**Department**

Laboratory for driven bionic systems

Maksimkin Aleksey Valentinovich, PhD, Head of laboratory,

https://www.sechenov.ru/univers/about\_lecturer/290202/

**Scientific interests**: Development of new actuators based on polymer composites for medicine

**Research project:**

Development of ion-polymer/metallic actuators

**Topics and content of the research project:**

Development of ion-polymer/metallic actuators for medicine

Supervisor – Tarek Dayyoub, PhD, Senior Researcher,

<https://www.sechenov.ru/univers/about_lecturer/290519/>

Chemistry and Materials Science

Physical and Technical Sciences

Engineering and Technology

Working languages: Russian, English

**Aims and Objectives of the research project:**

Development of actuators based on ionic polymer-metal composites (IPMC), which are capable of generating complex movements that imitate the movements of biological muscles; they should have low weight and dimensions, high efficiency, and they are biocompatible and controlled by low DC voltage up to 10 V.

Methods used:

Development and implementation of the optimal structure of composite materials based on IPMC, development of methods for applying and studying electrodes (metal and carbon) on polymer membranes, experimental studies

**Position Description:**

* Development and implementation of the optimal structure of the composite material based on IPMC, using various materials of polymer membranes and electrodes
* Development of methods for applying and studying electrodes (metal and carbon) on polymer membranes
* Saturation of the polymer membrane with electrolyte using various solutions
* Studying the relationship between the electrode material used and the coating method, as well as the behavior of the actuator during its operation
* Measurement of the functional properties of actuators, measurement of deformations, activation time, the force generated by a single layer of the actuator, and efficiency depending on the electrolyte solution used, the type of polymer membrane, the type of electrode, and the method of its coating
* Preparation and submission for publication of 1 scientific article in journals indexed in the Web of Science or Scopus databases. Presentation of the work at 1 conference.

Salary, position, contract term: 0.5-1.0 of the rates; senior research fellow; 1 year.

Salary: 40-100 thousand rubles (based on interview results).

Requirement for a postdoc: PhD in Chemistry, Materials Science, Polymer Engineering or a related discipline; strong background in polymer composites, polymeric membranes, of ion-polymer/metal materials; experience in materials characterization, such as structure and physical investigation, mechanical tests, electrical and chemical investigation; excellent written and oral communication as well as data analysis skill; strong skills in collaboration and ability to work independently; good skills in supervising students.

Expected work results: articles (at least 1 per year), participation in scientific conferences, student supervision.



**Tarek Dayyoub**,

Ph.D., chemical engineer, senior Researcher

Scientific and pedagogical experience of 8 years.

Scientific interests: polymers, actuators.

<https://scholar.google.com/citations?view_op=list_works&hl=en&user=RmQ4MVkAAAAJ>

<https://www.scopus.com/authid/detail.uri?authorId=57204317394>

<https://www.researchgate.net/profile/Tarek-Dayyoub>

**Topics and content of research project and educational activities**

Actuators based on polymer composites

**Supervisor’s main publications**

1. Linear Actuators Based on Polyvinyl Alcohol/Lithium Chloride Hydrogels Activated by Low AC-Voltage. Dayyoub, T.; Zadorozhnyy, M.; Filippova, K.V.; Iudina, L.D.; Telyshev, D.V.; Zhemchugov, P.V.; Ladokhin, D.G.; Maksimkin, A. J. Compos. Sci. 2024, 8, 323. <https://doi.org/10.3390/jcs8080323>
2. Influences of Chemical Modifications on the Structural, Mechanical, Tribological and Adhesive Properties of Oriented UHMWPE Films. Dayyoub, T.; Kolesnikov, E.; Filippova, O.V.; Kaloshkin, S.D.; Telyshev, D.V.; Maksimkin, A.V. The. *J. Compos. Sci.* 2024, *8*, 36. <https://doi.org/10.3390/jcs8010036>
3. Porous Shish-Kebab Structure Prepared from Oriented UHMWPE Films by Processing in Supercritical CO2. Sergey A. Lermontov, Aleksey V. Maksimkin, Nataliya A. Sipyagina, Tarek Dayyoub et al. Chin J Polym Sci (2023). <https://doi.org/10.1007/s10118-023-3036-x>
4. Preparation of Linear Actuators Based on Polyvinyl Alcohol Hydrogels Activated by AC Voltage. Dayyoub, T.; Maksimkin, A.; Larionov, D.I.; Filippova, O.V.; Telyshev, D.V.; Gerasimenko, A.Y. *Polymers* 2023, *15*, 2739. <https://doi.org/10.3390/polym15122739>
5. Structural, Mechanical, and Tribological Properties of Oriented Ultra-High Molecular Weight Polyethylene/Graphene Nanoplates/Polyaniline Films. Dayyoub, T.; Maksimkin, A.; Olifirov, L.K.; Chukov, D.; Kolesnikov, E.; Kaloshkin, S.D.; Telyshev, D.V. Polymers 2023, 15, 758. <https://doi.org/10.3390/polym15030758>
6. Shape Memory Polymers as Smart Materials: A Review. Dayyoub, T.; Maksimkin, A.V.; Filippova, O.V.; Tcherdyntsev, V.V.; Telyshev, D.V. Polymers 2022, 14, 3511. <https://doi.org/10.3390/polym14173511>
7. Electroactive Polymer-Based Composites for Artificial Muscle-like Actuators: A Review. Maksimkin, A.V.; Dayyoub, T.; Telyshev, D.V.; Gerasimenko, A.Y. Nanomaterials 2022, 12, 2272. <https://doi.org/10.3390/nano12132272>
8. A New Approach Based on Glued Multi-Ultra High Molecular Weight Polyethylene Forms to Fabricate Bone Replacement Products. Dayyoub, T.\*; Maksimkin, A.; Senatov, F.; Kaloshkin, S.; Anisimova, N.; Kiselevskiy, M. Polymers 2020, 12, 2545. <https://doi.org/10.3390/polym12112545>
9. Ultra-high molecular weight polyethylene with hybrid porous structure. Sergey A. Lermontov, Aleksey V. Maksimkin, Nataliya A. Sipyagina, Alena N. Malkova, Evgeniy A. Kolesnikov, Mikhail YuZadorozhnyy, Elena A.Straumal, Tarek Dayyoub. Polymer 2020, Volume 202, 122744. <https://doi.org/10.1016/j.polymer.2020.122744>
10. The Structural and Mechanical Properties of the UHMWPE Films Mixed with the PE-Wax. Tarek Dayyoub, Leonid K. Olifirov, Dilyus I. Chukov, Sergey D. Kaloshkin, Evgeniy Kolesnikov, Saidkhodzha Nematulloev. Materials 2020,13, 3422; <https://doi.org/10.3390/ma13153422>
11. Ultra-High MolecularWeight Polyethylene/Titanium-Hybrid Implant for Bone-Defect Replacement. Aleksey V. Maksimkin, Fedor S. Senatov, Kirill Niaza, Tarek Dayyoub, Sergey D. Kaloshkin. Materials 2020, 13, 3010. <https://doi.org/10.3390/ma13133010>
12. Treating UHMWPE surface for enhancing the adhesion properties by cellulose grafting. Tarek Dayyoub, Aleksey V.Maksimkin, Fedor S.Senatov, Sergey D.Kaloshkin, AnnaZimina, Evgeniy A.Kolesnikov. International Journal of Adhesion & Adhesives 98 (2020) 102535. <https://doi.org/10.1016/j.ijadhadh.2019.102535>
13. Coiled artificial muscles based on UHMWPE with large muscle stroke. A.V. Maksimkin, I.I. Larin, D.I. Chukov, M.Yu. Zadorozhny, T. Dayyoub, V.Yu. Zadorozhnyya, F. Spieckermann, V. Soprunyuk. Materials Today Communications 21 (2019) 100688. <https://doi.org/10.1016/j.mtcomm.2019.100688>

**Patents**

Russian Federation Patent for Invention N. 2829066 dated 10.23.2024: Dayyoub T., Maksimkin A. V., Larionov D. I., Telyshev D. V. Electroactive actuator based on polyvinyl alcohol hydrogel activated by alternating current (Priority dated 10.19.2023). <https://new.fips.ru/publication-web/publications/document?type=doc&tab=IZPM&id=B1C71FE8-560E-43B4-BB66-223E0049DFBF>

**Experience of scientific supervision**

Supervisor of RSF project N. 22-73-00136 (2022-2024).

Supervisor of 3 undergraduate students.

**Teaching Experience**

Course list:

Engineering Materials, Composite Materials, Thermodynamics, Physical Chemistry, Polymers.