



Synthesis and characterization of nanostructured systems based on Ag&ZnO obtained by solvothermal method for photocatalytic applications.



L. Muñoz^{*1}, A. Sierra-Fernández², L.S. Gómez-Villalba², O. Milošević³, M.E. Rabanal¹

¹ University Carlos III of Madrid and IAAB, Department of Materials Science and Engineering and Chemical Engineering, Avda. Universidad 30, 28911 Leganes, Madrid, Spain.

² Institute of Geosciences (CSIC, UCM), C/ José Antonio Novais 2, 28040 Madrid, Spain.

³ Institute of Technical Sciences of the Serbian Academy of Sciences and Arts, Knez Mihailova 35/IV, 11000, Belgrade, Serbia.

* limunozf@ing.uc3m.es



INTRODUCTION

NANOTECHNOLOGY: ENVIRONMENTAL APPLICATIONS

➤ Nanotechnology: one of the most active research fields, potential applications.

➤ Using semiconductors: TiO₂, ZnO

➤ ZnO: amazing optical, electrical and photocatalytic properties.

➤ Nanomaterials of ZnO with noble metals on surface could:

- * improve photocatalytic activity
- * enhance corrosion resistance

SO

Our work is

- ❖ Ag&ZnO: solvothermal method.
- ❖ Evaluation of different parameters: t_{reaction}, [precursors], dispersant presence.

EXPERIMENTAL METHOD

PREPARATION

➤ Synthesis by solvothermal method (at T=120°C), evaluating the influence of:

≠ times (3, 6, 18 h)

≠ [Zn²⁺] (1.875 & 3.750·10⁻² M)

* Ag⁺ (3.750·10⁻³ M) presence

* Dispersant (CTAB) presence

CHARACTERIZATION

➤ X-ray diffraction (Philips X'Pert)

➤ Scanning electron microscopy (Philips XL 30/EDAX-Dx4)

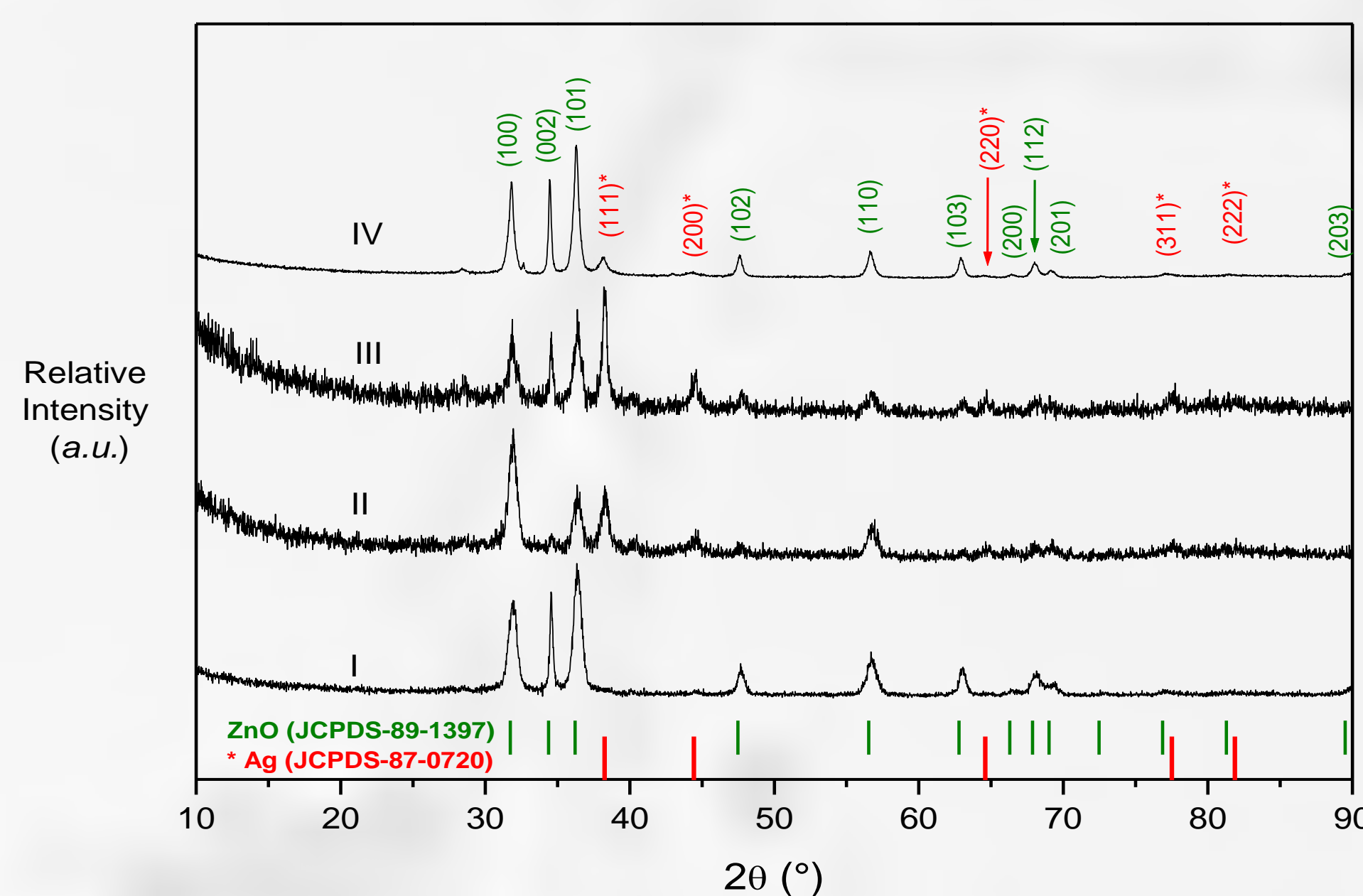
➤ Transmission electron microscopy (JEOL JEM 2100)

FUNTIONAL PROPERTIES

Photocatalytic behaviour:

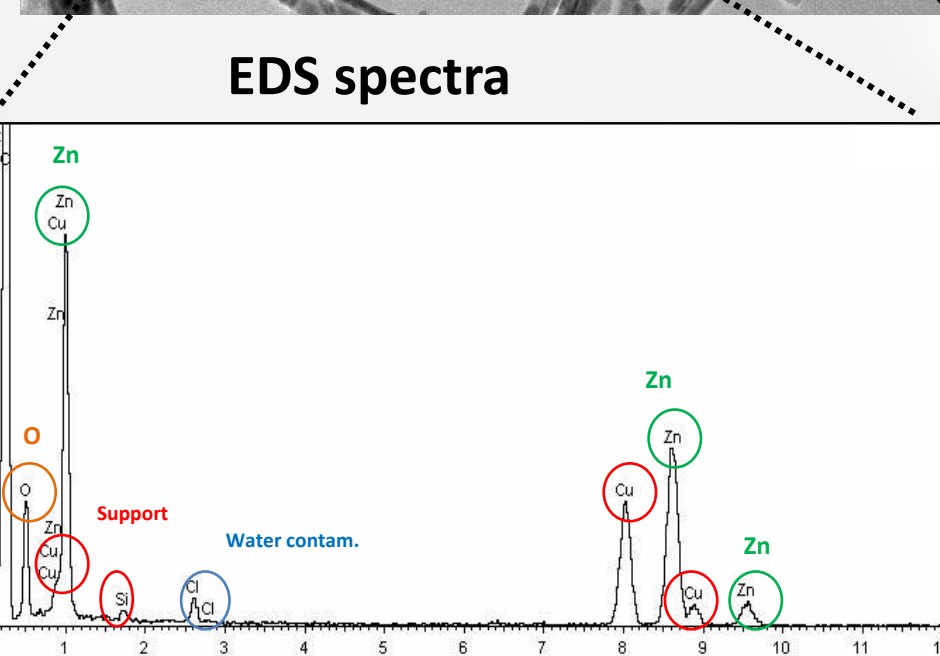
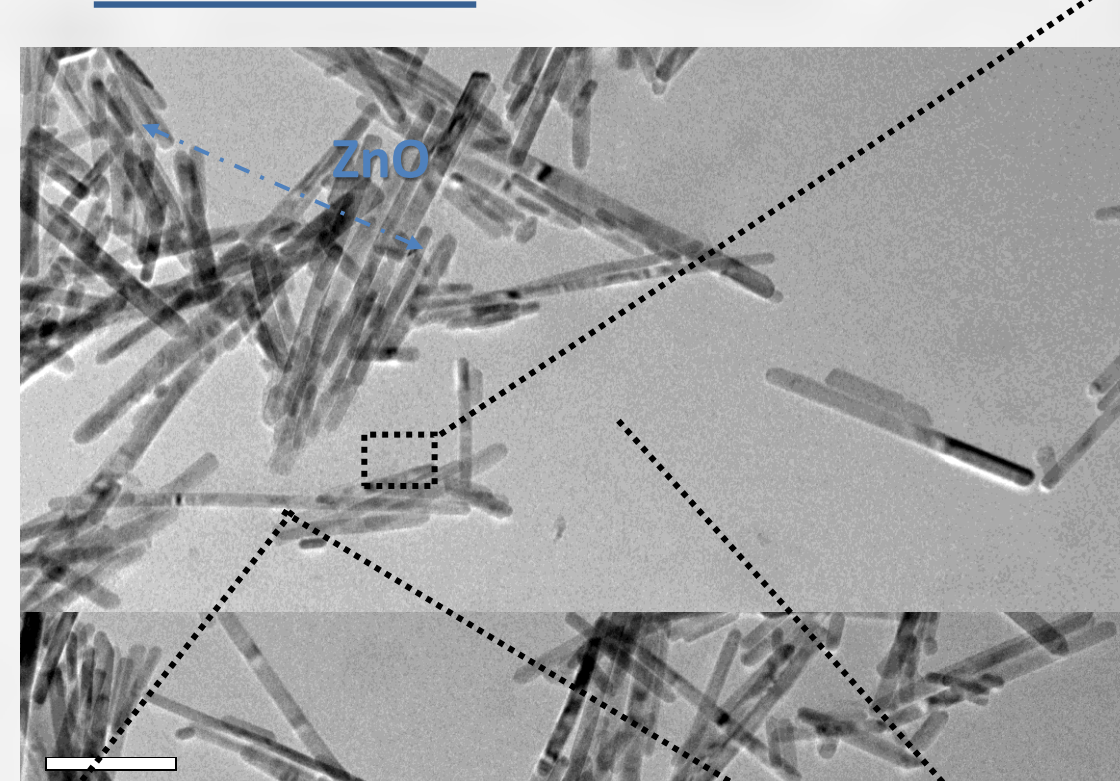
➤ Removal of methylene blue of a solution with [MB]₀ = 2,5 ppm

STRUCTURAL & MORPHOLOGIC CHARACTERIZATION RESULTS

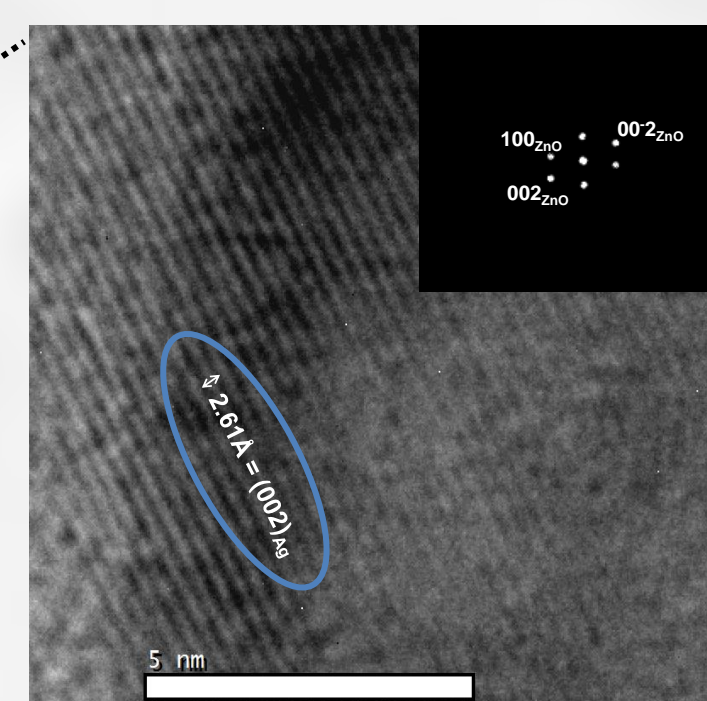


Parameter (Å)		JCPDS card	Experimental			
			I	II	III	IV
ZnO (89-1397)	a	3,253	3.246	3,244	3,239	3,251
	c	5,213	5.195	5,180	5,172	5,210
Ag (87-0720)	a	4,077	-----	4,067	4.072	4,087

SAMPLE I

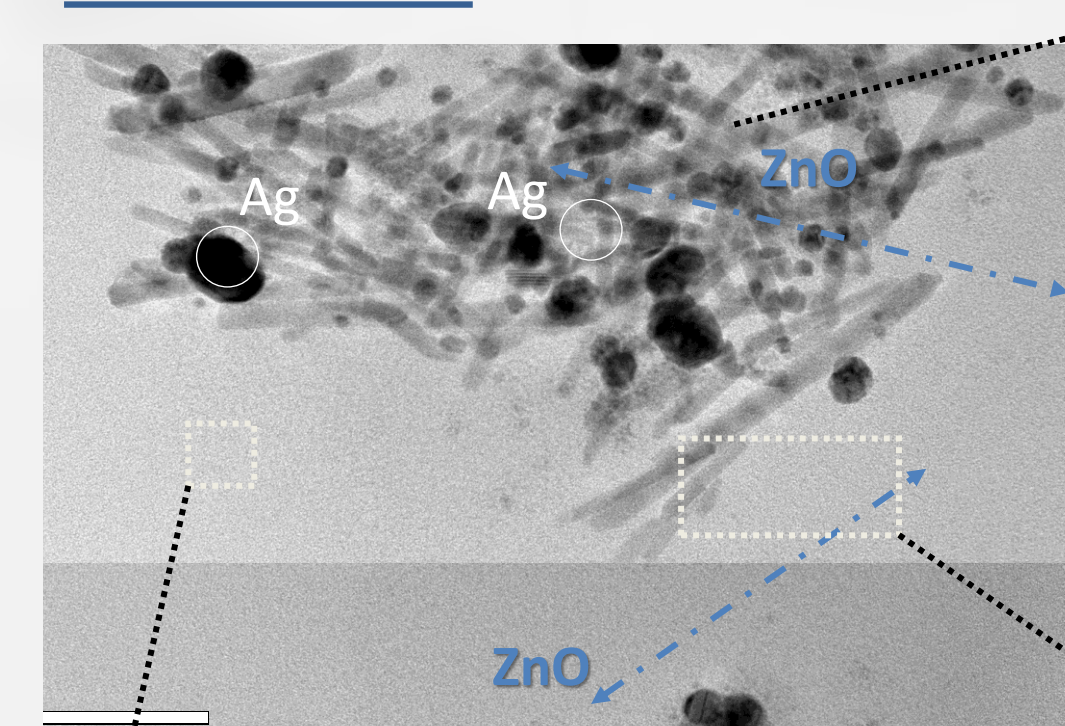


HRTEM

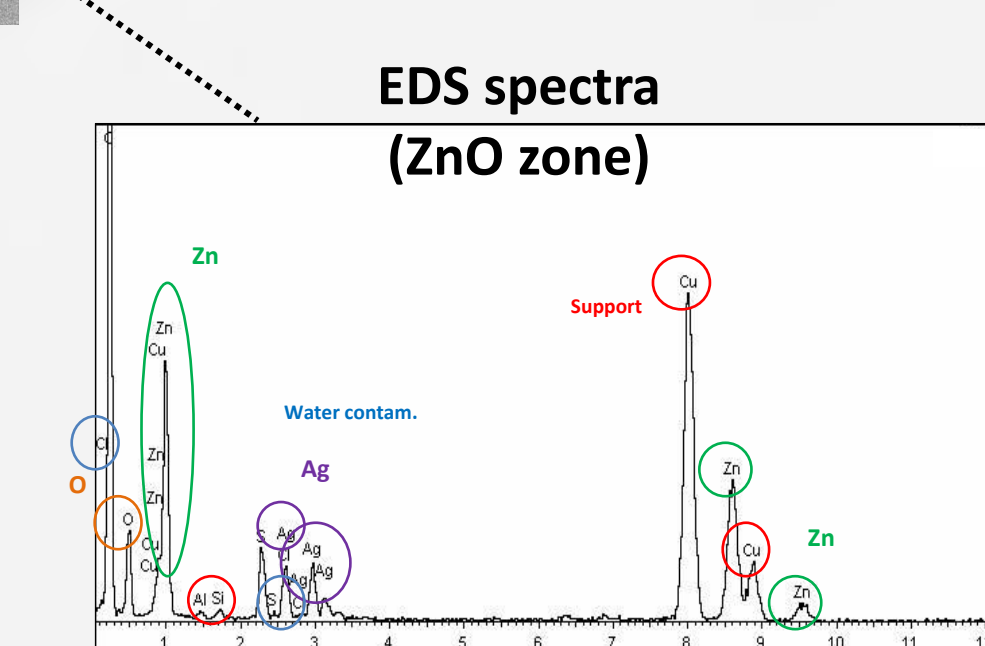
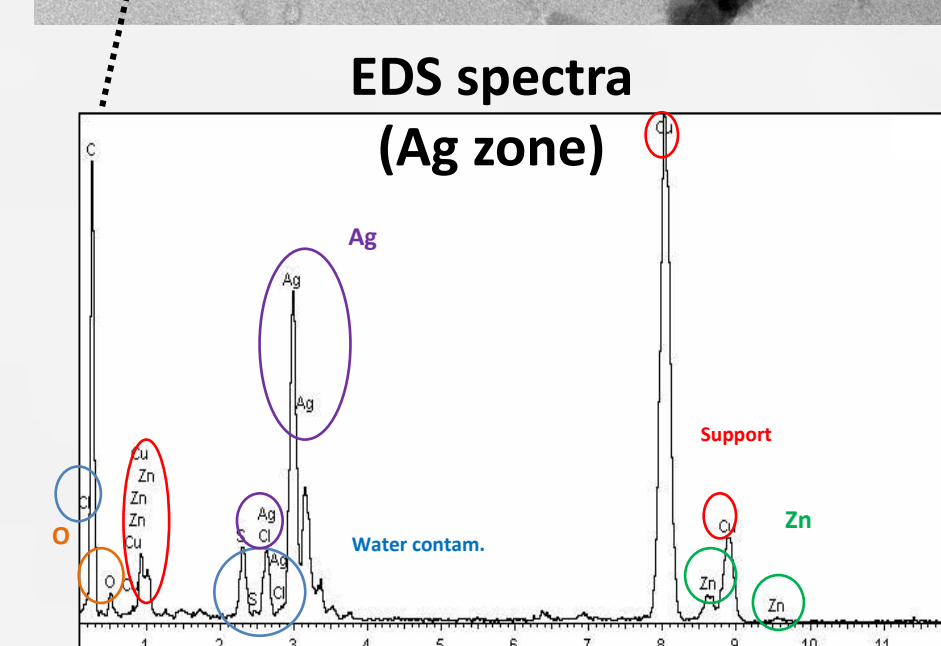
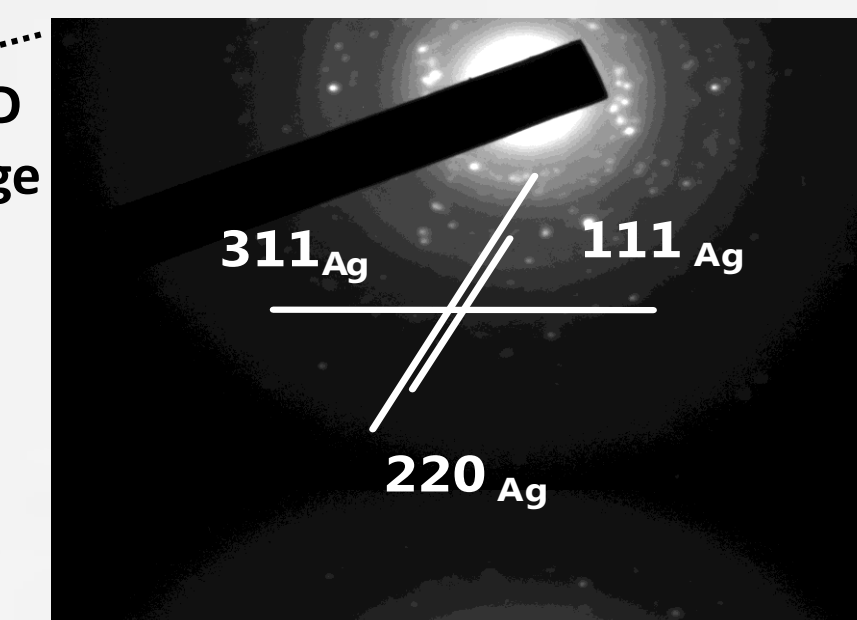


SAED image

SAMPLE II



SAED image



Synthesis conditions (T=120°C):

Sample I ([Zn²⁺]=1.85·10⁻² M, [Ag⁺]=3.75·10⁻³ M, 6h)

Sample II ([Zn²⁺]=1.85·10⁻² M, [Ag⁺]=3.75·10⁻³ M, 6h, CTAB)

Sample III ([Zn²⁺]=1.85·10⁻² M, [Ag⁺]=3.75·10⁻³ M, 18h, CTAB)

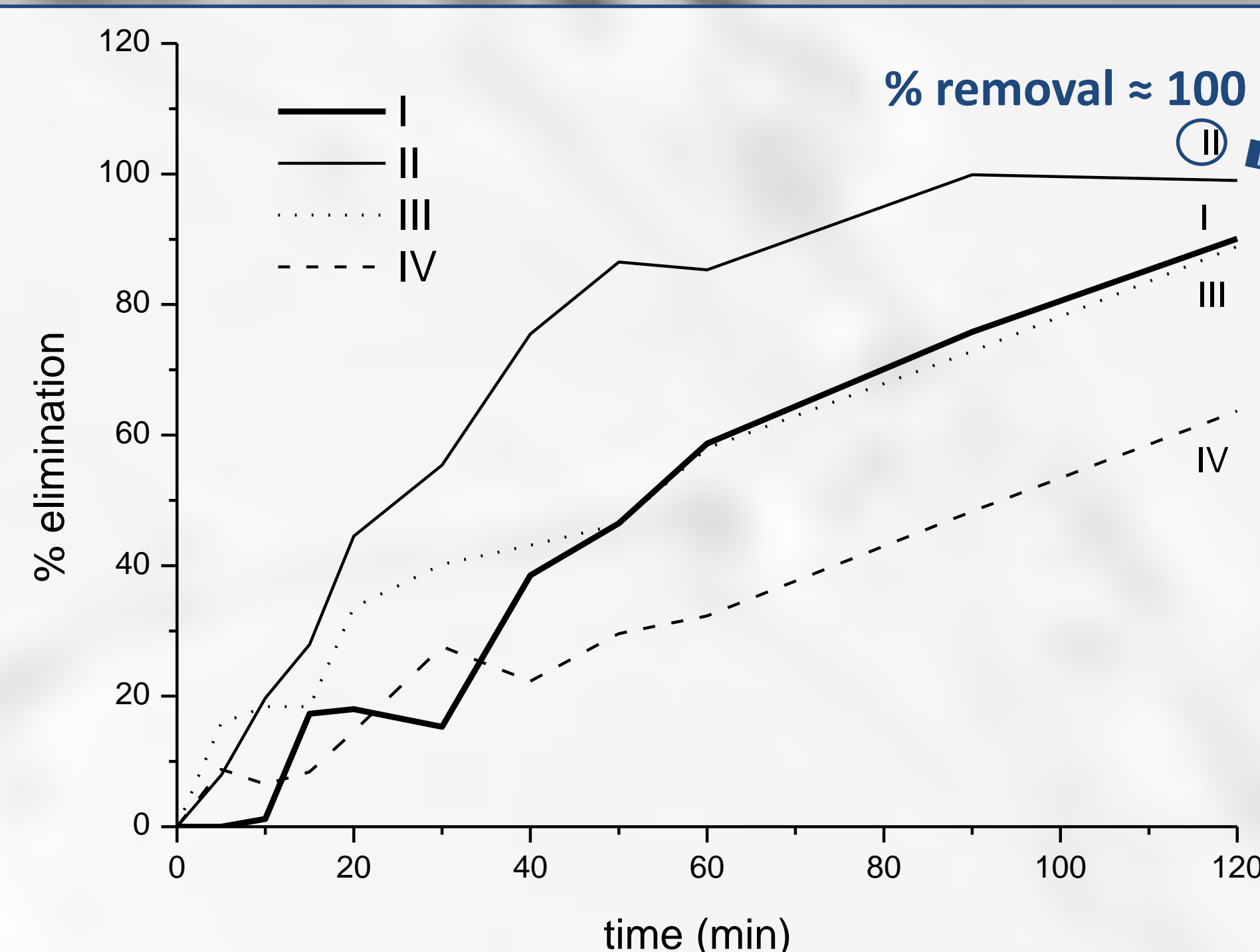
Sample IV ([Zn²⁺]=3.75·10⁻² M, [Ag⁺]=3.75·10⁻³ M, 18h)

Sample	I	II	III	IV
L (nm)	138.4 ± 23.9	143.4 ± 22.1	183.6 ± 27.2	125.4 ± 0.7
W (nm)	11.1 ± 2.0	12.6 ± 4.1	12.5 ± 3.8	14.8 ± 2.5
AR (L/W)	12.5 ± 4.4	11.4 ± 5.5	14.7 ± 6.6	8.5 ± 1.5

PHOTOCATALYTIC BEHAVIOUR

Hg Lamp

λ = 350 nm (UV)



REACTION TIME (min)

INITIAL TIME

120 min

❖ By XRD: ZnO (hexagonal wurtzite) and metallic silver (FCC) have been synthesized, which agree with the reported results in the JCPDS cards = 89-1397 and 87-0720, respectively. Impurities and other reaction phases are not present.

❖ By XRD: not evidence of the existence of silver in interstitial and/or substitutional positions in the host structure of ZnO hasn't been observed.

❖ By TEM:

a) in sample I only ZnO nanostructured particles are obtained.

b) in sample II two morphologies are obtained: cylindrical nanoparticles (ZnO NWs) & quasi-spherical particles (Ag nanoparticles, well-dispersed on NWs).

❖ The system viability for photocatalytic applications has been demonstrated (all cases present >58% removal: after 2h).

❖ Sample II (Ag⁺↑, Zn²⁺↓, 6h, CTAB) shows the best photocatalytic activity:

- incorporation of Ag nanoparticles improves the photocatalytic behavior of ZnO MWs.

- material morphology depends on dispersant presence (CTAB): which controls the dispersion of nanostructures obtained.

ACKNOWLEDGMENTS.

❖ The Master of "Materials Science" of Carlos III University (Spain) for providing financial and laboratory equipment support.

❖ The Innovation and Education Ministry (ref. MAT2013-47460-C5-5-P), the Autonomous Region Program of Madrid (ref. S2013/MIT-2862) and the Ministry of Education, Science and Technological Development of Serbia (projects No. 172035 & 45020) for supporting our work.

Fourth International Conference on
Multifunctional, Hybrid and Nanomaterials

9-13 March 2015, Sitges (near Barcelona), Spain

