PVA and Mo/Ti oxides nanocomposites prepared by underwater plasma discharge and its photovoltaic application [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2022.49.1.095

Sirotkin N.A., Khlyustova A.V., Titov V.A.

G.A. Krestov Institute of Solution Chemistry of the RAS, Russia, Ivanovo, alexsad8@yandex.ru

Dye-sensitized solar cells are currently being studied extensively. Such elements are created in the form of sandwich structures and contain an electrolyte, which plays the role of a reducing agent for dye molecules oxidized by light. When solar cells with liquid electrolytes are used, difficulties may arise in evaporation and electrolyte leakage, which affects the reliability of the cells. These problems can be solved by using quasi-solid electrolytic polymers. In recent years, the possibility of creating composite materials based on polyvinyl alcohol (PVA) for these purposes has been studied.

In this work, an underwater pulse discharge initiated in an aqueous solution of polyvinyl alcohol between metal (Mo or Ti) rods is used to obtain metal oxide nanoparticles and create polymer nanocomposites. Nanocomposites are characterized by atomic force microscopy, transmission electron microscopy, infrared spectroscopy, and X-ray diffraction. The details of the experiment are described in detail in [1].

X-ray analysis data show peaks related to PVA, α-MoO3 and TiO2. In experiments on the effect of plasma with titanium electrodes on a PVA solution, peaks related to the anatase and rutile phases are recorded. The shift of the peak at 19.8° relative to the initial PVA is associated with the strong interaction of the polymer with the formed oxide nanostructures of titanium and molybdenum. TEM observations showed that the nanoparticles are uniformly dispersed in the PVA matrix. The results of IR spectroscopy demonstrate the presence of van der Waals interactions between the polymer and nanoparticles. A significant decrease in the band gap of composites for indirect and direct electronic transitions due to the presence of regions with bulk heterojunctions in nanocomposites is shown. It was found that a small addition (up to 1.8%) of nanoparticles of metal oxides in PVA significantly improves its electrical conductivity. To study the photoelectric properties, a solar cell similar to that described in [2] was created. The values ​​of the maximum photocurrent turned out to be somewhat lower than the data obtained for the cells without polymer. This can be explained by the different composition of oxide nanoparticles and a lower concentration of doping nanoparticles. Despite this, the values ​​of the short-circuit current densities of photocells with polymer composites are higher than those of photocells without PVA.

Thus, the use of a pulsed underwater discharge plasma makes it possible to obtain nanocomposites in a one-stage process, which are promising materials for the manufacture of solar cells.

This work is supported by the Russian Science Foundation under grant 21-73-00034.

References

1. Sirotkin N. A., Khlyustova A. V., Titov V. A., Krayev A. S., Nikitin D. I., Dmitrieva O. A., Agafonov A. V. // Plasma Chem. Plasma Process., 2020, V. 40, P.571.
2. Khlyustova A.V., Sirotkin N. A., Titov V. A., Agafonov A. V. // J. Alloys Compnds., 2021, V. 858, P. 157664.
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLIX/Lt/ru/FA-Sirotkin.docx) [↑](#footnote-ref-1)