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

Stage 1
01.05.-31.12.2022

Summary

The studies carried out in the first stage of the research project aimed both to prepare photoemissive polymer complexes and photoluminescent polymer nanocomposites based on carbon nanostructures "Carbon Dots", as photon conversion layers for increasing the efficiency of photovoltaic solar cells, by harnessing the UV component of the incident solar radiation (approx. 5-8%). Conventional solar cells are mainly sensitive in the lower region of the visible spectrum, the UV photons within the incident solar radiation being not utilized in photovoltaic processes. The radiative processes characteristic of the materials developed within the project allow photonic "translation" within the UV-A/B spectral regions to the mid-lower region of the visible spectrum where the conversion efficiency of conventional photovoltaic solar cells is optimal.

A first notable result obtained within the experimental plan related to this stage, was the development of a new type of copolymer - poly(HEMA-co-NHNI) which presents multiple advantages both from the perspective of project-specific applications and as a general-purpose copolymer for various applications. The developed copolymer has a chemical structure favorable to various chemical functionalization, including obtaining polymers complexes, high optical transparency and specific characteristics, including possible application in 3D printing, thin films by spray coating or ink jet printing. The copolymer was further studied, to obtain polymer complexes with intense photoluminescent emission in the red and green area of the visible spectrum also able to be processed in thin films as photonic conversion mediums for improving the conversion yields of photovoltaic solar cells.

Another result obtained during this stage was the preparation of a photoluminescent nanocomposite with intense emission in the blue area of the visible spectrum, obtained by introducing "Carbon Dots" into a cyclic olefin copolymer matrix. The material can also be processed in thin layers. The new materials obtained were morpho-structurally investigated and preliminary thin layer deposition tests were performed, the investigations for structural and morphological optimization will be further continued in the next stage of the research project.