FIRST INTERNATIONAL CONFERENCE ON ELECTRON MICROSCOPY OF NANOSTRUCTURES

ELMINA 2018

ПРВА МЕЂУНАРОДНА КОНФЕРЕНЦИЈА О ЕЛЕКТРОНСКОЈ МИКРОСКОПИЈИ НАНОСТРУКТУРА

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FIRST INTERNATIONAL CONFERENCE

ELMINA 2018

PROGRAM & BOOK OF ABSTRACTS

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FIRST INTERNATIONAL CONFERENCE
ELMINA 2018
Program and Book of Abstracts

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At the beginning we wish you all welcome to Belgrade and ELMINA2018 International Conference organized by the Serbian Academy of Sciences and Arts and the Faculty of Technology and Metallurgy, University of Belgrade. We are delighted to have such a distinguished lineup of plenary speakers who have agreed to accept an invitation from the Serbian Academy of Sciences and Arts to come to the first in a series of electron microscopy conferences: Electron Microscopy of Nanostructures, ELMINA2018. We will consider making it an annual event in Belgrade, due to this year's overwhelming response of invited speakers and young researchers. The scope of ELMINA2018 will be focused on electron microscopy, which provides structural, chemical and electronic information at atomic scale, applied to nanoscience and nanotechnology (physics, chemistry, materials science, earth and life sciences), as well as advances in experimental and theoretical approaches, essential for interpretation of experimental data and research guidance. It will highlight recent progress in instrumentation, imaging and data analysis, large data set handling, as well as time and environment dependent processes. The scientific program contains the following topics:

- Instrumentation and New Methods
- Diffraction and Crystallography
- HRTEM and Electron Holography
- Analytical Microscopy (EDS and EELS)
- Nanoscience and Nanotechnology
- Life Sciences

To put this Conference in proper prospective, we would like to remind you that everything related to nanoscience and nanotechnology started 30 to 40 years ago as a long term objective, and even then it was obvious that transmission electron microscopy (TEM) must play an important role, as it was the only method capable of analyzing objects at the nanometer scale. The reason was very simple - at that time, an electron microscope was the only instrument capable of detecting the location of atoms, making it today possible to control synthesis of objects at the nanoscale with atomic precision. Electron microscopy is also one of the most important drivers of development and innovation in the fields of nanoscience and nanotechnology relevant for many areas of research such as biology, medicine, physics, chemistry, etc. We are very proud that a large number of contributions came from young researchers and students which was one of the most important objectives of ELMINA2018, and which indicates the importance of electron microscopy in various research fields. We are happy to present this book, comprising of the Conference program and abstracts, which will be presented at ELMINA2018 International Conference. We wish you all a wonderful and enjoyable stay in Belgrade.

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Sunlight-driven Photocatalytic and Photo-electrochemical Activity of ZnO/SnO_2 Composite

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Due to their high photoactivity, photostability, chemical inertness, simple syntheses procedures as well as low cost, semiconductor materials such as TiO_2, ZnO, V_2O_5, and SnO_2, are recognized as materials with a great potential for photoelectrochemical and photocatalytic applications. In particular, they can be used as photoanode in the process of photoelectrolysis of water, or to initiate decomposition of different organic or biological pollutants in water under light irradiation [1]. Which wavelength of light will be absorbed depends on the semiconductor band gap; semiconductors with a wide band gap (> 3 eV) can absorb light in the UV range only, while those with a narrow band gap (< 3 eV) can be activated by visible light. Current trend in photo(electro)catalysis is to develop efficient semiconductors which can be activated by absorbing natural sunlight. During the years, various approaches have been developed to modify optical properties of semiconductors thus to be capable to absorb sunlight, for example: the incorporation of transition metal ions or defects into the crystal structure, the particles' surface sensitization, hydrogenation, coupling of semiconductors with different band gap energies, etc. [2].

In this work, to enhance photo(electro)catalytic activity of ZnO, we prepared composite with SnO_2. ZnO/SnO_2 composite was prepared by high-energy ball milling of commercially available ZnO and SnO_2 powders in a 0.9:0.1 molar ratio [3]. The oxides were milled during 2 h in planetary ball mill with the angular velocity of the vessels of 400 rpm. Stainless steel vessels and balls were used, while the balls to powder weight ratio was 10:1. The phase composition and crystal structure were analyzed by XRD and Raman spectroscopy. XRD patterns were recorded at

Philips PW-1050 over a 2θ range 10–70° with a step of 0.05° and a counting time of 5 s. The μ-Raman spectra were recorded in the frequency interval of 50–1200 cm^{-1} (DXR Raman microscope, Thermo Scientific). The particles morphology and size distributions were examined by FE–SEM (Ultra plus, Carl Zeiss, Germany), TEM (JEOL 2100), and laser diffraction particle size analyzer (Mastersizer 2000; Malvern Instruments Ltd., U.K.); elemental mapping was performed by EDXS analysis (JEOL ARM 200CF equipped with JEOL centurion 100). Optical properties were studied by UV–Vis diffuse reflectance (Thermo Scientific, Evolution 600 UV–Vis spectrophotometer) and photoluminescence spectroscopy (Horiba Jobin Yvon Fluorolog FL3–22 *spectrofluorometer*). The photocatalytic activity of ZnO/SnO_2 composite was tested for a degradation of methylene blue dye under direct sunlight illumination with intensity of about 1000 lux. The pollutants concentration during degradation was monitored by the UV-Vis spectrophotometer and calculated according to the maximum absorbance value. The total organic carbon (TOC) was determined by the TOC Analyser Multi N/C (Analytik Jena, Austria). The photoelectrochemical performance was tested under lamp which simulates sunlight (Osram Ultra Vitalux lamp, 300 W), by cyclic voltammetry CV using Gamry PCI4/750 in the three-electrode quartz cell composed from the working electrode, platinum foil as the counter electrode and saturated calomel electrode (SCE) as the reference electrode. All the results obtained for ZnO/SnO_2 composite are compared with the ones for pristine ZnO powder.

According to the XRD analysis, composite powder is of high crystallinity, consisted of hexagonal ZnO and tetragonal SnO_2 phases, without any other crystal phases. Results of HRTEM, EDXS mapping and FE–SEM showed that after milling surface of ZnO crystals is covered with small spheroidal particles of tin oxide. Figure 1 shows the FE–SEM micrograph of ZnO/SnO_2 powder.

The cyclic voltammogram was measured in 1 M KCl at 20 $mV \cdot s^{-1}$, under dark and during illumination. For pristine ZnO it was measured that the potential decreased from -0.310 to -0.292 V versus SCE in dark and light, respectively; while for ZnO/SnO_2 the onset hydrogen evolution potential decreased from -0.351 V versus SCE in dark to -0.337 V versus SCE during illumination. What's more, at the potential of -0.7 V versus SCE, the current during illumination of photoanode increased about 40 % in the case of composite material, while for the pristine ZnO it increased just about 10 %, Figure 1.

When ZnO/SnO_2 was used MB dye solution was completely de-colorized after 40 min, whereas the time necessary for the de-colorization of 50% of the dye was $t_{1/2}$ = 3.85 min.

Raman and PL results implicate that the enhanced photo(electro)activity of ZnO/SnO_2 as compared to pristine ZnO is due to the surface defects which contributes to the visible light absorption. The presence of Zn_i point defects contributes to the visible light absorption due to the defect level located in the band gap, at 0.22 eV below the conductive band (narrowing band gap to about 3.15 eV or 400 nm). These defects also promote charge transfer and suppress electron-hole recombination [3,4].

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[4] This study was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia under Grant no III45004 and the Serbian Academy of Sciences and Arts through the project F-190 “Electrocatalysis in the contemporary processes of energy conversion”.

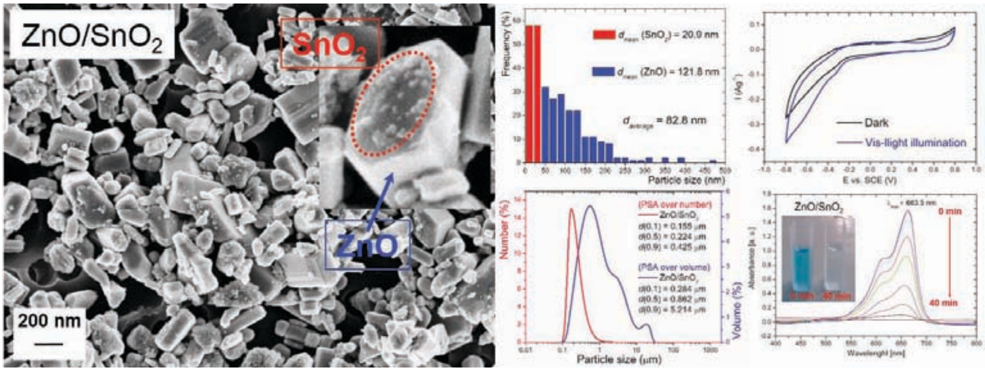

Figure 1. FE–SEM micrograph, particle size distributions, and photo(electro)catalytic activities of ZnO/SnO_2 composite.

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