

Final Report

Project acronym: HyMatSiRen

Project number: 300107

M-ERA.NET Call 2016

Period covered: 01/10/2017 to 30/09/2020

Publishable project summary

The project proposes novel hybrid/composite materials for applications in Si-based solar cells and batteries. The new material is based on PEDOT:PSS functionalized with inorganic nanomaterials NiO, TiO₂, SnO₂, TiO₂, and Si as well as on oxide-based composite nanomaterials. Potential of the new materials is evaluated for applications in solar cells and batteries..

The innovative results achieved in the project are:

- This project has led to a new material for Si surface passivation that distinct from other known materials can be deposited at room temperature and low cost method;
- A Si-based solar cell is fabricated that uses the hybrid/composite nanomaterials;
- The oxide-based composite nanomaterials have shown potential for Li-ion battery applications with enhanced durability;
- Li-ion battery is fabricated and characterized by the SME Enwair, participating in the project;
- A software with GNU license is developed to study of optical properties of composite nanomaterials;

During the project, the partners have published more than 17 journal articles (and one more is under preparation), a patent application, and one oral, six poster presentations, and two invited talk at prestigious international conferences and symposia, from which we highlight the following:

1. Félix del Prado, H. F. Andersen, M. Taeño, et. al. Comparative study of the implementation of tin and titanium oxide nanoparticles as electrodes materials in Li-ion batteries. *Sci. Reports.* **10**, 5503, (2020).
2. Vázquez-López, A. Yaseen, D. Maestre, et. al. Synergetic improvement of stability & conductivity of hybrid composites formed by PEDOT:PSS and SnO nanoparticles. *Molecules*, **25**(3), 695 (2020).
3. M García-Carrión, J Ramírez-Castellanos, et. al. Hybrid solar cells with β - and γ -gallium oxide nanoparticles *Mater. Lett.* **261**, 127088 (2020).
4. G. Cristian Vázquez, D. Maestre, A. Cremades, J. Ramírez-Castellanos, E. Magnano, S. Nappini, S. Zh. Karazhanov. Effects of the electronic properties and local environment of rutile TiO₂. *Sci. Rep.*, **8**(1), 8740 (2018).

Two Symposia have been organized: one “Metal oxide- and oxyhydride-based nanomaterials for energy and environment-related applications” is organized in E-MRS Fall Meeting, 15-19th September **2019**, Warsaw, Poland and the other one “Advanced Functional Materials” in the University Jaffna, Jaffna, Sri Lanka. February 6-8, 2019. Two Editorial work has been completed for the Elsevier journals journal *Materials Today Proc* and *Materials Lett*. One more Editorial work is ongoing. The results obtained within the project have been included into thesis of four PhD students. Four Master students have defended Master thesis on the topic of the proposal.