Scientific Final Report–PN-III-P1-1.1-TE-2021-0417

(Project implementation period: 15 may 2022 – 14 may 2024)

The objectives foreseen and achieved in this project were the following:

O1. Development of novel pseudocapacitive cathode electrodes based on nanocomposite electrochromic thin films of TiO<sub>2</sub>rNSs-WO<sub>3</sub>NSs on FTO substrate (part 1) – carried out in Phase 1 (*Period: 15 May - 31 December 2022*);

O2. Development of new cathodic nano-composite TiO<sub>2</sub>rNSs-WO<sub>3</sub>NSs thin films / FTO electrochromic / pseudocapacitive electrodes (part 2 - morphological characterisation by SEM, electrochemical and electrochromic). Developing new nanohybrid anode electrodes using PEDOT:PSS-TiO<sub>2</sub>rNSs şi PPyNSs-TiO<sub>2</sub>rNSs deposited thin films on an FTO substrate. Obtaining biopolymer electrolytes with high ionic conductivity by doping DNA with Li<sup>+</sup> or Zn<sup>2+</sup> ions. – made in Phase 2 (*Period: 1 January* - 31 December 2023);

**O3.** – **Assembly and characterization of new bifunctional EESWs** - carried out in Phase 3 (*Period: 1 January - 14 May 2024*) and presented in the final scientific report - with the following <u>Activity 3.1 - Electrochromic and pseudocapacitive optimization of EESWs</u>, which includes the following sub-activities

*Sub-activity 3.1.1 a)* Selection of new optimal active bifunctional electrodes and new SPE membranes from the previous steps and assembly of bifunctional EESWs;

Sub-activity 3.1.1 b) Test the electrochromic-pseudocapacitance behaviour of the assembled EESWs by calculating CE,  $\Delta$ T,  $\Delta$ OC, specific capacitance, energy storage/release and cycle stability parameters;

*Sub-activity 3.1.1 c)* Dissemination of results.

Small Electrochromic Windows (ECWs) were assembled in a sandwich like structure:



**Dissemination of results** - The following results were proposed in the grant application:

# - 2 ISI articles accepted for publication in Q1 or Q2 rated journals (achieved - 2 Q1 articles published;

Part of the results obtained were published in 2 ISI articles, Q1 rated:

- "Titanium Dioxide Thin Films Produced on FTO Substrate Using the Sol-Gel Process: The Effect of the Dispersant on Optical, Surface and Electrochemical Features", authors: Vasilica Mihaela Mîndroiu, Andrei Bogdan Stoian, Roberta Irodia, Roxana Truşcă, Eugeniu Vasile. Materials, 16 April 2023, 16, 3147. https://doi.org/10.3390/ma16083147;
- "Photocatalyst Based on Nanostructured TiO2 with Improved Photocatalytic and Antibacterial Properties", authors: Roberta Irodia, Camelia Ungureanu, Veronica Sătulu, Vasilica Mihaela Mîndroiu, *Materials* 05 December 2023, 16(24), 7509; https://doi.org/10.3390/ma16247509.

# - Participation in 2 International Conferences (achieved - 4 International Conferences);

Part of the results were presented in 5 papers at 4 International Conferences:

### I. 22nd Romanian International Conference on Chemistry and Chemical

**Engineering,** Sinaia, ROMANIA - September 7 – 9, 2022, title: *Optimization of Physical and Optical Properties of*  $TiO_2$  Nanostructures Deposited on FTO Substrate by Slow Hydrolyses, authors: <u>Vasilica Mihaela Mîndroiu</u>, Grațiela Teodora Tihan, Roxana Gabriela Zgârian, Andrei Stoian.

### **II. 3<sup>rd</sup> International Conference on Bioengineering and Polymer Science**, University

of POLITEHNICA of Bucharest, Bucharest, ROMANIA – June 7-11, 2023, title: *Polypyrrole based thin films with ZnO for smart window applications*, authors: <u>Vasilica Mihaela Mîndroiu</u>, Cristina Dumitriu.

III. 20<sup>th</sup> International conference of Advanced Nanomaterials, University of Aveiro, Aveiro-Portugal, 26-28 iulie 2023, title: *Synthesis of tungsten oxide/electrochemical reduced titanium dioxide thin films on FTO substrates and its electrochromic-pseudocapacitive properties*, authors: <u>Roberta Irodia</u>, Mihaela Vasilica Mîndroiu, Sorin Vizireanu and Andrei Stoian.

IV. 20<sup>th</sup> International conference of Advanced Nanomaterials, University of Aveiro, Aveiro-Portugal, 26-28 iulie 2023, title: *Development of Electrochromic Nanostructures Based on WO3/TiO2 Composite for Smart Window Applications: The Effects of Polydopamine and the Electrochemical Reduction Process*, authors: <u>Mihaela Vasilica Mîndroiu</u>, Roberta Irodia and Andrei Stoian.

V. 9<sup>th</sup> World Congress on Recent Advances in Nanotechnology (RAN 2024), London, United Kingdom –April 8 – 10, 2024, title: *The electrochromic device performance with doped DNA based electrolyte*, author: <u>Mihaela Vasilica Mîndroiu</u>.

## - <u>Patent application filing (completed - one patent application published):</u>

A patent application with no. RO20230000298 20230615 was filed at OSIM where the original results were disseminated: "*Process for the fabrication of a novel pseudo-capacitive cathodic electrode based on wo3\_nanofibers/TiO2\_type nanocomposite electrochemically grown on FTO substrate with improved electrochemical activities*", authors: Mîndroiu Mihaela, Dumitriu Cristina and Irodia Roberta. - Published: RO137718 (A0) - 2023-10-30.

- Project website (constantly updated with the project results) - available at: http://innobifeesw.chimie.upb.ro.