NEW ZINC OXIDE PHOTOCATALYTIC THIN FILMS PREPARED BY DIP-COATING TECHNIQUE AND APPLICATION FOR DYE-DEGRADATION

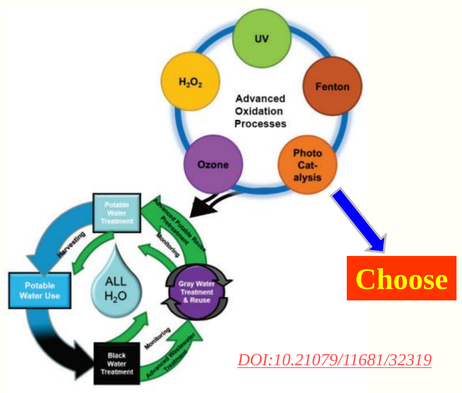
NOVELTY OF THE STUDY

- ☞ Dip-coating technique was first used to fabricate zinc oxide and tin-doped zinc oxide thin films;
- ☞ These new thin films accelerated effectively the methylene blue degradation under both UV light and solar light.

PRACTICALITY OF THE STUDY

Water pollution is now becoming a matter gaining great attention. Not only a country but also the world is facing this big challenge on water pollution. The consequences of water pollution are very serious, threatening humans' health and living quality.

INTRODUCTION



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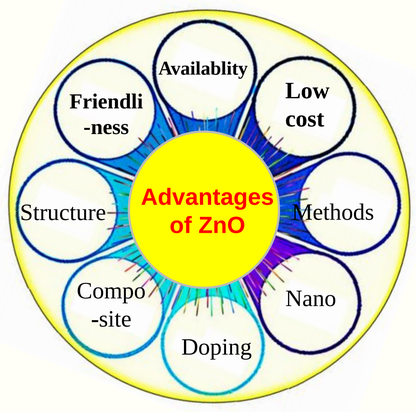

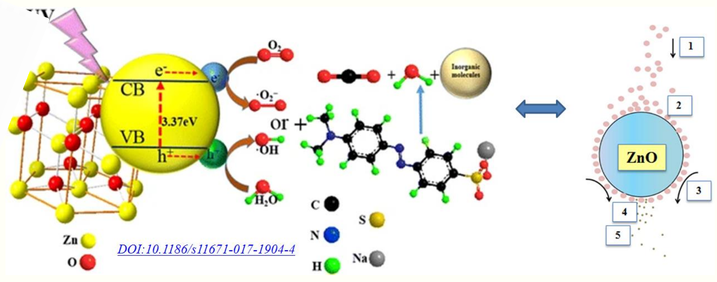

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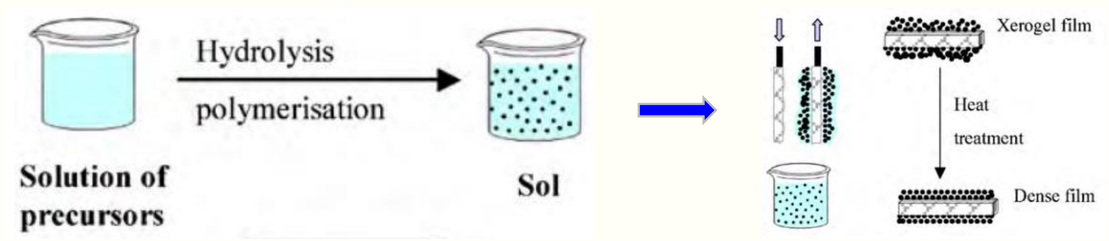


DOI:10.1016/j.mseb.2010.07.001

EXPERIMENTAL METHOD

❖ Synthesized solution

3.2950 g $Zn(CH_3COO)_2.2H_2O$ + $SnCl_4$ (0, 2, 4 mol.%) + 22.5 mL $(CH_3)_2CHOH$

Stirring 45 mins at 50°C

Opalescent solution + 7.5 mL $C_2H_4(OH)_2$

Stirring and down to room temperature

+ Ethanolamine Mol: $(Zn^{2+}+ Sn^{4+})$: MEA = 1:1

Stirring 3 hours at r.t

Homogenerous ZnO and SZO solution

❖ Fabricate the films

Clean subtrate glass

Drying 250°C in 2 hours

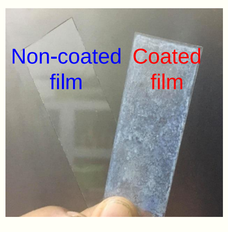
Dip-coating

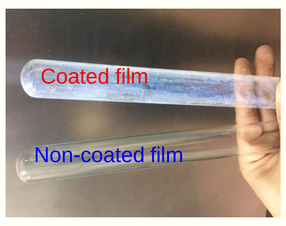
Repeated for multilayers

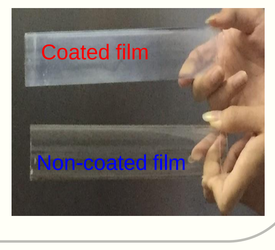
50 mm in min

Heat treatment at 150 °C in 10 mins

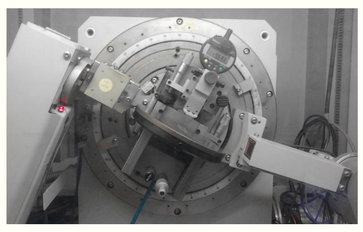
Annealed at 550°C for 3 hours in air atmosphere



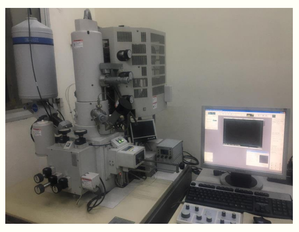




❖ Implementation of the research

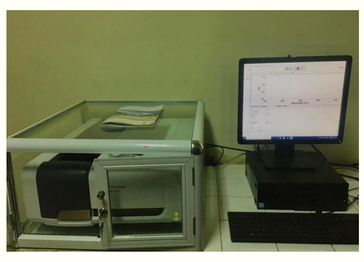


♦ XRD Siemen D5005 Brucker

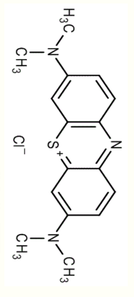


♦ FESEM S4800

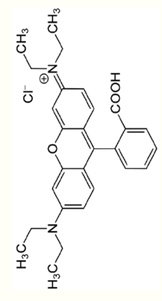
♦ EDX



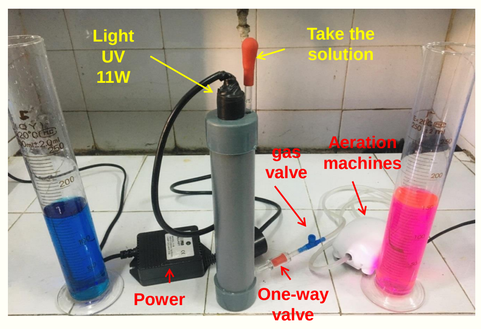
♦ UV-Vis Cary 60



♦ MB

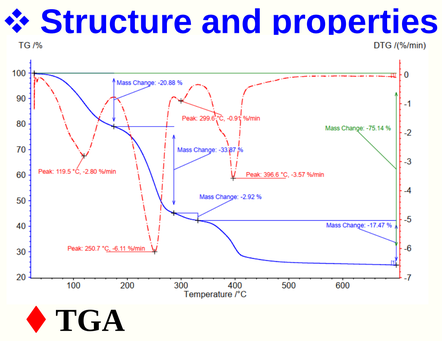


♦ RhB

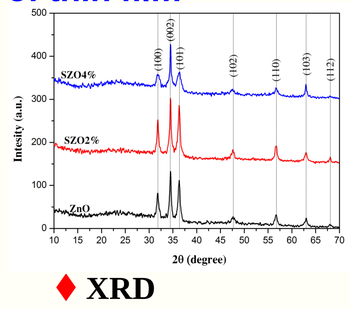


RESULTS AND DISCUSSION

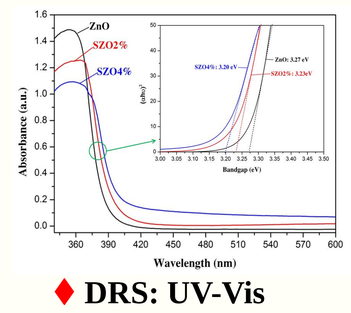
❖ Structure and properties of thin film



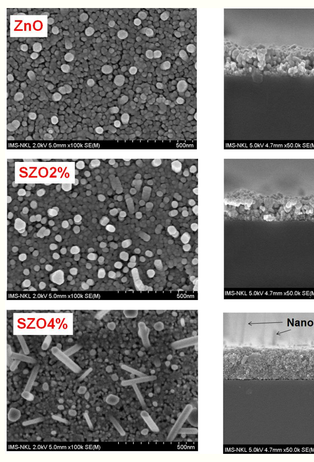
♦ TGA



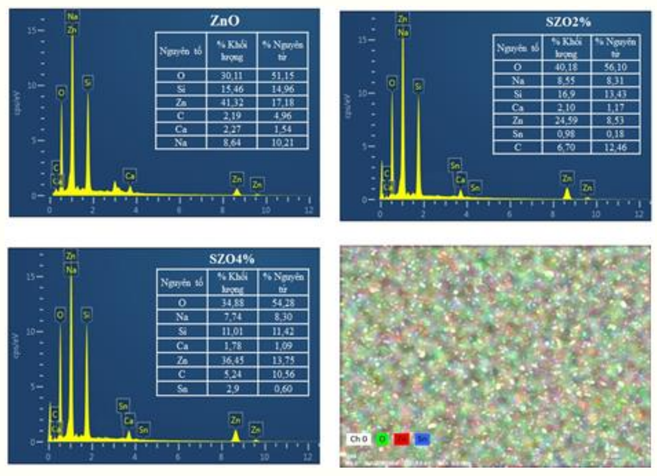
♦ XRD



♦ DRS: UV-Vis

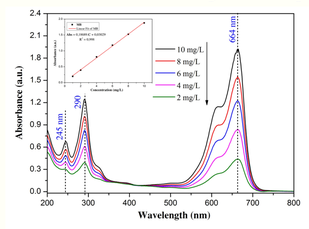


♦ FESEM and Cross

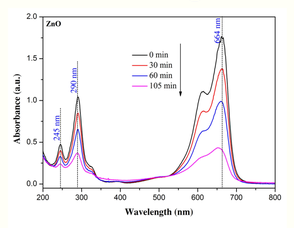


♦ EDX and SEM-Mapping

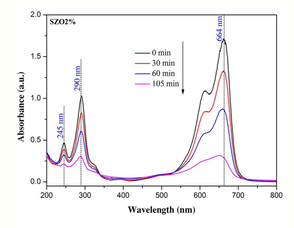
❖ Photocatalytic application with UV light



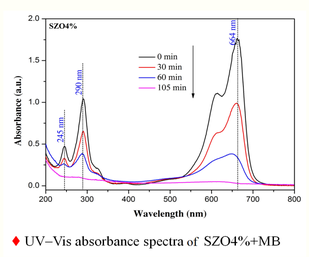
♦ UV–Vis absorbance spectra and standard of MB



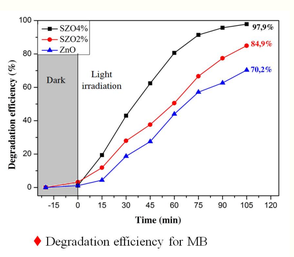
♦ UV–Vis absorbance spectra of ZnO+MB



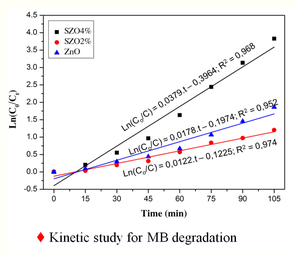
♦ UV–Vis absorbance spectra of SZO2%+MB



♦ UV–Vis absorbance spectra of SZO4%+MB

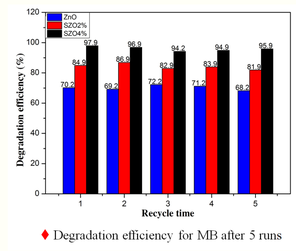


♦ Degradation efficiency for MB



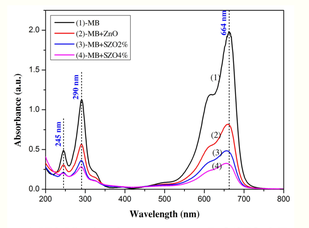
♦ Kinetic study for MB degradation

MB	k	Yield (%)	mg/(h.m²)	mg/(h.g)
150 mL	min^{-1}	105 min		
ZnO	0.0122	70.2	56.57	28.29
SZO2%	0.0178	84.9	67.71	33.86
SZO4%	0.0379	97.9	78.00	39.00

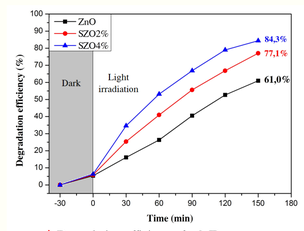


♦ Degradation efficiency for MB after 5 runs

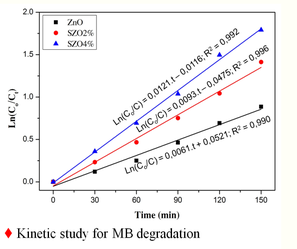
❖ Photocatalytic application with solar light



♦ UV–Vis absorbance spectra of ZnO/SZO+MB



♦ Degradation efficiency for MB



♦ Kinetic study for MB degradation

MB	k	Yield (%)	mg/(h.m²)	mg/(h.g)
150 mL	min^{-1}	105 min		
ZnO	0.0061	61.0	31.2	15.60
SZO2%	0.0093	77.1	34.4	17.20
SZO4%	0.0121	84.3	37.6	18.80

Conclusion

1. ZnO and Sn-doped ZnO thin films were made successfully on a glass tube by dip-coating technique. Structure and some specific properties were determined with modern physical methods: XRD, SEM, EDX, TGA, and DRS. EDX indicated the ratio of Sn was the same as the ratio of Sn in the initial solution. DRS spectra confirmed ZnO and Sn-doped ZnO thin films can absorb effectively UV-Vis light.
2. Methylene blue in aqueous solution was degraded faster under UV light in presence of Sn-doped films SZO2% and SZO4% in which SZO4% was the best photocatalytic material of all; 2.1 times and 3.1 times faster than SZO2% and ZnO thin films did. All ZnO, SZO2%, and SZO4% can be reused many times. The degradation of MB followed the first-order equation.
3. Our new films also accelerated the methylene blue degradation under solar light close to UV light. This result will play an essential role to manufacture a green method for solving our current environmental issue.