Technical University Gheorghe Asachi Iasi, TUIasi
Faculty of Chemical Engineering and Environmental Protection

Project code: COFUND-LEAP-RE-NANOSOLARCELL
RO contract: ERANET 293/2022

Integration of photonic conversion layers based on photoemissive nanostructured materials for improving sunlight harvesting ability of solar cells

Stage 3
01.01.-31.12.2024

Summary

In the final stage of implementation of the research project, studies were continued on the development of materials that would allow the increase of the photonic conversion efficiencies of commercially available photovoltaic solar panels, the objectives pursued being the following:

- obtaining photonic materials with high conversion efficiencies applicable in thin layers on the external surface of PV panels and allowing an increase of at least 1.5-2% in the conversion efficiency;
- using widely available chemical compounds/precursors and low costs and easy-to-obtain procedures;
- to allow implementation on commercially available solar panels used on a wide scale (especially mono/polycrystalline PV panels);
- to allow the “on-site” modernization of already existing PV panels through simple procedures that do not require expensive equipment;
- increased resilience of the photonic conversion layers applied on the PV surface to long-term exposure to various environmental factors.

In addition to the main objective of improving the conversion efficiencies of existing PV solar panels, the aforementioned objectives are also part of the general framework of the LEAP-RE projects and the partnership with African countries/regions in the particular economic context of each project partner. Thus, one of the objectives aimed at the valorization of local raw material resources. In this regard, experimental studies carried out by the research team related to the ERANET 293/2022 project led to the preparation of carbon nanostructures (CNDs) with remarkable photoluminescent emission properties from agricultural waste from the preparation of argan oil. All countries involved in the LEAP-RE partnership (Morocco, Algeria, Egypt) present extremely favorable conditions for the valorization of solar energy, having already developed photovoltaic parks on extensive areas. In addition to the sustained efforts of collaboration with the countries of the Mediterranean basin, the EU also aims to develop energy infrastructure, shift to sustainable energy sources and reduce dependence on fossil fuels. Therefore, increasing the conversion efficiencies of existing/newly installed solar panels is of great interest,

especially in the context of implementation solutions that involve low manufacturing/modernization costs. Under the above-mentioned conditions, in Stage 3 of the implementation of the research project, a series of notable results were obtained regarding the increase in the photonic conversion efficiencies of photoluminescent nanostructured materials used in the film-forming materials developed within the project and implementable in photovoltaic solar panels. In Stage 3 (2024), of the research project, the related activities were carried out, obtaining the photonic conversion media in an optimized version and prepared for possible practical application. The optimized recipe for practical applications of mixtures of Bi(III)-doped CNDs, monomer, crosslinker, photoinitiator, dispersion medium was developed, and the optimized deposition/photopolymerization/drying procedures for integration as photonic conversion layers in photovoltaic solar cells were experimentally studied. An important achievement was the increase in the photoluminescence quantum conversion yields of carbon nanostructures used to obtain photoemissive film-forming nanocomposites. The significant increase in conversion yields (practically double values) was obtained through a new approach in which the dispersion medium used is D_2O. The mechanism involved in increasing the efficiency of radiative processes specific to the carbon nanostructures prepared within the project was investigated in detail, by using D_2O as dispersion medium, the conclusions being interesting also from the perspective of general research on photoemissive carbon nanostructures. The use of a polymer matrix based on poly(acrylic acid) cross-linked with N,N'-Methylenebisacrylamide was also investigated to obtain film-forming nanocomposites applicable to photovoltaic solar panels. The recipes for preparing the nanocomposites were developed, and they were prepared for potential practical use. During the stage, the electrical operating parameters of photovoltaic solar panels equipped with a photonic conversion layer based on COC-CNDs and PScA-CNDs were measured, highlighting a 2.86% increase in the electrical energy produced by solar conversion. The behavior of the nanocomposite films developed within the project was also investigated, upon accelerated exposure to solar radiation (and the UV component) to highlight the stability and preservation of their characteristics in the long term, the results obtained being satisfactory.

Scientific papers/patent applications developed in Stage 3 (2024)

Int. Patent: Preparation method of a photonic conversion medium for improving the efficiency of the photovoltaic solar panels; Authors: Corneliu S. Stan, Cristina Albu, Marcel Popa, Maria Conception Ania Ovin; RO O.S.I.M. reg. no. A/00607 / 11.10.2024; EU. Patent Office (EPO) reg. no. 24464009.0/EP24464009 / 30.10.2024.

- Scientific paper: Efficient Synthesis Process of Carbon Dots via the Hydrothermal method using Green Precursors: comparative study; Authors: Noumane ELouakassi, Abdelmajid Almaggoussi, Corneliu S. Stan, Marcel Popa, Larbi Belachemi, Jaafar Ghabaja, Hamid Kaddami; trimisa in vederea publicarii 10.2024 Elsevier- Carbon.

- Scientific paper: Markedly enhanced photoluminescence of Carbon Dots dispersed in deuterium oxide; Authors: Corneliu S. Stan*, Adina Coroaba*, Conchi O. Ania, Cristina Albu, Marcel Popa; trimisă în vederea publicării 11.2024