Report on the outcomes of a Short-Term Scientific Mission[1]

Action number: CA21126

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Details of the STSM

Title:Spectroscopic Study of GO and rGO–Polysiloxane Nanocomposites in Triboelectric Nanogenerators for Hybrid Energy Harvesting and Storage towards Space-Relevant Applications

Description of the work carried out during the STSM

Description of the activities carried out during the STSM. Any deviations from the initial working plan shall also be described in this section.

The STSM was carried out at the National Institute of Materials Physics (NIMP), Romania, within the Laboratory of Optical Processes in Nanostructured Materials, under the supervision of Prof. Mihaela Baibarac. The main goal of this visit was to study the spectroscopic and structural properties of GO and rGO–polysiloxane nanocomposites and to better understand their performance in triboelectric nanogenerators (TENGs) for hybrid energy harvesting and storage applications.

During the STSM, both experimental work and material characterization were actively conducted. Nanocomposite samples with different GO/rGO concentrations were analyzed using a range of advanced techniques. Raman spectroscopy was used to examine structural disorder and defect density, while FTIR provided information about chemical bonding and interactions between the polymer matrix and carbon nanostructures. Photoluminescence (PL) helped to explore defect-related electronic states, and UV–Vis spectroscopy was used to analyze optical absorption behavior. In addition, X-ray photoelectron spectroscopy (XPS) was performed to investigate surface composition and oxidation states, and scanning electron microscopy (SEM) was used to study morphology and dispersion.

In parallel, TENG performance measurements were carried out, including tests under different humidity conditions to evaluate the environmental influence on electrical output. These measurements were important for understanding the stability and real-world applicability of the developed materials.

The collected data were analyzed to establish clear links between material properties and triboelectric performance, particularly focusing on charge trapping, surface functionalization, and interfacial effects.

[1] This report is submitted by the grantee to the Action MC for approval and for claiming payment of the awarded grant. The Grant Awarding Coordinator coordinates the evaluation of this report on behalf of the Action MC and instructs the Grant Holder Manager to verify the grant documents compliance and proceed with the payment.

The work was completed largely as planned, with slight extensions in some spectroscopic analyses (especially XPS and PL) to obtain more detailed insights. Overall, the STSM provided valuable hands-on experience, strengthened collaboration, and enabled meaningful knowledge exchange between Karabakh University and NIMP.

Description of the STSM main achievements and planned follow-up activities

Description and assessment of whether the STSM achieved its planned goals and expected outcomes, including specific contribution to Action objective and deliverables, or publications resulting from the STSM. Agreed plans for future follow-up collaborations shall also be described in this section.

The STSM successfully achieved its planned objectives, focusing on the spectroscopic and structural investigation of GO and rGO–polysiloxane nanocomposites and their application in triboelectric nanogenerators (TENGs). The experimental work provided valuable insights into the relationship between material composition and device performance.

A key achievement of this STSM was the systematic study of nanocomposites prepared with different concentrations of GO and rGO (0, 0.01, 0.03, 0.05, and 0.1). The results clearly indicated that an optimal concentration of 0.05 provided the best performance in TENG measurements for both GO- and rGO-based systems. This finding is important for the design and optimization of efficient energy harvesting devices.

Comprehensive material characterization was carried out using advanced techniques, including Raman, FTIR, PL, UV–Vis, XPS, and SEM, enabling a deeper understanding of structural, chemical, and electronic properties. In addition, TENG performance was evaluated under different humidity conditions, providing insight into environmental effects on device stability and output, which is particularly relevant for practical and space-related applications.

The STSM has already resulted in significant scientific outputs. The article titled "Performance Optimization of Polysiloxane/GO Nanocomposite-Based Triboelectric Nanogenerators with Varying GO Concentrations" has been published in Fullerenes, Nanotubes and Carbon Nanostructures (https://doi.org/10.1080/1536383X.2026.2663955). In addition, a second manuscript entitled "Flexible Triboelectric Nanogenerators Based on Polysiloxane/Graphene Oxide Nanocomposites for Sustainable Mechanical Energy Harvesting" has been submitted to the Journal of Materials Science: Materials in Electronics and is currently under revision. Furthermore, a new article focusing on rGO-based systems is in preparation.

The STSM also significantly strengthened the collaboration between Karabakh University and the National Institute of Materials Physics (NIMP). Future activities include joint publications, extended studies on nanocomposite-based energy systems under varying environmental conditions, and the preparation of collaborative proposals for European research programs such as COST and Horizon Europe.

Overall, the STSM successfully met its scientific goals, generated high-quality research outputs, and established a solid foundation for long-term international collaboration.