NANOMATERIALS IN THE ENERGY SECTOR

Kovalova Tetiana
Higher education student
Kucheruk Snizhana
Ph.D., Associate Professor
Svyrydiuk Kateryna
Assistant Lecturer
Denysiuk Roman
Candidate of Chemical Sciences (Ph. D.), Associate Professor
Department of Chemistry
Zhytomyr Ivan Franko State University, Ukraine

Recent decades have seen the rapid development of nanomaterials, which have become key elements in improving energy technologies. Their unique properties - large specific surface area, the ability to control the electronic structure, and quantum effects - have opened up new ways to improve the efficiency of energy production, storage, and conversion systems.

The purpose of this paper is to review the role of nanomaterials in the energy sector, with a focus on their use in lithium-ion batteries, supercapacitors, solar cells and fuel cells. By analysing current scientific developments, we aim to find out the mechanisms by which nanomaterials improve the performance of energy devices and outline the prospects for their further use.

The most common energy nanomaterials include carbon nanotubes, graphene, nanostructured metal oxides and perovskites. In lithium-ion batteries, nanostructured electrodes provide higher capacity and faster charge-discharge cycles due to the reduced ion diffusion length and increased surface area [1]. In supercapacitors, for example, nickel hydroxide nanoplates grown on graphene demonstrate high specific capacitance and cycling stability [2].

In the field of solar energy, nanomaterials increase efficiency by improving light absorption and charge separation. The use of plasmonic nanoparticles in photovoltaic cells can broaden the absorption spectrum and increase the power output [3]. Perovskite nanomaterials are also promising, as they provide high energy conversion efficiency and have the potential for low-cost production technology [4].

In fuel cells, nanocatalysts significantly improve reaction kinetics and reduce the need for expensive metals. For example, platinum and palladium nanoparticles deposited on carbon nanotubes demonstrate high catalytic activity and stability [5].

It is worth noting that nanomaterials play a key role in the transformation of energy systems, contributing to increased efficiency, reduced costs and the development of new technologies. Further research in this area is important to ensure a sustainable energy future.

References

1. Wang, H., Casalongue, H. S., Liang, Y., & Dai, H. (2010). Ni(OH)2Nanoplates Grown on Graphene as Advanced Electrochemical Pseudocapacitor Materials. *Journal*

of the American Chemical Society, *132*(21), 7472–7477. https://doi.org/10.1021/ja102267j

2. Jariwala, D., Sangwan, V. K., Lauhon, L. J., Marks, T. J., & Hersam, M. C. (2013). Carbon nanomaterials for electronics, optoelectronics, photovoltaics, and sensing. *Chem. Soc. Rev.*, *42*(7), 2824–2860. https://doi.org/10.1039/c2cs35335k

3. Yue, Z., Cai, B., Wang, L., Wang, X., & Gu, M. (2016). Intrinsically core-shell plasmonic dielectric nanostructures with ultrahigh refractive index. *Science Advances*, *2*(3), Стаття e1501536. https://doi.org/10.1126/sciadv.1501536

4. Pandey, R., Vats, G., Yun, J., Bowen, C. R., Ho-Baillie, A. W. Y., Seidel, J., Butler, K. T., & Seok, S. I. (2019). Mutual Insight on Ferroelectrics and Hybrid Halide Perovskites: A Platform for Future Multifunctional Energy Conversion. *Advanced Materials*, *31*(43), 1807376. https://doi.org/10.1002/adma.201807376

5. Bobinski, T. P., & Fuchs, P. L. (2015). Citric acid mediated catalytic osmylation/oxidative cleavage of electron deficient olefins: a vinyl sulfone study. *Tetrahedron Letters*, *56*(28), 4151–4154. https://doi.org/10.1016/j.tetlet.2015.05.044