



Hybrid ZnO-based nanostructured materials with photoluminescent and antimicrobial properties

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OUTLINE

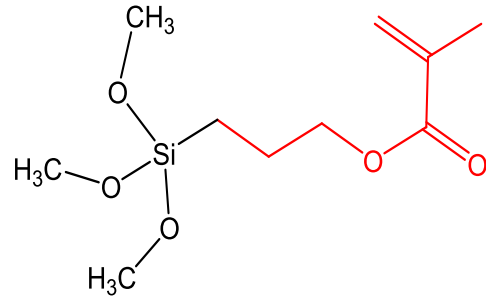
- I. Abstract
- II. ZnO QDs functionalized with organosilane surfactants
- III. Morphology and structure of organosilane- functionalized ZnO hybrid NPs
- IV. Optical properties (T, R, E_g) of organosilane- functionalized ZnO hybrid NPs
- V. Photoluminescence properties of organosilane- functionalized ZnO hybrid NPs
- VI. Photocatalytic properties of organosilane- functionalized ZnO hybrid NPs
- VII. Antimicrobial activity of organosilane- functionalized ZnO hybrid NPs
- VIII. Organosilane-functionalized Ag:ZnO/chitosane biocompatible materials
- IX. Conclusions
- X. Invitation to CSSD-UDJG 2015

I. Abstract

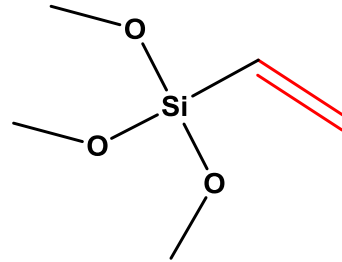
- Based on the great potentiality of organosilane species to establish stable covalent bonds by ZnO surface grafting, with direct influence on its particle size, morphology and electronic features, the choice of organosilane surfactant was part of our strategy to explore the tuning of ZnO optical properties taking into consideration the nature of end group bound to silicon. No, or very few similar data were found in literature.
- We investigated the effect of several representatives of organosilanes class, as 3-(trimethoxysilyl)propylmethacrylate(MPS), 3-glycidyloxypropyl trimethoxysilane (GPTMS) and vinyltrimethoxysilane (VTMS), also in addition with chitosan, for building new hybrid nanostructured materials and biocompatible materials with high potential applicability in optoelectronics (HLED) and photocatalysis, as well as for antimicrobial (functional textile), intelligent food packaging and fluorescent probes in biomedical applications.
- The syntheses of organosilane-based hybrid nanomaterials were conducted through a simple and non-expensive modified precipitation method, in some cases associated with sol-gel method.

II. ZnO QDs functionalized with organosilane surfactants

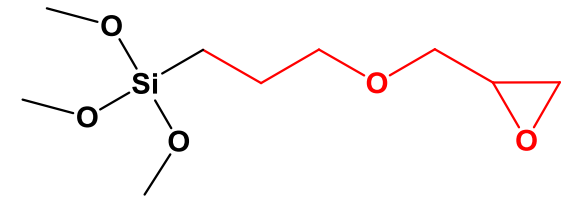
Tuning optical properties by QDs size control



3-(trimethoxysilyl)propyl methacrylate (MPS)

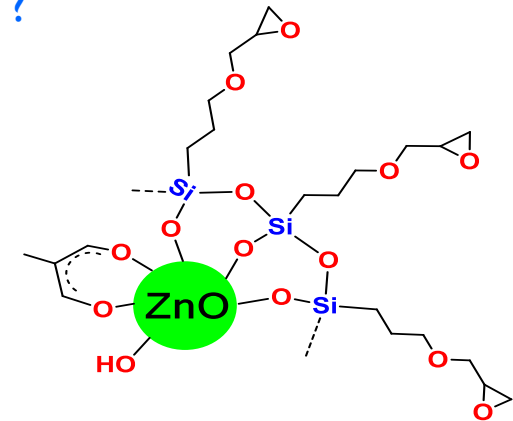
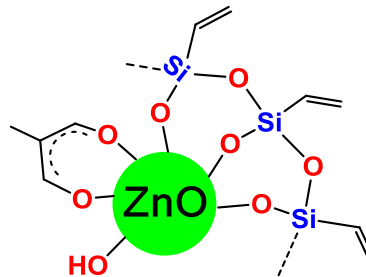
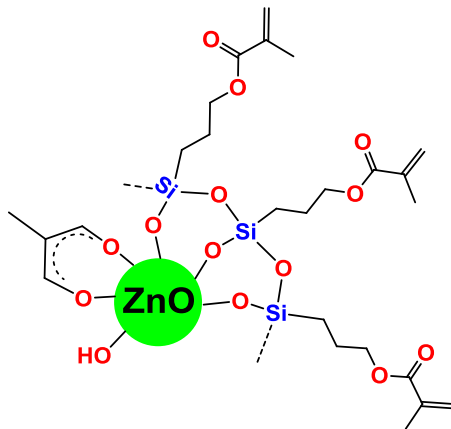


vinyltrimethoxysilane (VTMS)



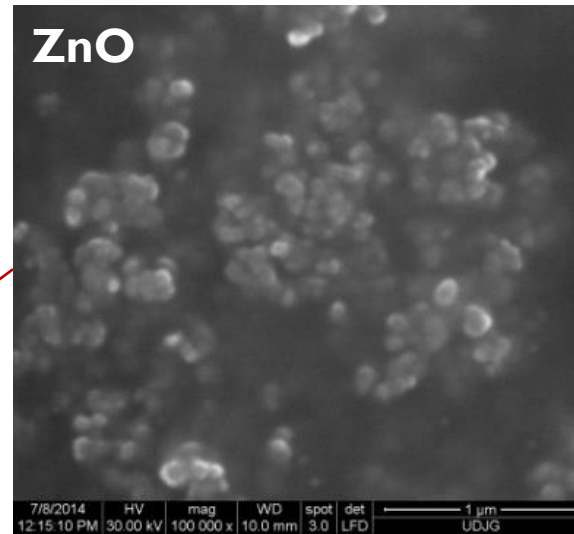
(3-Glycidyloxypropyl)trimethoxysilane (GPTMS)

- Size controlling agents
- Cross-linking agents
- Optical properties modifiers ?

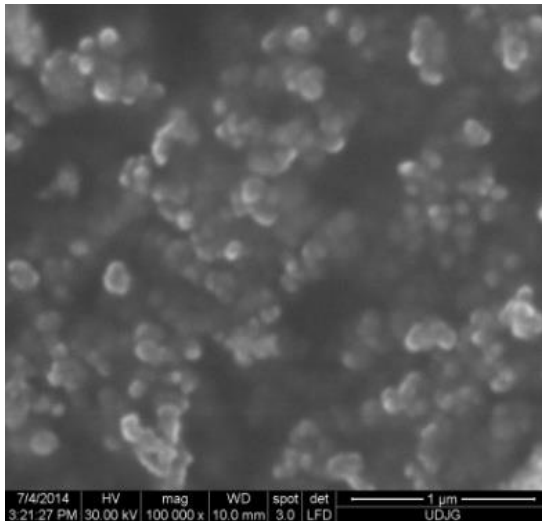


III. Morphology & structure of organosilane-functionalized ZnO hybrid NPs

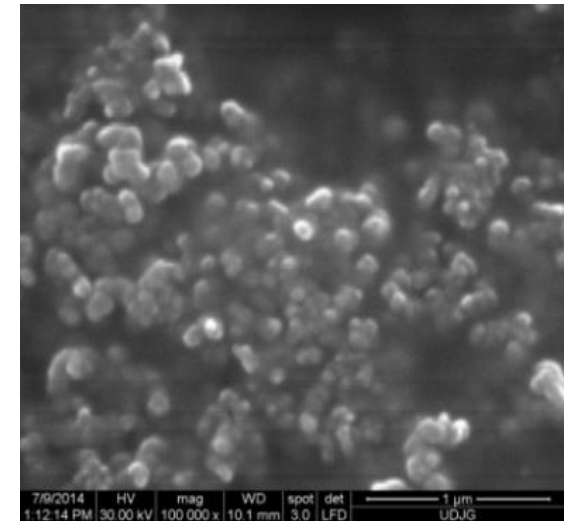
SEM images of organosilane-ZnO QDs



ZnO-MPS (10%)

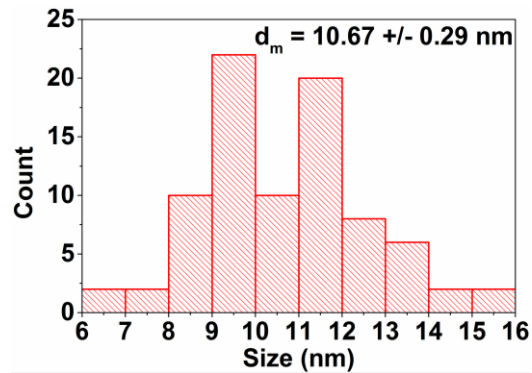
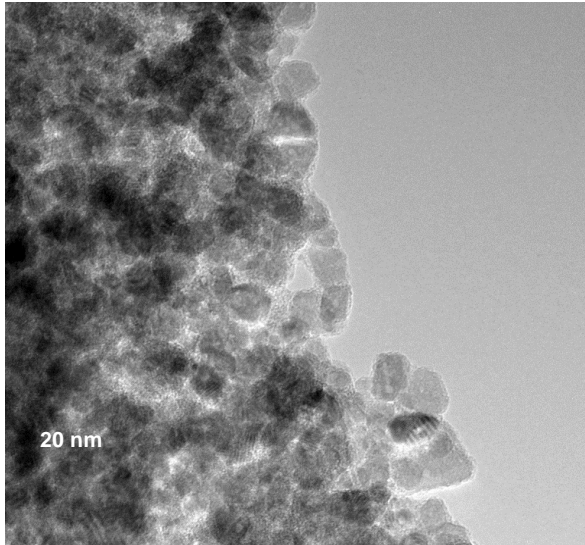


ZnO-VTMS (10%)

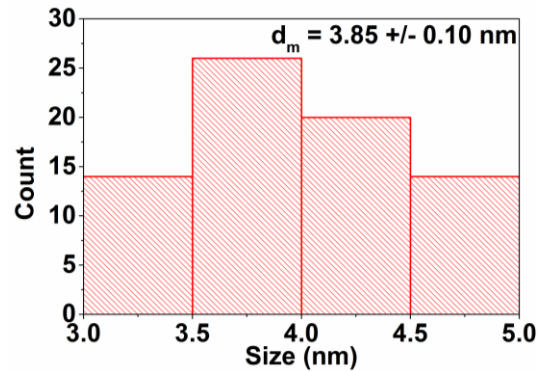
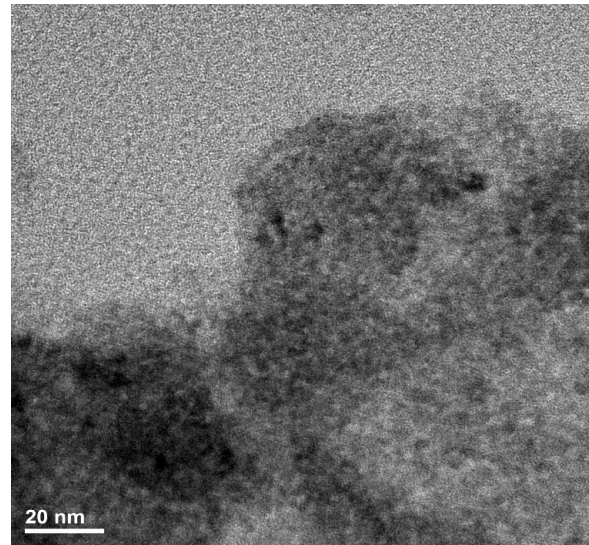


HRTEM images of organosilane-ZnO NPs

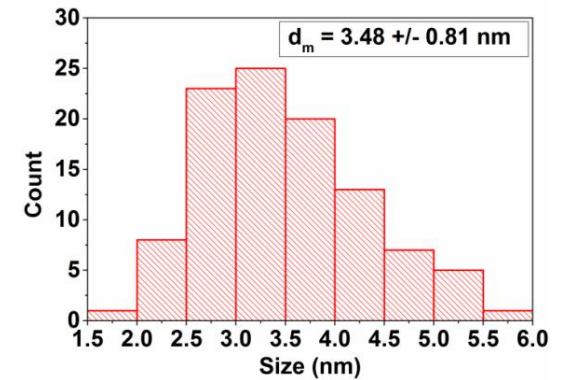
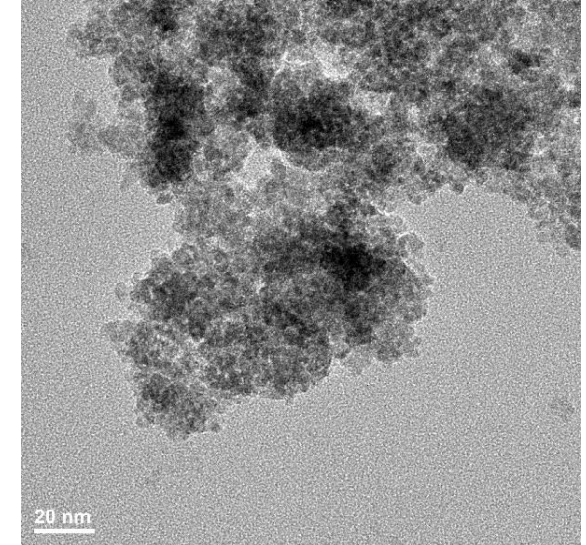
ZnO*



ZnO-MPS (10%)*



ZnO-VTMS (10%)**

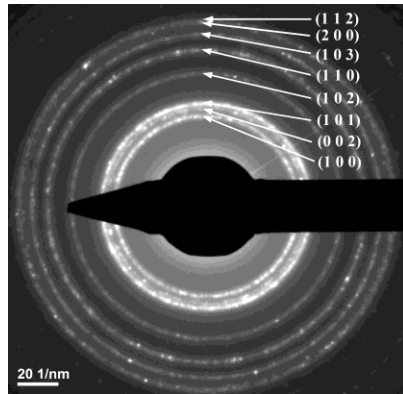


* V. Musat, A. Tabacaru, B.S. Vasile, V.-A. Surdu, *RSC Adv.* **2014**, *4*, 63128.

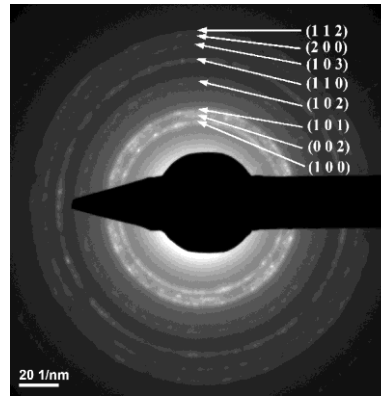
** A. Tabacaru, V. Musat, N. Tigau, B.S. Vasile, V.-A. Surdu, submitted to *Langmuir*.

SAED patterns and lattice fringes (d -spacing)

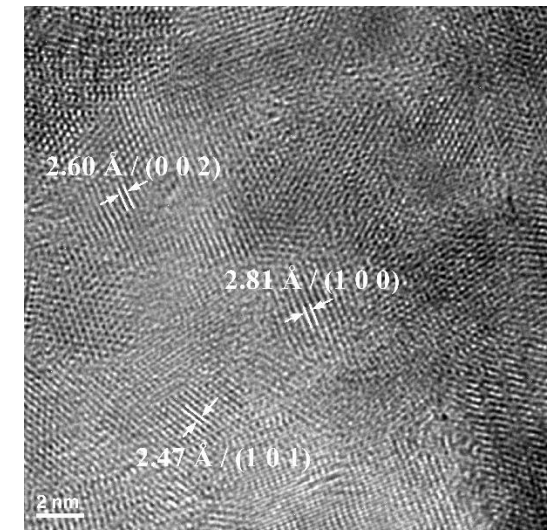
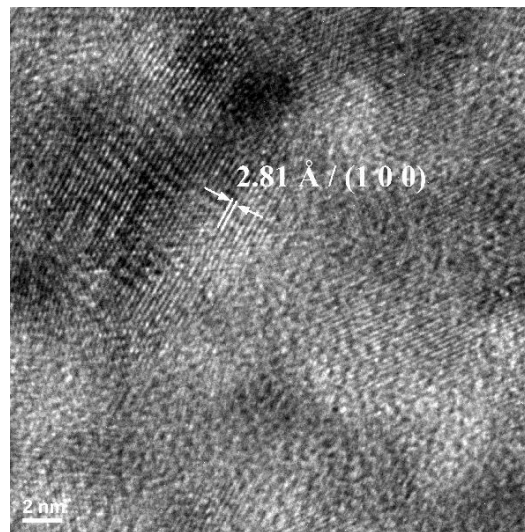
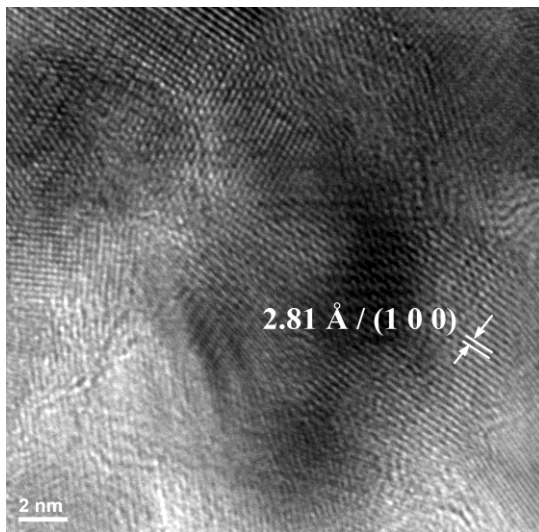
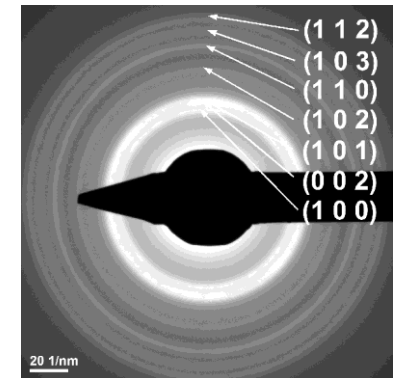
ZnO*



ZnO-MPS (10%)*



ZnO-VTMS (10%)**

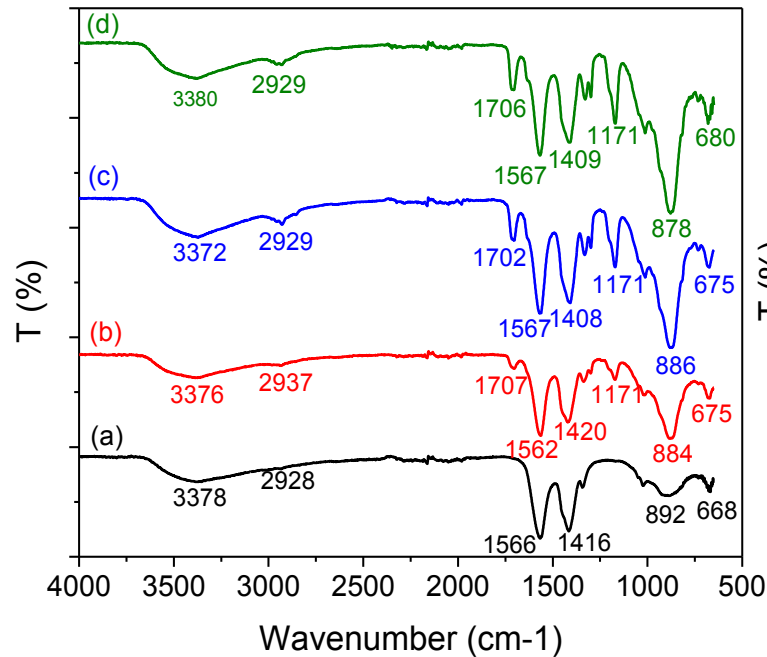


* V. Musat, A. Tabacaru, B.S. Vasile, V.-A. Surdu, *RSC Adv.* **2014**, 4, 63128.

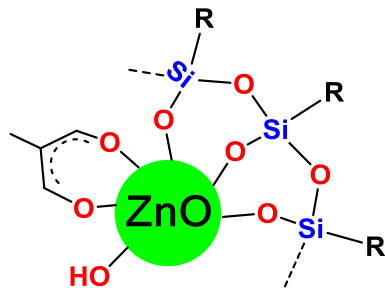
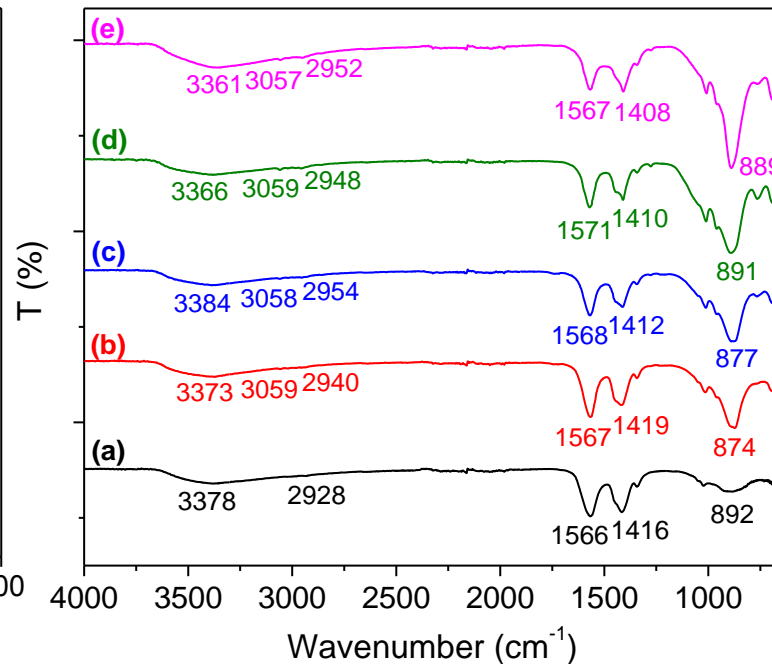
** A. Tabacaru, V. Musat, N. Tigau, B.S. Vasile, V.-A. Surdu, submitted to *Langmuir*.

FTIR spectra of organosilane-ZnO NPs

ZnO-MPS*



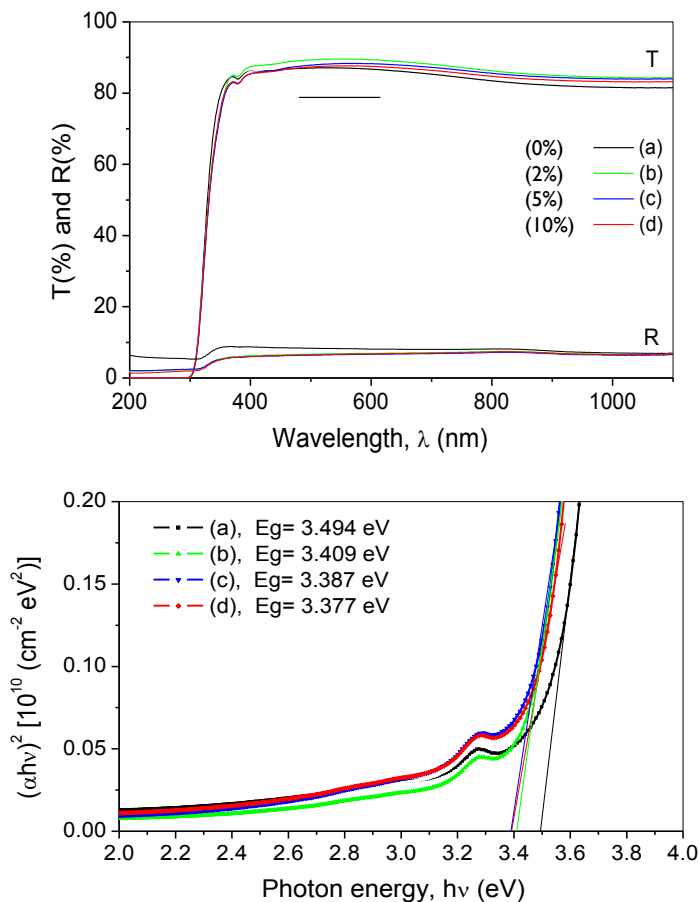
ZnO-VTMS**



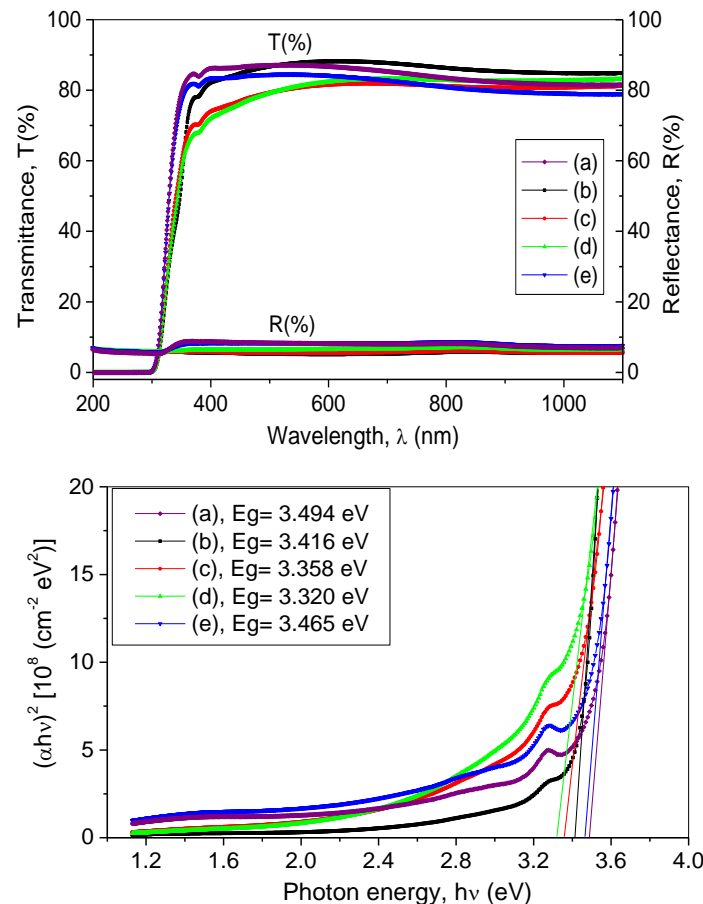
- Zn–O–Si and Si–O–Si : 870-890 cm⁻¹
- C OO group (1560 and 1410 cm⁻¹)
- OH group (3380 cm⁻¹)

IV. Optical properties of organosilane-functionalized ZnO NPs

ZnO-MPS*



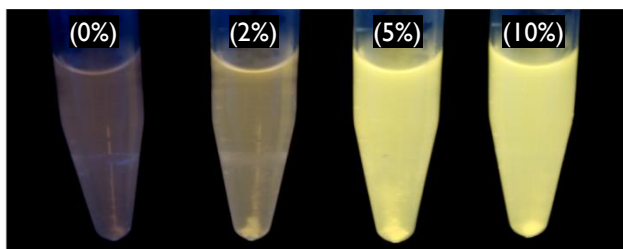
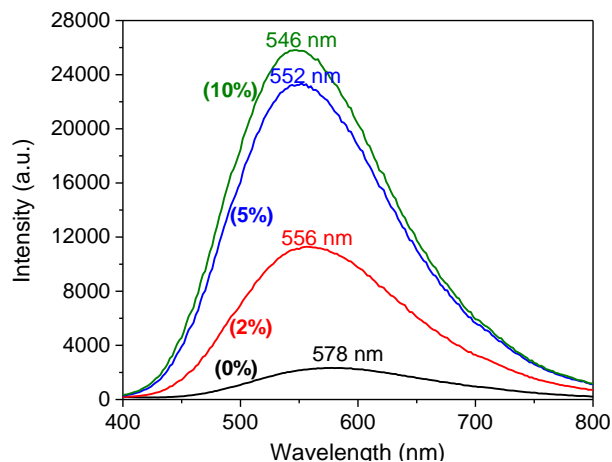
ZnO-VTMS**



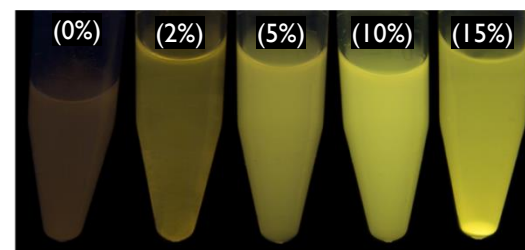
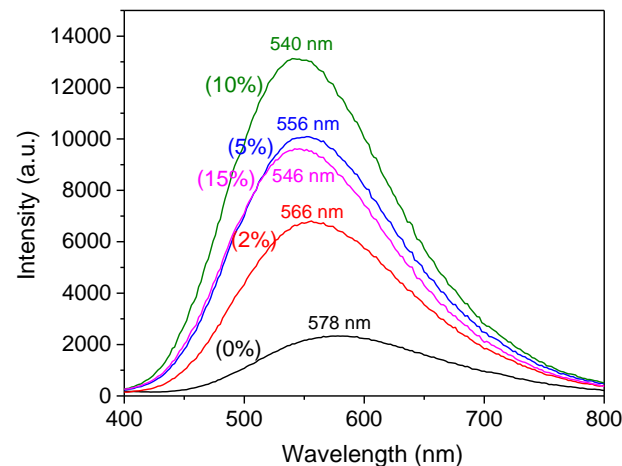
- Optical transmittances between 85 and 90% and low reflectance between 0 and 5%, in the visible domain.
- E_g decreases from 3.494 eV (ZnO NPs) to 3.32-3.28 eV surfactant-doped ZnONPs

V. Photoluminescent properties of organosilane-functionalized ZnO NPs

ZnO-MPS*



ZnO-VTMS**



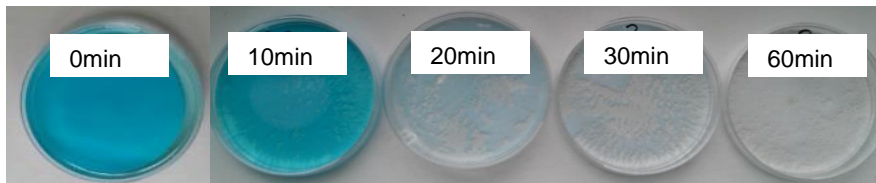
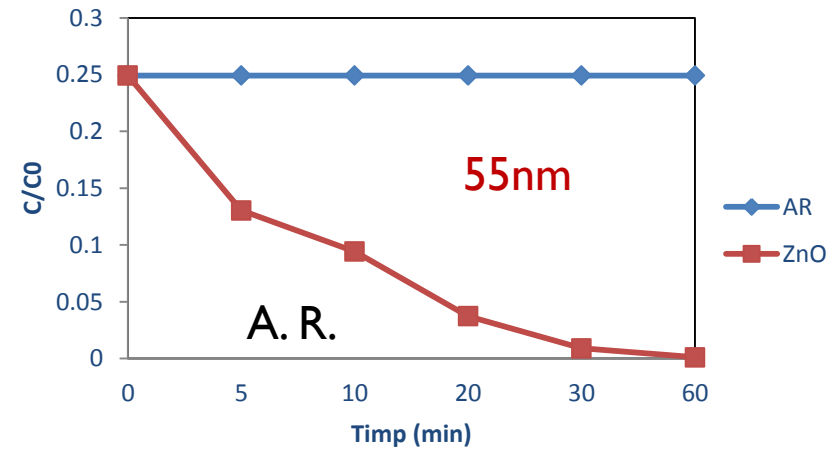
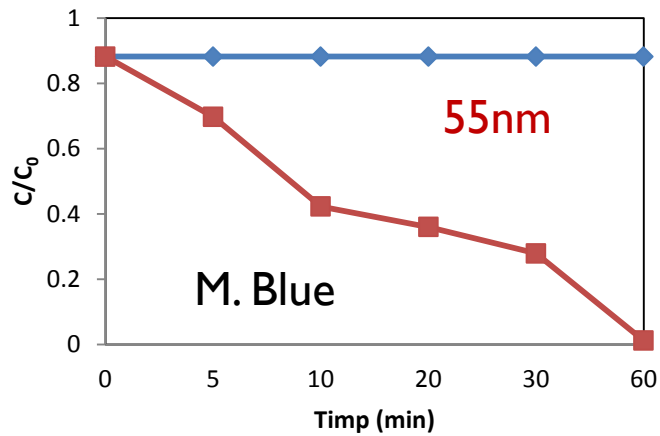
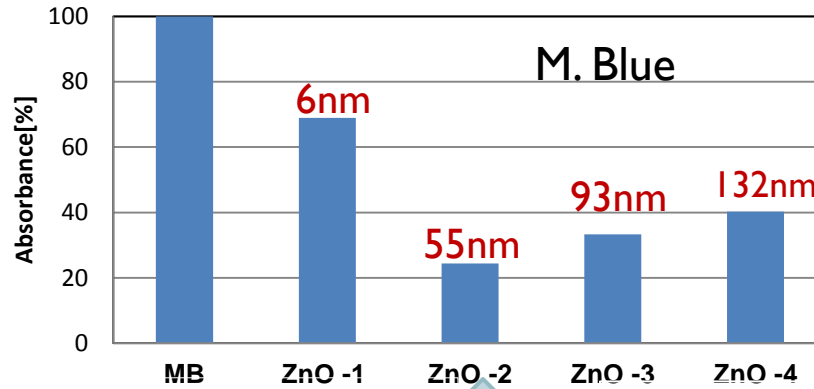
➤ Higher organosilane loading from 2 to 10%, a blue-shift, accompanied by an increase of the emission intensity.

* V. Musat, A. Tabacaru, B.S. Vasile, V.-A. Surdu, *RSC Adv.* **2014**, 4, 63128.

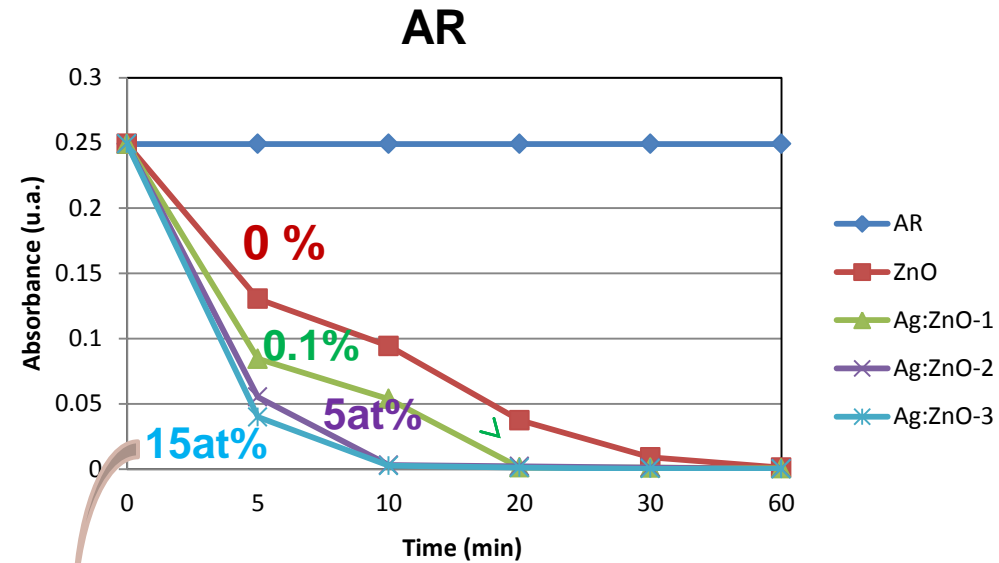
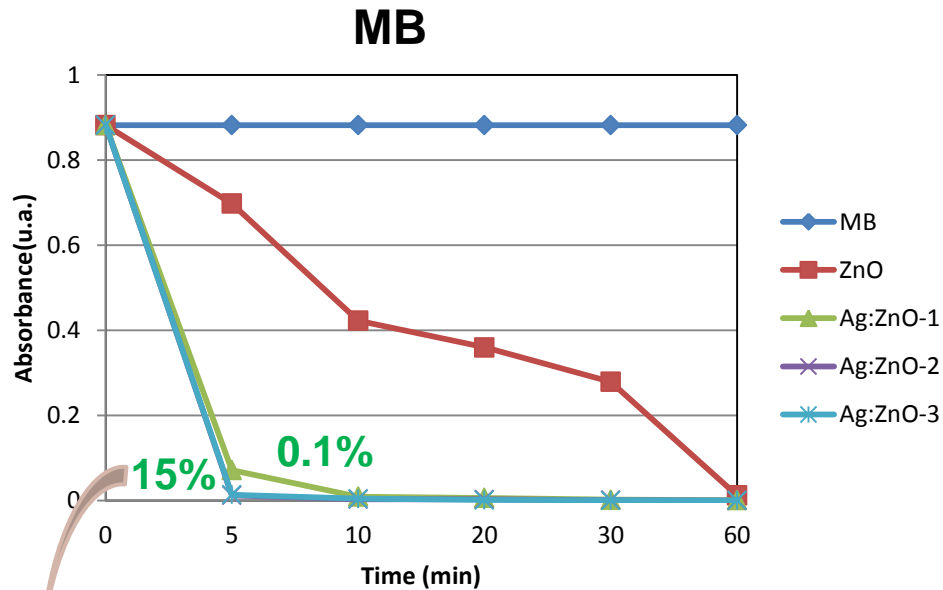
** A. Tabacaru, V. Musat, N. Tigau, B.S. Vasile, V.-A. Surdu, submitted for publication.

VI. Photocatalytic activity of organosilane-functionalized ZnO NPs

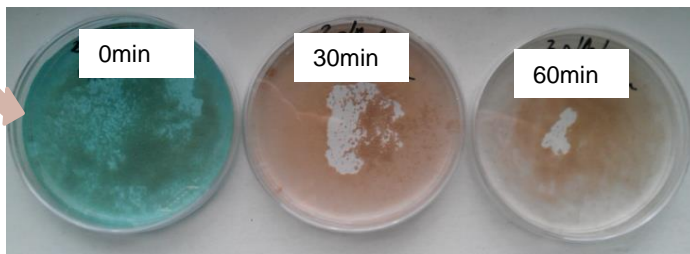
ZnO-GPTMS NPs



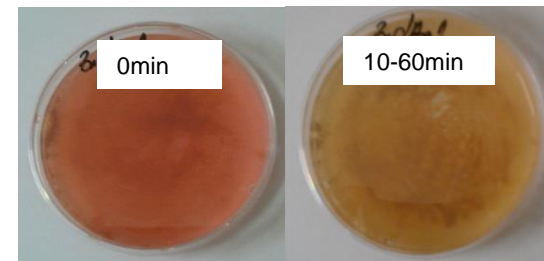
Ag:ZnO-GPTMS NPs (in solution) in UV light ($\lambda > 210\text{nm}$)



Ag(15at%):ZnO-GPTMS

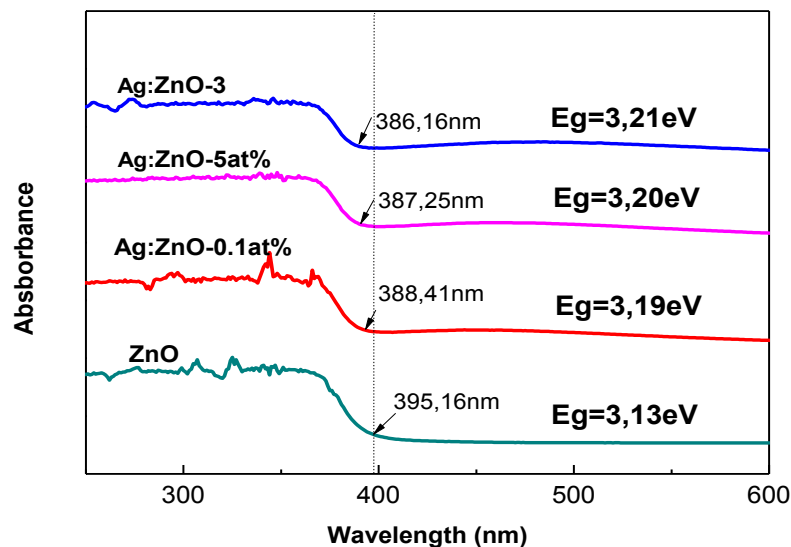


Ag (15at%) :ZnO-GPTMS

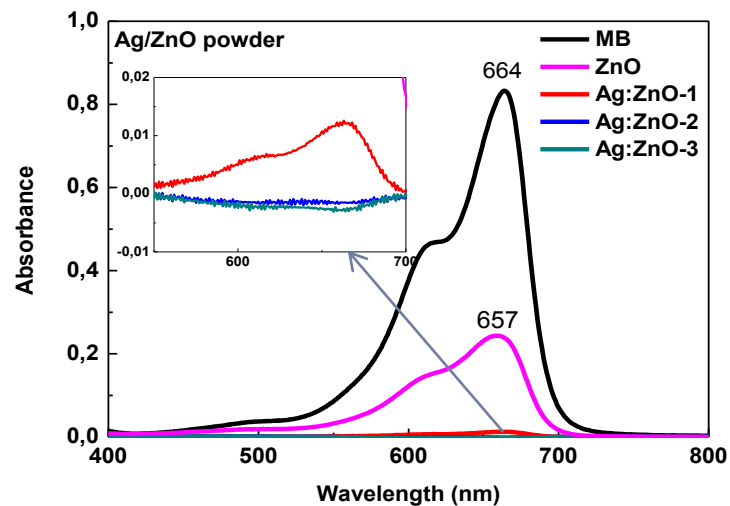


Band gap and Photocatalytic activity

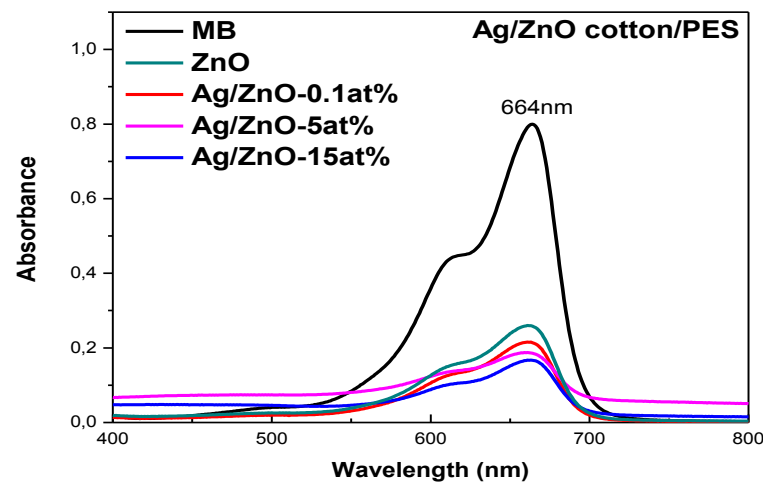
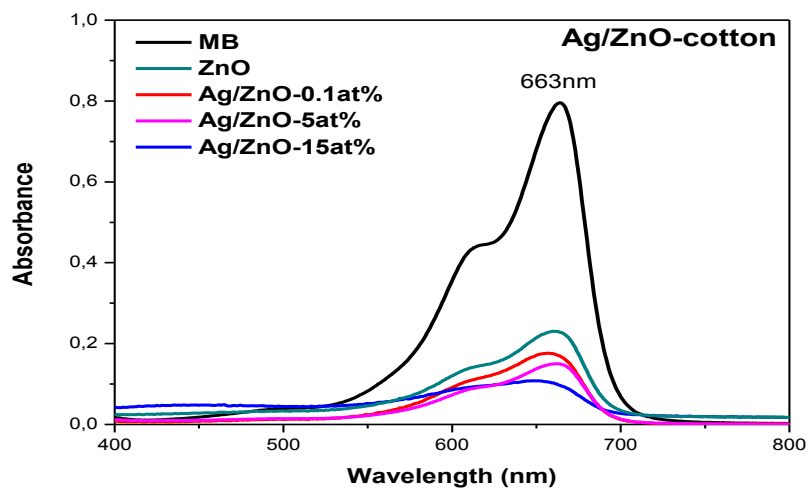
Ag:ZnO-GPTMS NPs and coatings *



Effect of Ag-doping concentration



Activitatea fotocatalitica creste cu cresterea concentratiei dopantului



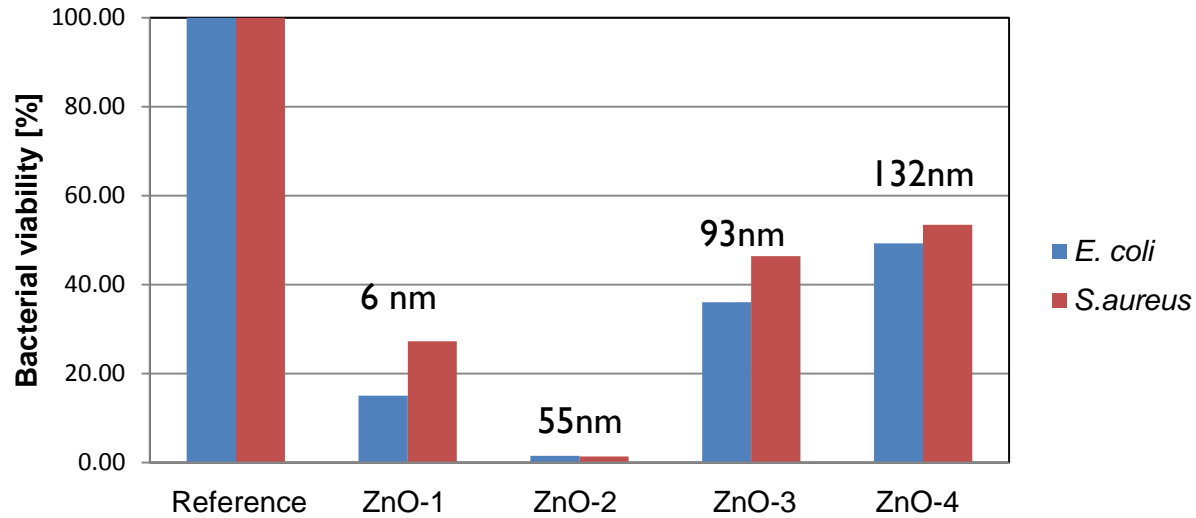
*M. Ibănescu (Busilă), V. Mușat, T. Textor, V. Badilita, B. Mahtig, Journal of Alloys and Compounds 610, 2014, 244–249

VII. Antimicrobial activity of organosilane-functionalized ZnO NPs

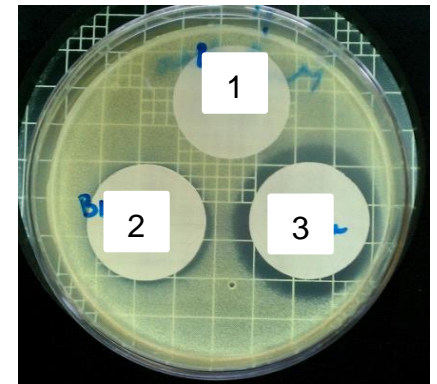
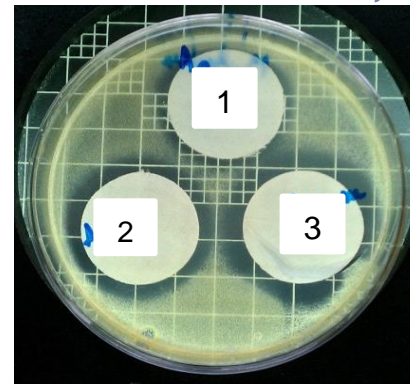
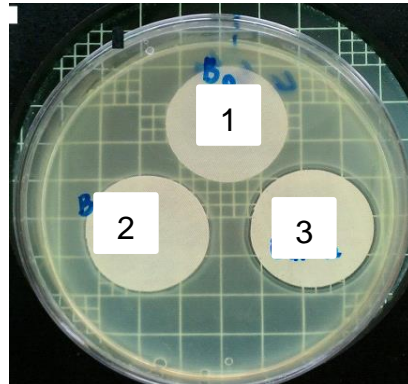
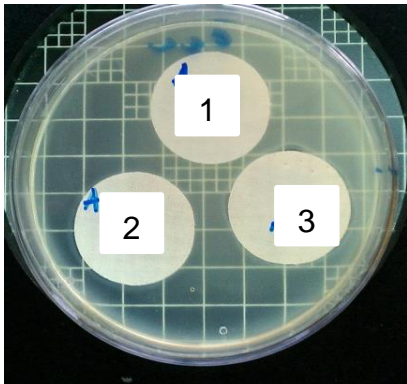
ZnO-GPTMS NPs

Effect of nanoparticle size on the bacteria viability

1. Efectul (cantitativ)
Metoda TTC
(tetrazolium)

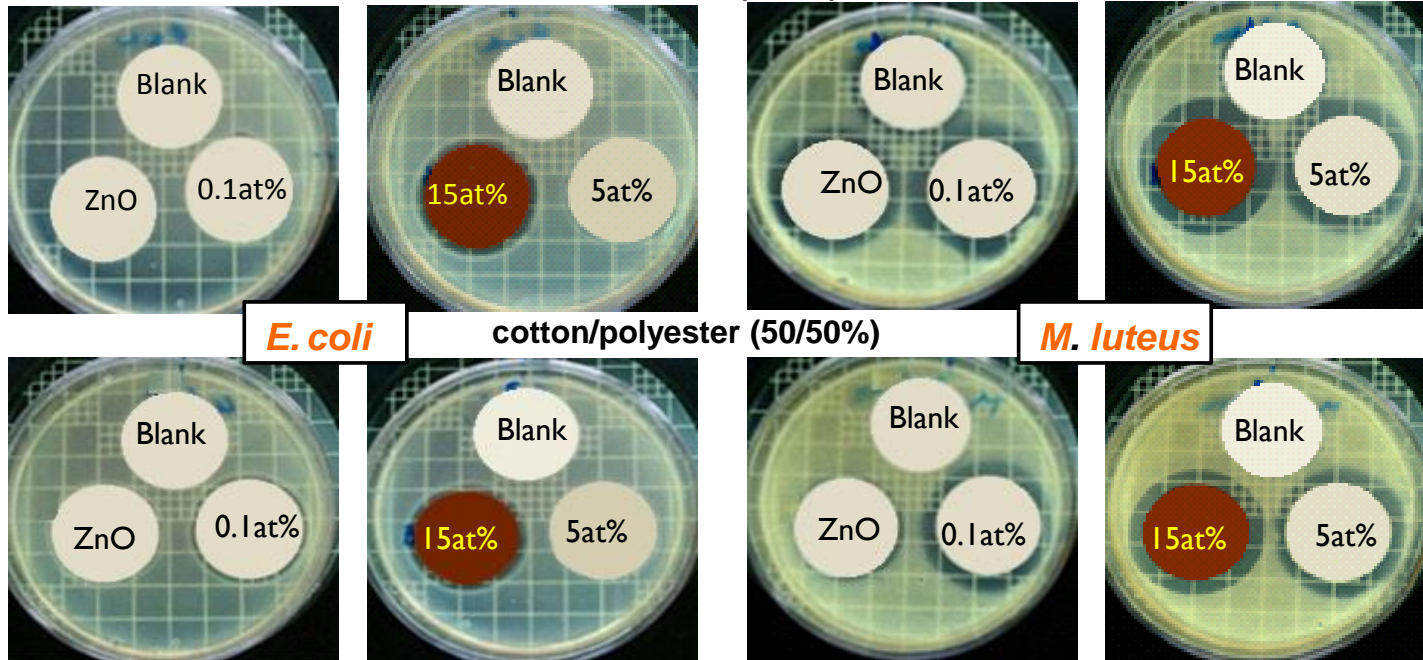
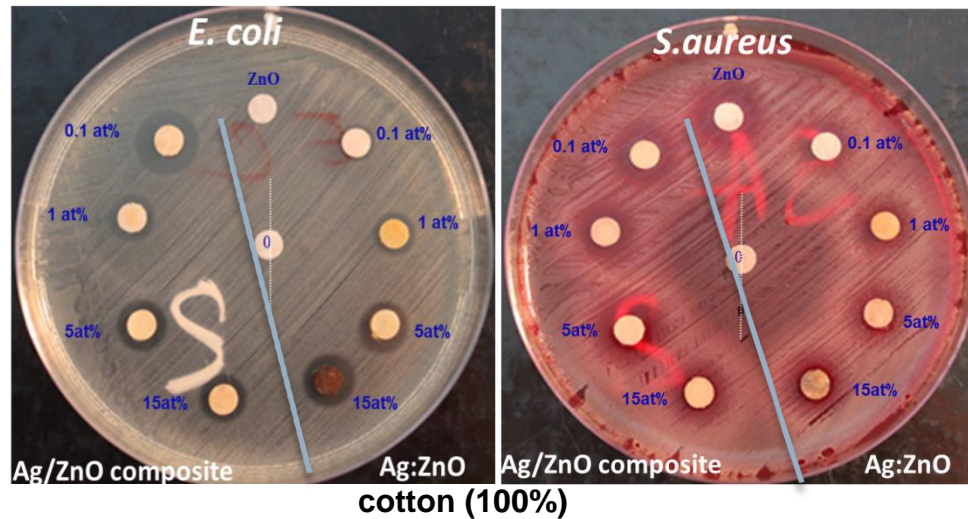


II. Efectul (calitativ) - Testul Zona de inhibiție



Ag:ZnO-GPTMS NPs

Inhibition zone test

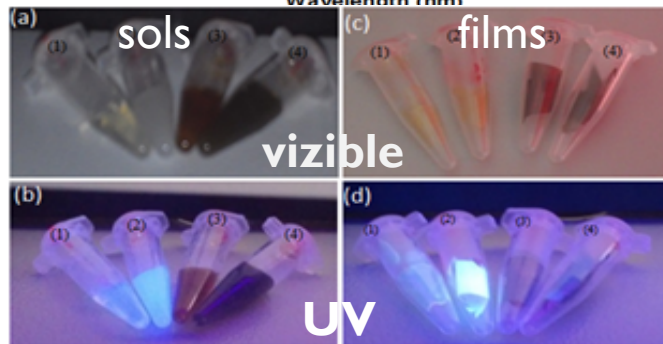
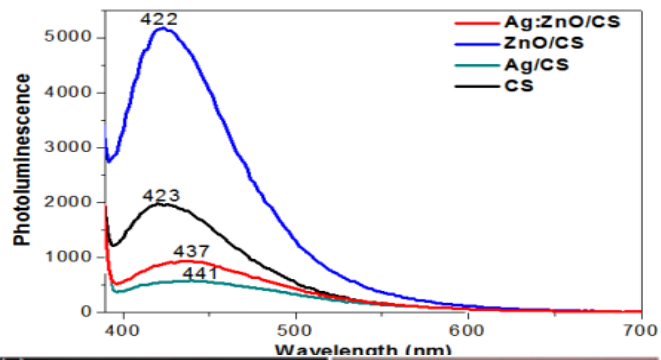
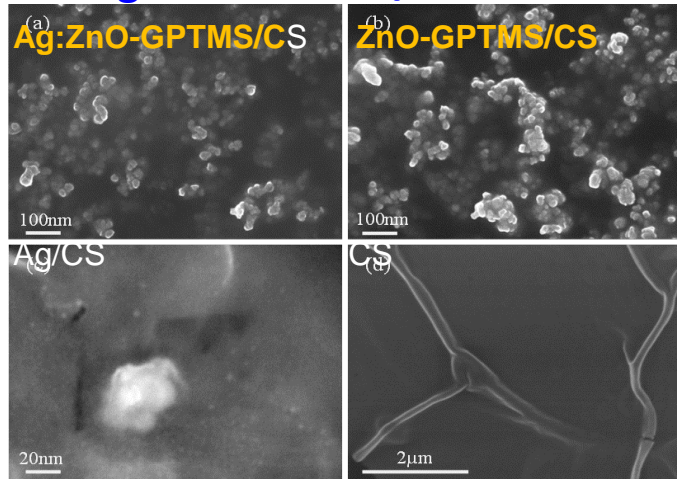


Activitate mai buna la **bacteria gram +** (*M. Luteus*) comparativ cu **bacteria gram +** (*E. coli*)

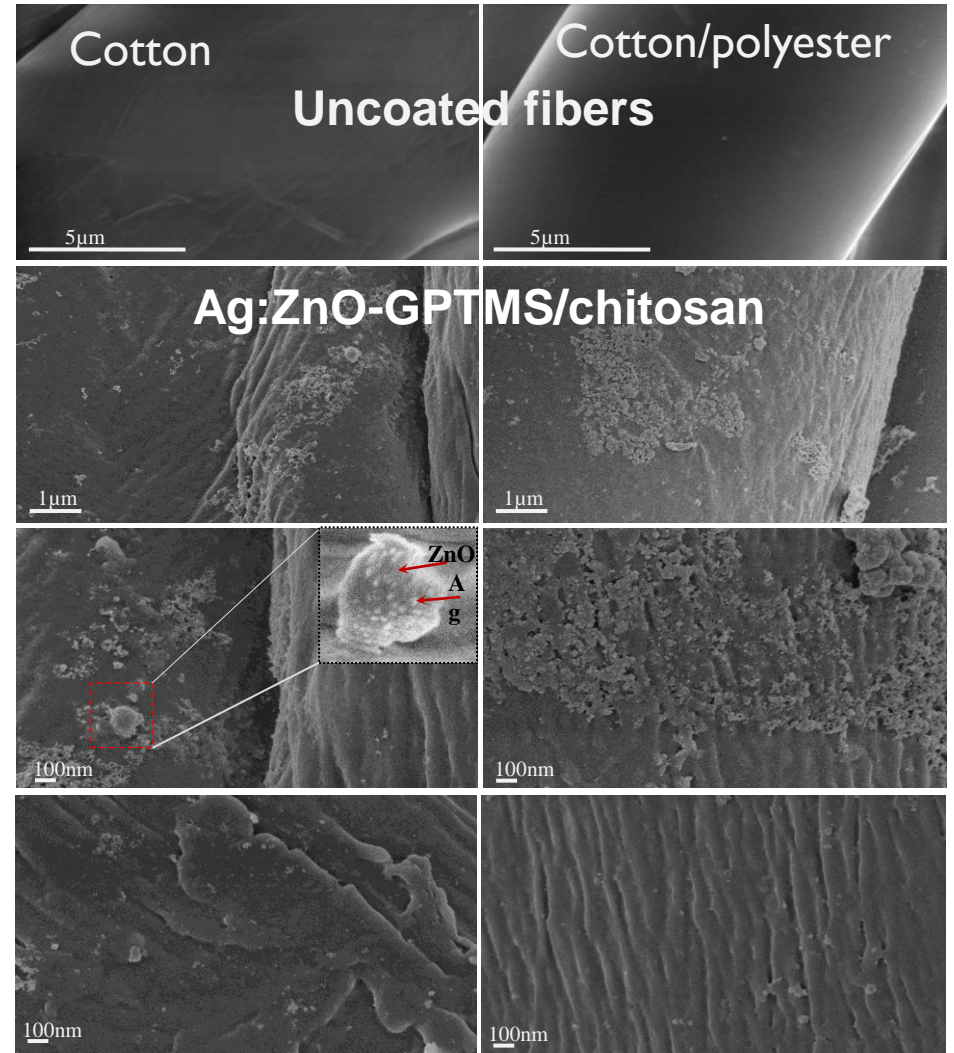
M. Ibănescu (Busilă), V. Mușat, T. Textor, V. Badilita, B. Mahltig, *Journal of Alloys and Compounds* 610, 2014, 244–249

VIII. Organosilane-functionalized Ag:ZnO/ZnO/chitosane biocompatible materials

Ag:ZnO-GPTMS/CS sols*



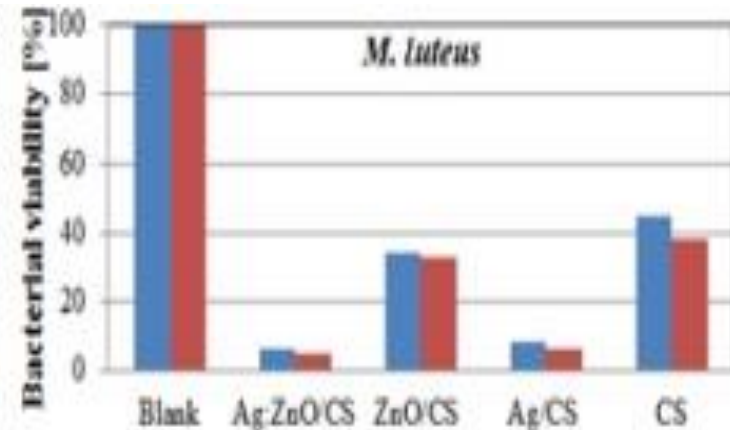
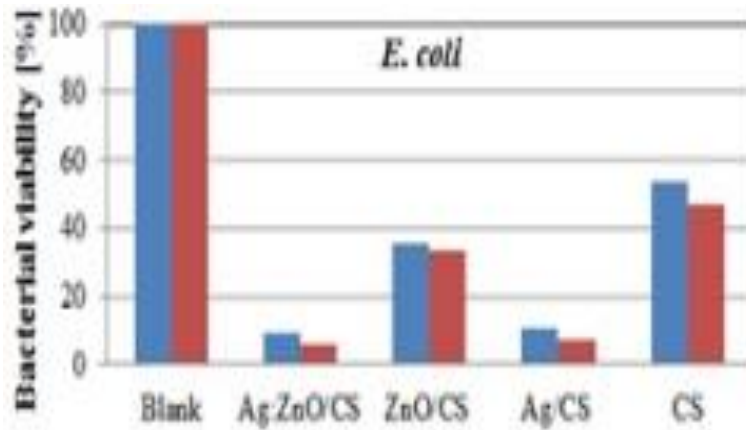
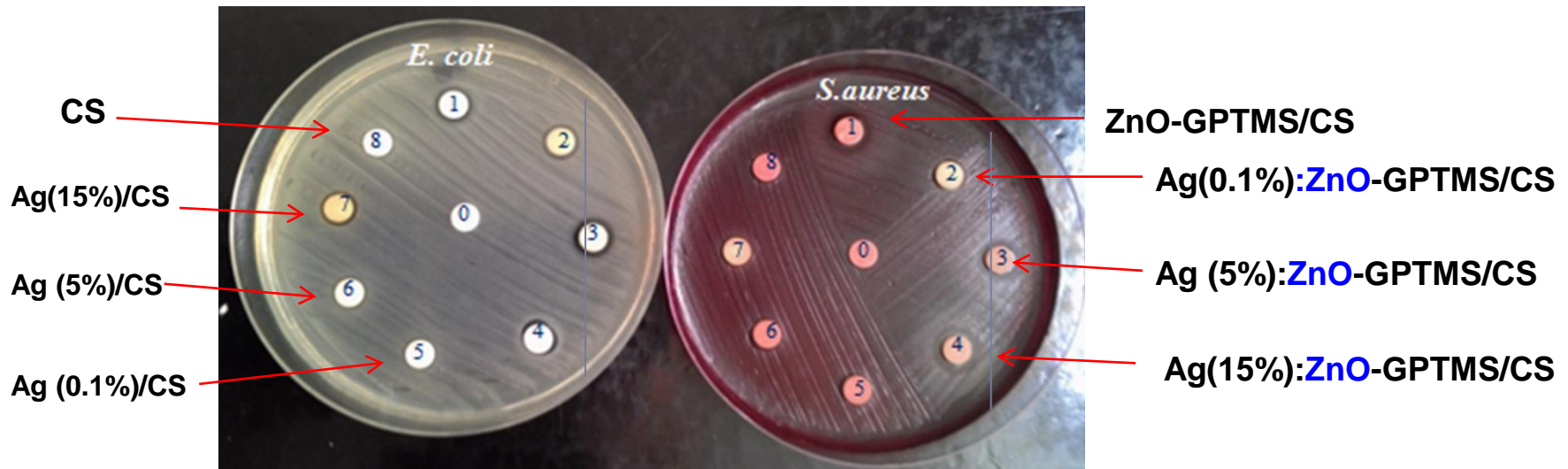
Ag:ZnO-GPTMS/CS coatings on textiles*



* M. Buşilă, V. Muşat, T. Textor and B. Mahltig, *RSC Adv.*, **2015**, *5*, 21562–21571

Antimicrobial activity

Ag:ZnO-GPTMS/chitosan (sol)**



■ cotton ■ cotton/polyester

■ cotton ■ cotton/polyester

M. Buşilă, V. Muşat, T. Textor and B. Mahtig, *RSC Adv.*, **2015, 5, 21562–21571

IX. Conclusions

- ZnO-organosilane, ZnO-organosilane/bioPolymer (chitosan-CS), M (Ag,Fe,Mn)-**doped** ZnO-organosilane, M(Ag,Fe,Mn) **doped** ZnO-organosilane/CS new hybrid quantum dots and coating materials were synthesised and characterised.
- Very interesting, tunable, multy-functional nanomaterials
- Potential applications are in optoelectronics (HLED), photocatalysis, antimicrobial (functional textiles), inteligent food packaging and fluorescent probes in medicine.

X. Invitation to CSSD-UDJG 2015

Galati,
4-5 Iunie 2015

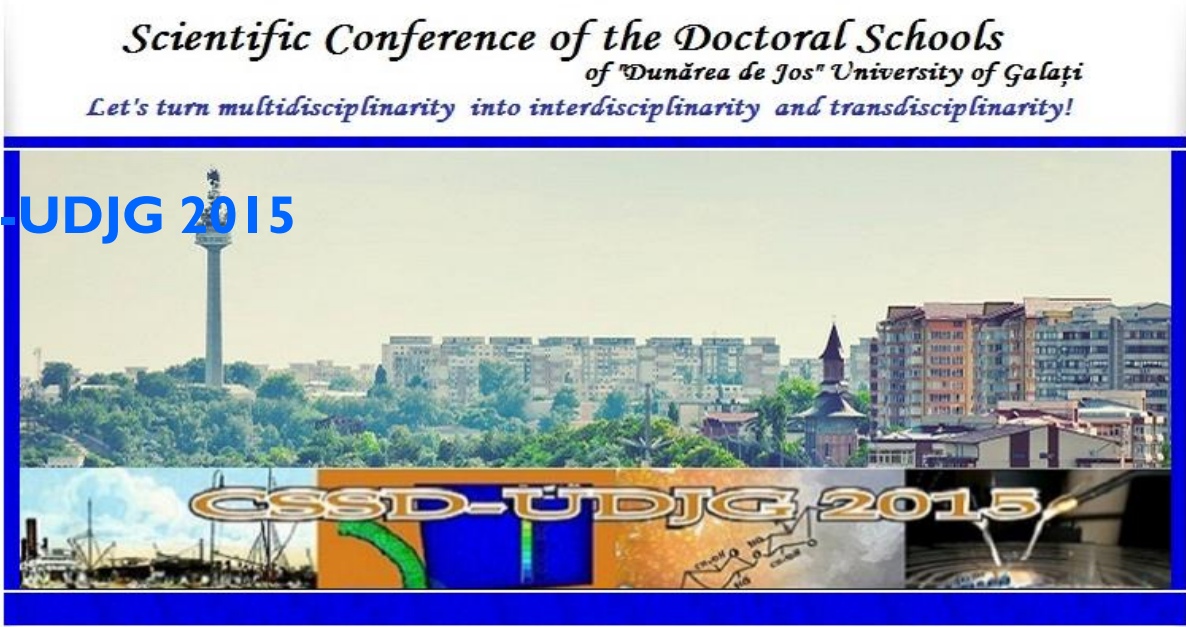
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Dear PhD Students and Postdoc Researchers,
Dear Colleagues and Collaborators,

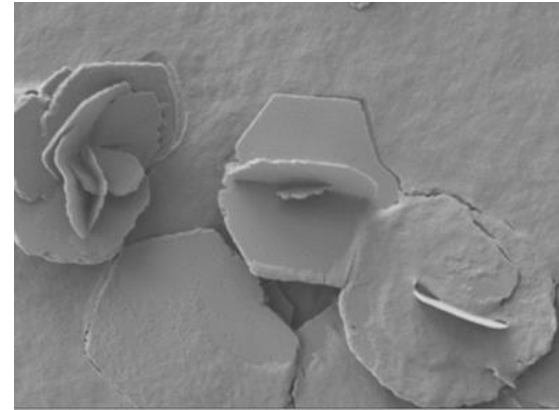
It is our pleasure to invite you to participate in the third edition of the Scientific Conference organised by the Doctoral Schools of "Dunărea de Jos" University of Galați (CSSD-UDJG 2015), 4-5 June 2015.

The management team and the two multidisciplinary doctoral schools of UDJG, i.e. the Doctoral School of Engineering and the Doctoral School of Humanities and Social Sciences, aim to promote excellence in research within a broader framework of interdisciplinarity, to set up partnerships and collaborative relationships in related fields through the exchange of knowledge and expertise.

Along these lines, this conference is intended to bring together young researchers and internationally acclaimed specialists in view of emphasizing the impact of scientific research on the knowledge based society of today.

Given the multidisciplinary nature of the conference, the invited keynote speakers, renowned academics and scientists from Romania and other EU countries, will deliver presentations on topics of interest to all participants. The general theme for this year's plenary speeches is **"From the Technical and Cultural Heritage of the Lower Danube Porto-Franco Space to Emerging Technologies"** (transparent electronics, e-paper, nanobiotechnologies).

If the present day communication technologies allow access to information "at the touch of a button", thus , contributing to the development of international, cross-institutional and multidisciplinary research, and if "only the sky's the limit" for the communication technology of the future, let's turn multidisciplinary into interdisciplinarity, transdisciplinarity and



Thank You!

