NANOMATERIALS FOR ENERGY AND WATER TREATMENT APPLICATIONS

Dr. Ruxandra Vidu

ABSTRACT

The Habilitation Thesis titled "NANOMATERIALS FOR ENERGY AND WATER TREATMENT APPLICATIONS" presents the experimental work carried out over 20 years of research and teaching. Most of them were performed at the University of California Davis, as a postdoc researcher and then associate adjunct professor. The main scientific challenges on nanomaterials have been addressed in a comprehensive manner and published in ISI journals with high impact factor (IF). The mean value of the journal impact factor in which the candidate published the work was 4.34, where the lowest and the highest IF values were 0.588 and 15.621, respectively. The candidate's scientific contribution to science for over 35 years of which the last 25 years were devoted to nanomaterials and their applications in energy and water, was recognized by many patents and awards received by the candidate. The international visibility and recognition point to the importance of her work for the scientific community in the field of materials science and engineer. The Habilitation Thesis is structured around the template synthesis of 1-D nanomaterials, i.e. nanowire and nanocable arrays. This technology was developed at the University of California Davis (UC Davis) and brought to the University Politehnica of Bucharest (UPB) first during her Fulbright Scholarship in 2012, and then during the 4-year European project led by the candidate.

In the first chapter of the Habilitation Thesis, an introduction in nanomaterials as the key building block of nanotechnology is presented along with the core of research efforts to integrate them into novel devices. Template synthesis provides metallic nanostructure array with a broad range of functionalities in electronic applications, magnetism, catalysis, biological tagging, photonics and plasmonics, and controlled self-assembly.

The second chapter presents the study of growth mechanism and kinetics of ultrathin film with ultraflat surface in the early stage of formation. This study is of great importance not only for understanding the growth of thin films but also for the advancement of new technologies until the fabrication of nanodevices. One of the goals of this research was to understand the mechanism of ultra-thin film growth of CdTe versus Te with the aim of understanding the role played by Cd in both the deposition of CdTe and Te films using the underpotential deposition (UPD).

The third chapter is dedicated to the nanocable structure, which offers unusual opportunities to explore properties at nanoscale dimensions for a wide range of potentially useful applications. The technology of creating metal/semiconductors and metal/semiconductors/metal nanocables that are co-axially grown, lays down a platform for constructing a group of previously

unavailable materials. Nanocables and nanocable arrays may be used as nanodevices such as biosensors, nanoelectronics, solar cells, and nanoelectrical-mechanical devices.

Chapters 4 and 5 present the developments of nanowires array for thermoelectric applications. Among them, the Co-Sb system was investigated due to the skutterudite structure formed by Co3Sb, which has a great potential in structural manipulation to increase the thermoelectric properties of this compound. Because of the versatility of the electrochemical method to grow nanowires in a template, electrochemical doping of the Co3Sb is presented in Chapter 5.

Chapter 6 presents a comprehensive investigation on the Co hybrid nanostructure obtained in template synthesis. The mechanism of the formation of such structure and a detailed microscopy investigation are presented. In the Chapters 7 and 8, a technique to fabricate Co-Ni nanowire array with controlled composition is presented. The challenge in this system is originated in the anomalous deposition observed for Co-Ni system during electrochemical deposition. Iron-group alloys such as Co-Ni and nanomaterials fabricated therefrom are a broadly applicable class of materials thanks to their conductivity and magnetic properties. Nanowires consisting of cobalt and nickel in particular find applications in batteries and thermoelectrics.

A strategy on how to control the composition of Co-Ni nanowire is developed in Chapter 8. Understanding the electrochemical behavior of the constituent elements is paramount to exerting full control over the synthesis of these nanomaterials and their properties.