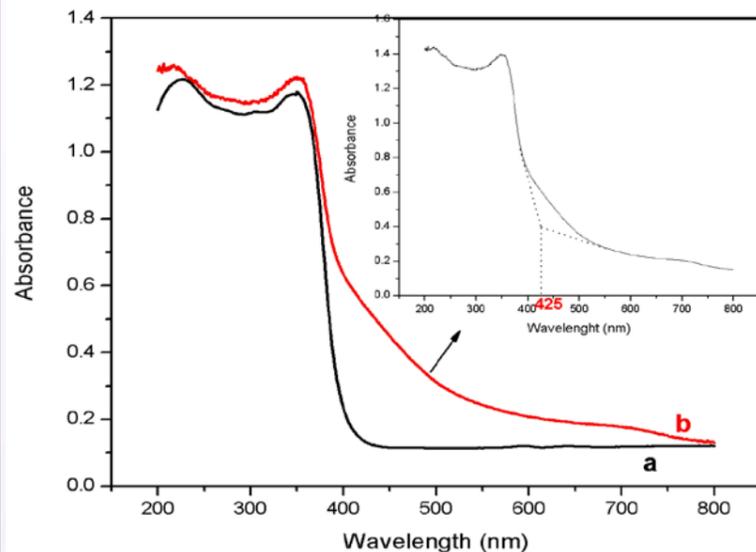
Stage 3: 1 hour exposure to UV radiation, tested on efficiency of salicylic acid degradation.

## XRD Results



- ✦ XRD graphs of synthesized pure titania in powder form (black) and of 1%Tb-doped titania in powder form (red).
- ✦ The peaks are assigned to anatase phase.

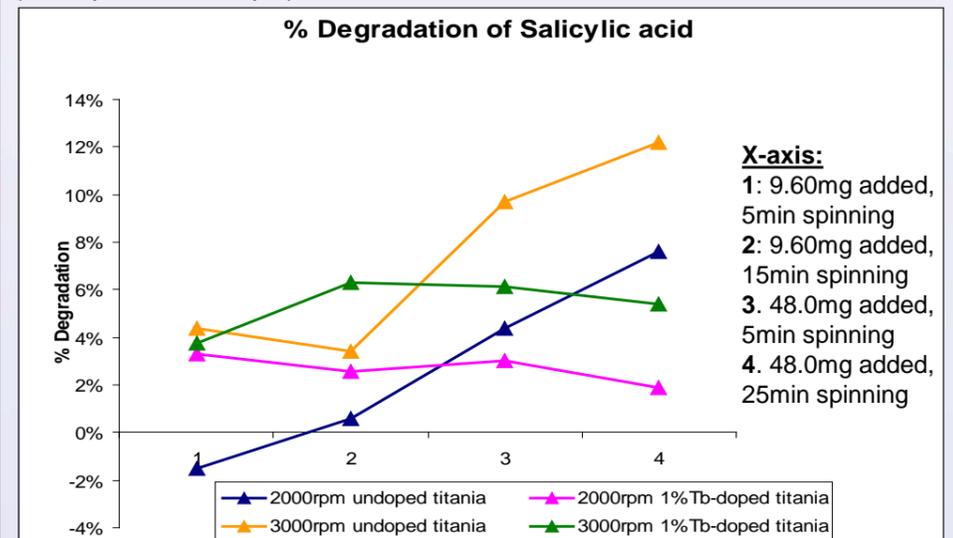
## UV-Vis Spectrophotometry Results



- ✦ The UV-Vis spectrophotometry results for pure titania (black) and 1%Tb-doped titania (red) showed that our Tb-doped titania had an increase in visible light absorbance (380 - 750nm). The picture to the right shows (from top to bottom): uncoated glass slide, pure titania coated glass slide and 1%Tb-doped titania coated glass slide. Note the yellowish tint of the Tb-doped titania glass slide.

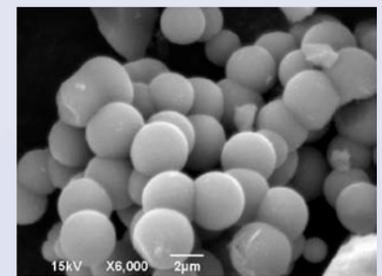
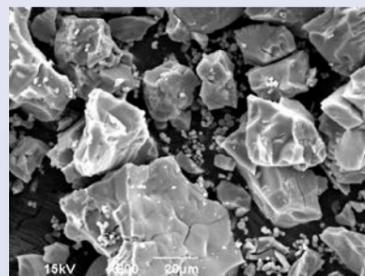
## 1 hour UV Photodegradation Results

- ✦ The slides were coated with varying amounts (from 9.60mg to 48.0mg) of titania, for 5 different durations (from 1min to 25min) and at 2 different rates of spinning (2000 rpm and 3000 rpm).



## Discussions

- ✦ Both pure titania and 1%Tb-doped titania showed degradation of salicylic acid. The results are however non-conclusive at this stage, as the coating layer has a tendency to peel off and affect optical density reading.
- ✦ The general trend was that higher degradation of salicylic acid was observed when more milligram of titania was added.
- ✦ Comparing spinning speed, glass slides that were coated while spun at 3000 rpm showed higher % degradation of salicylic acid.
- ✦ One major challenge in this work is to address the mechanical strength of the coating layer and more work is underway to improve the stability of the coating layer.



SEM images of 1%Tb-doped titania in powder form at 800 (left) and 6000 magnification (right)