



# **BOOK OF ABSTRACTS**

**Samarkand, Uzbekistan  
2025**

**The Third International Conference «Microplastics in Polymer Science»:  
book of abstracts.**— Samarkand State University named after Sharof Rashidov,  
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The Book contains abstracts of plenary lectures of the conference, oral and poster presentations of sections.

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## CONFERENCE PROGRAMME

October 21, Tuesday

09:50–10:30	Opening Ceremony (Sergey Lyulin)			
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10:30–12:00	Morning Plenary Session 1			
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**Chairperson: Sergey Lyulin**

10:30–11:00	PL-01	Jose Kenny	Terni	UPDATE ON NEW STRATEGIES FOR DEALING WITH MICROPLASTICS AS A POTENTIAL THREAT TO HUMANS AND THE NATURAL ENVIRONMENT
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11:00–11:30	PL-02	Alexei Khokhlov	Moscow	THE PROBLEM OF MICROPLASTICS FROM THE VIEWPOINT OF PHYSICS AND CHEMISTRY
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11:30–12:00	PL-03	Valentin Kudyshkin	Tashkent	RATIONAL USE OF A BY-PRODUCT OF POLYETHYLENE PRODUCTION: MODIFICATION OF LOW MOLECULAR-WEIGHT POLYETHYLENE FOR THE DEVELOPMENT OF COMPATIBILIZERS IN BIODEGRADABLE POLYMER SYSTEMS
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12:00–14:00	Lunch			
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12:00–14:00	Poster Session 1			
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14:00–15:40	Oral Session 1			
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**Chairperson: Francesco Saliu**

14:00–14:20	O-01	Alessandro Becchi	Milan	EXPLORING THE ENVIRONMENTAL IMPACT OF TEXTILE POLYMER PHOTODEGRADATION THROUGH A MULTIANALYTICAL APPROACH
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14:20–14:40	O-02	Mikhail Glagolev	Veliky Novgorod	EFFICIENT CONSTRUCTION OF STABILITY DIAGRAMS OF AGED POLYMER NANOPARTICLES
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14:40–15:00	O-03	Pavel Komarov	Veliky Novgorod	THE FATE OF AGED POLYETHYLENE NANOPARTICLES: TWO-SCALE MODELING
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15:00–15:20	O-04	Evgeny Karpulevich	Moscow	INTELLIGENT ANALYSIS OF MICROPLASTIC SPECTRAL DATA
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15:20–	O-05	Elena	Moscow	FROM SURFACE TO SPRING: THE
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15:40		Filimonova		PATHWAY AND FATE OF MICROPLASTICS IN AQUIFERS
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15:40–16:10	Coffee Break			
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16:10–17:50	Oral Session 2			
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Chairperson: **Geeta Somaroo**

16:10–16:30	O-06	Ivan Zorin	Saint-Petersburg	MICROPLASTICS FROM COSMETICS AND MEDICAL DEVICES: ISOLATION AND ANALYSIS
16:30–16:50	O-07	Roman Gerasimov	Moscow	FRONTIER LAB SOLUTION FOR MICROPLASTICS PY-GCMS QUALITATIVE AND QUANTITATIVE ANALYSIS

16:50–17:10	O-08	Petr Fetin	Saint-Petersburg	HYDROGEL MICROPARTICLES FOR SORPTION OF MODEL POLLUTANTS
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17:10–17:30	O-09	Kristina Ordzhonikidze	Moscow	COMPARATIVE GENOTOXICITY OF POLYDISPERSE SUBMICRON PARTICLES OF TWO TYPES OF POLYMERS: PLASTIC VS ORGANIC POLYMER
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17:30–17:50	O-10	Qodirbek Berdinazarov	Tashkent	MULTICOMPONENT PA/PP/CLAY NANOCOMPOSITES
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### Poster Presentations of Day 1

P-01	5	Violetta Abdurakhmanova	Tashkent	SYNTHESIS AND PROPERTIES OF BIODEGRADABLE POLYMERIC MATERIALS BASED ON POLYVINYL ALCOHOL AND POLYSACCHARIDES
P-02	2	Davide Riseri	Milan	CHARACTERIZATION OF LUBRICANT WASTE FROM STEEL WIRING INDUSTRY AND ITS POTENTIAL INCLUSION IN A POLYMERIC MATRIX, WITHIN A CIRCULAR ECONOMY APPROACH
P-03	5	Sherzod Yuldoshov	Tashkent	DRINKING WATER PURIFICATION FROM MICROPLASTICS
P-04	1	Ilmar Nurgaliev	Tashkent	COMPUTATIONAL INSIGHTS INTO PROTEIN–MICROPLASTIC INTERACTIONS USING MOLECULAR DOCKING AND SHORT MD SIMULATIONS
P-05	4	Liubov Abramova	Moscow	METABOLOMICS FOR ASSESSING THE CONDITION OF WHITEFISH FRY UNDER THE INFLUENCE OF MICROPLASTICS

P-06	1	Anastasiia Badikova	Moscow	CELLULOSE PARTICLES AS A MODEL FOR BIODEGRADABLE MICROPLASTICS: COMPLEXES WITH POLYCATIONS AND THEIR CYTOTOXICITY
P-07	3	Ivan Kushnov	Veliky Novgorod	INFLUENCE OF MICROPLASTIC ADDITION ON SOIL HYDROPHYSICAL PROPERTIES
P-08	2	Irina Medvedeva	Yekaterinburg	MAGNETIC EXTRACTION OF POLYETHYLENE TEREPHTHALATE MICROPARTICLES FROM WATER BY USING COMPOSITE MAGNETITE NANOPARTICLES WITH SILICON DIOXIDE, CHITOSAN AND GELATINE COATINGS
P-09	1	Anastasiia Mikhel	Veliky Novgorod	EVALUATION OF POLYSTYRENE MICROPARTICLES EFFECTS ON RABBITS (ORYCTOLAGUS CUNICULUS): A PILOT STUDY
P-10	2	Alexandra Nikolaeva	Saint-Petersburg	AGING OF MODEL POLYSTYRENE MICROPLASTICS UNDER UV LIGHT
P-11	3	Timur Nizamutdinov	Veliky Novgorod	THE EFFECT OF DIFFERENT DOSES OF MICROPLASTICS ON THE RESULTS OF STANDARD AGROCHEMICAL METHODS FOR MONITORING SOIL QUALITY
P-12	4	Aleksandra Osechkova	Novosibirsk	SAMPLE PREPARATION OF RAT HEART SAMPLES TO DETECT MICROPLASTICS
P-13	2	Natalia Shevchenko	Veliky Novgorod	ANALYSIS OF THE SORPTION CAPACITY OF MODEL MICROPLASTIC PARTICLES WITH NATURAL MICROPARTICLES
P-14	2	Elizaveta Shtro	Veliky Novgorod	STUDY ON THE ADSORPTION OF METAL IONS ONTO MODEL POLYSTYRENE PARTICLES
P-15	2	Kirill Yuzhanin	Moscow	NANOMETER-SIZED PARTICLES OF HYDROGEL AS MODEL MICROPLASTICS: INTERACTION WITH POLYCATION IN SOLUTION AND PRECIPITATE
P-16	2	Igor Zhdanov	Moscow	MICROPLASTIC FATE IN ARCTIC COASTAL WATERS: ACCUMULATION HOTSPOTS AND ROLE OF RIVERS IN SVALBARD

## October 22, Wednesday

10:30–12:30	Morning Plenary Session 2
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Chairperson: **Alexei Khokhlov**

10:30–11:00	PL-04	Tatiana Kuznetsova	Moscow	DEVELOPMENT OF AN INTERNATIONAL PLASTIC TREATY: KEY MESSAGES
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11:00–11:30	PL-05	Alfonso Maffezzoli	Lecce	DEVELOPMENT OF MODEL MICRO AND NANOPLASTICS AND THEIR INTERACTIONS WITH LIVING ORGANISMS
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11:30–12:00	PL-06	Geeta Somaroo	Mauritius	MICROPLASTICS AND THE ISLAND WATCH PROGRAM
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12:00–14:00	Lunch
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12:00–14:00	Poster Session 2
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14:00–15:40	Oral Session 3
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Chairperson: **Petr Fetin**

14:00–14:20	O-11	Yulia Frank	Tomsk	QUANTITATIVE ASSESSMENT OF THE NUMBER AND MASS OF POLYETHYLENE TEREPHTHALATE MICROFIBERS RELEASED INTO THE SEWAGE DURING THE WASHING OF POLYESTER SPORTSWEAR
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14:20–14:40	O-12	Victor Nazarychev	Veliky Novgorod	ALL-ATOM MOLECULAR DYNAMICS SIMULATION OF ANTIBIOTIC ADSORPTION ON MICROPLASTICS SURFACES
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14:40–15:00	O-13	Maria Krivosheina	Novosibirsk	SPECIFICITY OF ENVIRONMENTAL SAMPLES PRETREATMENT FOR THE ANALYSIS OF MICROPLASTIC CONTAMINATION
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15:00–15:20	O-14	Vladimir Toshchevnikov	Veliky Novgorod	MODELLING OF MICROPLASTICS PARTICLES FORMATION AND ADSORPTION OF MACROMOLECULAR POLLUTANTS
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15:20–16:10	Coffee Break
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16:10–18:10	Oral Session 4
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Chairperson: **Xiaomin Zhu**

16:10– 16:30	O-15	Anastasiia Vladimiro va	Mosco w	PERFORMANCE PARAMETERS OF FLUORESCENT MICROSCOPIC QUANTIFICATION OF MICROPLASTICS IN NATURAL WATERS
16:30– 16:50	O-16	Igor Zhdanov	Veliky Novgor od	MICROPLASTIC PARTICLES IN THE ARCTIC MARINE ENVIRONMENT: MICROSCAN DATABASE OF IR SPECTRA AND ITS VERIFICATION BY MACHINE LEARNING METHODS
16:50– 17:10	O-17	Svetlana Klushina	Mosco w	THE SIGNIFICANCE OF SOIL IN THE FATE OF MICROPLASTICS
17:10– 17:30	O-18	Maria Pogojeva	Mosco w	FIELD STUDIES OF PLASTIC FRAGMENTS FROM DIFFERENT GEOGRAPHICAL REGIONS
17:30– 17:50	O-19	Tatyana Rauen	Sevasto pol	STRATEGIES OF MICROPLASTIC CONSUMPTION BY ORGANISMS WITH DIFFERENT TROPHIC SPECIALIZATIONS (OXYRRHIS MARINA AND ARCTODIAPTOMUS SALINUS) AND ITS IMPACT ON THEIR FUNCTIONAL CHARACTERISTICS
17:50– 18:10	O-20	Evgeniy Kiselev	Krasno yarsk	POLYHYDROXYALKANOATES (BIOPOLYMERS) WERE SYNTHESIZED FROM FATTY WASTE FROM FISH PROCESSING

### Poster Presentations of Day 2

P-17	<b>3</b>	Laura Ismukhanova	Almaty	ASSESSMENT OF MICROPLASTIC POLLUTION IN THE AQUATIC ECOSYSTEM OF THE HIGH-ALTITUDE LAKE MARKAKOL (EAST KAZAKHSTAN)
P-18	<b>3</b>	Dmitry Kalinov	Minsk	INVESTIGATION OF MICROPLASTIC CONTENT IN THE NEMAN RIVER AND PATHWAYS OF ITS ENTRY INTO THE RIVER SYSTEM (CASE STUDY OF THE MIDDLE REACH)
P-19	<b>1</b>	Alexey Dobrovskiy	Veliky Novgorod	MOLECULAR DYNAMICS SIMULATIONS OF BISPHENOL A RELEASE FROM POLYVINYL CHLORIDE MICROPLASTICS

P-20	<b>1</b>	Anna Ivanova	Veliky Novgorod	THEORETICAL STUDY OF HOMOPOLYMER ADSORPTION ONTO MODEL MICROPLASTIC PARTICLES
P-21	<b>2</b>	Olga Kuznetsova	Moscow	SECTOR-FIELD INDUCTIVELY COUPLED PLASMA MASS SPECTROMETRY (SF-ICP- MS) METHOD FOR ANALYZING OF THE TOXIC METALS IN MICROPLASTICS FROM SEAWATER AND BEACH SEDIMENTS FROM THE CASPIAN SEA
P-22	<b>4</b>	Anton Lyakh	Sevastopol	IMPACT OF MICROPLASTICS ON DINOFLAGELLATE MOTILITY
P-23	<b>3</b>	Daria Repnikova	Moscow	MICROPLASTICS IN CRIMEAN GROUNDWATER: OCCURRENCE, IDENTIFICATION, AND TRANSPORT PATHWAYS
P-24	<b>5</b>	Elnara Zhiganshina	Nizhny Novgorod	SYNTHESIS OF HYBRID COPOLYMERS OF LACTIDE AND METHYL METHACRYLATE BY RADICAL PHOTOPOLYMERIZATION
P-25	<b>5</b>	Sergey Chesnokov	Nizhny Novgorod	LACTIDE POLYMERIZATION ON GROUP II METAL ALKOXIDES
P-26	<b>5</b>	Yuliya Kuznetsova	Nizhny Novgorod	NEW APPROACH TO BIODERADABLE BLOCK PLA-PMMA COPOLYMERS
P-27	<b>1</b>	Vladislav Forer	Veliky Novgorod	THE CRITICAL ROLE OF PARTICLE SIZE IN MICROPLASTIC-POLLUTANT STABILITY: INSIGHTS FROM ATOMISTIC SIMULATIONS

**October 23, Thursday**

10:40–12:30	Morning Plenary Session 3
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Chairperson: **Sergey Lyulin**

10:40–11:00	PL-07	Kirill Medvedev Khuraman Geydarova	Moscow	MICROPLASTICS: KEY CHALLENGES FOR THE INDUSTRY AND MITIGATION STRATEGIES IN PRODUCTION
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11:00–11:30	PL-08	Francesco Saliu	Milan	TACKLING PLASTIC MICROFIBER EMISSIONS IN TEXTILES – FROM SCIENTIFIC UNDERSTANDING TO INDUSTRIAL INNOVATION
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11:30–12:00	PL-09	Xiaomin Zhu	Hangzhou	MICROPLASTICS IN THE TEXTILE INDUSTRY: SOURCES, IMPACTS, AND SUSTAINABLE SOLUTIONS
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12:00–12:30	PL-10	Todd Gouin	Sharnbrook	MICROPLASTIC PARTICLES AS VECTORS OF TRANSPORT FOR HYDROPHOBIC ORGANIC CHEMICALS
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12:30–14:00	Lunch
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14:00–17:40	Oral Session 5
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Chairperson: **Ivan Zorin**

14:00–14:20	O-21	Igor Volgin	Veliky Novgorod	STRUCTURAL STABILITY OF NANOSIZED POLYETHYLENE PARTICLES IN AQUEOUS ENVIRONMENT: ALL-ATOM COMPUTER SIMULATIONS
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14:20–14:40	O-22	Anastasiia Vladimirova	Moscow	PERFORMANCE PARAMETERS OF FLUORESCENT MICROSCOPIC QUANTIFICATION OF MICROPLASTICS IN CHICKEN EGGS
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14:40–15:00	O-23	Vyacheslav Molchanov	Moscow	3D-PRINTABLE ALGINATE NANOCOMPOSITE GELS
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15:00–15:20	O-24	Alexey Sazonov	Moscow	ASSESSMENT OF MICROPLASTIC CONTENT IN RIVERS IN THE EUROPEAN PART OF RUSSIA: RESULTS OF EXPEDITION STUDIES
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15:20–15:40	O-25	Anastasia Vainberg	Veliky Novgorod	MICROPLASTIC CONTAMINATION IN NORTHERN FUR SEALS (CALLORHINUS URSINUS): DETECTION AND QUANTIFICATION
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15:40–16:10	Coffee Break			
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16:10–17:50	Oral Session 6			
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Chairperson: **Elena Filimonova**

16:10–16:30	O-26	Yuriy Yurasov	Rostov-on-Don	DISTRIBUTION OF MICROPLASTICS IN BOTTOM SEDIMENTS OF THE COAST OF THE SPIT CURVE OF THE SEA OF AZOV
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16:30–16:50	O-27	Vladislav Forer	Veliky Novgorod	MOLECULAR MECHANISMS OF PESTICIDE ADSORPTION ON MICROPLASTICS: RESULTS OF MICROSECOND SIMULATION
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16:50–17:10	O-28	Anna Shitikova	Ryazan	STUDYING MICROPLASTIC TOXICITY USING IN VITRO MODELS: FROM PBMC VIABILITY TO LYSOSOMAL DYSFUNCTION
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17:10–17:30	O-29	Michael Tolstunov	Rostov-on-Don	STUDY OF THE FRASS OF ULOMOIDES DERMESTOIDES (COLEOPTERA, TENEBRIONIDAE) LARVAE DURING BIOCONVERSION OF POLYSTYRENE-BASED PLASTIC
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17:30–17:50	O-30	Badma Mankaev	Moscow	SYNTHESIS AND PROPERTIES OF BIODEGRADABLE POLYMERS BASED ON L-LACTIDE, ε-CAPROLACTONE AND ALIPHATIC POLYCARBONATES
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17:50–18:20	Keynote speaker			
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17:50–18:20	O-31	Yusuke Saraya	Osaka	TACTICS OF BUSINESS FOR MICROPLASTICS SOLUTIONS
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19:00	Conference Dinner			
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### October 24, Friday

10:00–12:00	Round Table: New Approaches in Microplastics Research – From AI to Industrial Solutions			
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**Moderators – Prof. S.S. Karlov, Prof. A.I Avetisyan**

12:00–14:00	Closing Ceremony			
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## **PLENARY LECTURES**

### **PL-01 UPDATE ON NEW STRATEGIES FOR DEALING WITH MICROPLASTICS AS A POTENTIAL THREAT TO HUMANS AND THE NATURAL ENVIRONMENT**

Kenny J.M.<sup>1,2</sup>, Lyulin S.V.<sup>2,3</sup>

*1 - European Center for Nanostructured Polymers, Terni, Italy*

*2 - Yaroslav the Wise Novgorod State University, Veliky Novgorod, Russia*

*3 - Saint Petersburg State University, Saint Petersburg, Russia*

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This presentation is mainly focused on the results of the Megagrant project awarded in 2024 with the main goal to develop and integrate new scientific approaches to address the problem of microplastics. Within the framework of the project, which was one of the main results of our first Microplastics Conference in 2023, we have developed the first microplastics interdisciplinary laboratory in the Russian Federation, coordinated by the Novgorod State University, integrating research scientists from different scientific fields (chemistry, physics, biology, mathematics, medicine) to develop new approaches addressing the global problem of microplastics. In this regard, this presentation will present the last results regarding the following objectives:

1. Assess the effects of the most hazardous size microplastics (50 micrometers and smaller) on human health and the environment, in three major environments – water, soil, and living organisms – using a wide range of theoretical and experimental methods ranging from in silico to in vivo.
2. Analysis of the adsorption and transport of various health hazardous pollutants (pesticides, antibiotics, polycyclic aromatic hydrocarbons, heavy metal ions, etc.) on microplastic particles.
3. Development of approaches for detection and characterization of microplastics smaller than 50 micrometers. Development of regulations for detection and characterization of microplastics in different environments.
4. Study of the processes of “aging” of microplastic particles in nature and in artificial laboratory conditions, as well as assimilation of microplastic at the final stage of destruction (polymer particles of nanometer sizes).
5. Development of the technology for obtaining biodegradable polymers as an alternative to some industrial large-tonnage polymers.

This presentation intends to provide an overview of the results obtained in the first two years of the project leaving specific details to the presentation of the several research groups that integrate the Megagrant project.

## ORAL PRESENTATIONS

### **O-01 EXPLORING THE ENVIRONMENTAL IMPACT OF TEXTILE POLYMER PHOTODEGRADATION THROUGH A MULTIANALYTICAL APPROACH**

Becchi A.<sup>1</sup>, Gatti T.<sup>1</sup>, Cavestro S.<sup>2</sup>, Lasagni M.<sup>1</sup>, Saliu F.<sup>1</sup>

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Recent studies have demonstrated that microplastics (MPs) exert adverse physiological and ecological effects on aquatic organisms. Similarly, synthetic microfibers (MFs) have attracted growing scientific attention regarding their environmental distribution, degradation pathways, and biological impacts. [1][2]

This study investigated the release of polymer degradation products following UV-induced photoaging. To isolate polymer-specific effects, only additive-free materials were used. A selection of natural and synthetic fibers was tested before and after photoaging. Fourier-transform infrared spectroscopy (FTIR) and scanning electron microscopy (SEM) analyses revealed surface oxidation and structural defects in photoaged polymers, which were absent in pristine samples. [3] These findings confirmed the physicochemical changes induced by photoaging. However, not all materials exhibited detectable surface modifications.

To comprehensively assess the molecules released into the environment, we employed two complementary extraction techniques, solid-phase microextraction (SPME) and liquid-liquid extraction (LLE), combined with gas chromatography-mass spectrometry (GC-MS) for leachate analyses. Both techniques were applied in untargeted mode to maximize the number of detected compounds. This approach generated a large dataset, subsequently processed with advanced machine learning tools that enhanced spectral annotation, ensuring higher accuracy and reducing the rate of mismatches.

As expected, for most compounds aged materials showed a release higher than pristine ones (at 95% confidence level), in particular for specific molecular classes such as ketones, carboxylic acids, and aldehydes.

These findings underscore the environmental relevance of microfiber aging, suggesting that photo-induced degradation products may contribute to the overall toxicity of fibrous pollutants in aquatic ecosystems.

#### **References**

[1] <https://doi.org/10.1016/j.chemosphere.2020.127199> - R. P. Singh et. Al. Chemosphere, **Volume 257**, (2020).

[2] <https://doi.org/10.1016/j.scitotenv.2025.179239> - V. Isa et. Al. Science of The Total Environment, **Volume 975**, (2025).

[3] <https://doi.org/10.1016/j.scitotenv.2020.143170> - L. Sørensen, A. S. Groven. Science of The Total Environment, **Volume 755, Part 2**, (2021).

## O-02 EFFICIENT CONSTRUCTION OF STABILITY DIAGRAMS OF AGED POLYMER NANOPARTICLES

Glagolev M.K., Komarov P.V.

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Computer simulations are a powerful tool for studying the degradation of microplastics in the environment. In our report, we present an efficient method for creating stability diagrams of polymer nanoparticles that considers factors such as the degree of chain scission, monomer unit composition, and cross-linking extent. We simulate the degradation of nanoparticles under the influence of ultraviolet light, oxygen, and temperature by varying these parameters. We created stability diagrams using coarse-grained models of aged nanoparticles based on Langevin and dissipative particle dynamics and cross-checked our results using all-atom molecular dynamics (MD) simulations. Our approach allows us to predict the stability of polymer nanoparticles across spatial and temporal scales that are beyond the reach of all-atom MD.

Although coarse-grained simulation techniques offer high performance, scanning the 3D parameter space step by step still requires significant computational resources. To save time, we applied deep learning methods to determine the boundaries between different final states of modeled systems with fewer attempts. This is achieved iteratively by using already obtained simulation results to rank the points in the parameter space according to the assumed probabilities of different simulation outcomes and conducting the following simulations in the areas of the parameter space area where the result is least certain. The proposed method can be scaled to run in parallel and serves as an automated alternative to the expert selection of parameters in different simulation frameworks.

*This study was supported by the Ministry of Science and Higher Education of the Russian Federation (state contract no. 075-15-2025-016, MegaGrant). The calculations were carried out using the equipment of the shared research facilities of HPC computing resources at Lomonosov Moscow State University” [1].*

### References

[1] Vl. Voevodin, A. Antonov, D. Nikitenko, P. Shvets, S. Sobolev, I. Sidorov, K. Stefanov, Vad. Voevodin, S. Zhumatiy. Supercomputing Frontiers and Innovations, **6**, 4-11 (2019).

## O-03 THE FATE OF AGED POLYETHYLENE NANOPARTICLES: TWO-SCALE MODELING

Glagolev M.K., Malyshev M.D., Volgin I.V., Komarov P.V.

*Yaroslav-the-Wise Novgorod State University, Veliky Novgorod, Russia*  
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The widespread use of polymer-based materials has created a significant environmental pollution problem in the form of microplastic particles resulting from the degradation or aging of polymer waste. Factors such as mechanical influences, temperature fluctuations, ultraviolet radiation, oxidation, and hydrolysis gradually break down polymers into pieces of varying sizes. As these particles become smaller, their total surface area in contact with the environment increases. Exposure to ultraviolet radiation and oxidation reactions also alters the chemical composition and structure of microplastic particles, particularly on their surfaces. These changes directly affect the particles' ability to absorb and transfer low-molecular-weight pollutants present in the environment. Therefore, it is important to understand the results of polymer particle degradation in order to predict their impact on the environment and human health.

The report discusses the results of our research, which we obtained using three complementary models based on all-atom molecular dynamics (MD) and two mesoscopic methods: Langevin dynamics (LD) and dissipative particle dynamics (DPD). We used these models to examine the stability of aged polyethylene nanoparticles. We used the MD model as a reference to fine-tune interactions in our mesoscale simulations. The LD- and DPD-based models allowed us to systematically study the stability of polyethylene nanoparticles across a broad spectrum of parameters. According to our model predictions, the stability of aged polyethylene nanoparticles decreases due to the gradual accumulation of polymer chain breaks (reduction in polymer molecular weight) and enrichment with oxygen-containing groups. Meanwhile, the accumulation of polymer chain crosslinking plays a stabilizing role. Because generalized polymer chain models are used in mesoscale simulations, in which monomeric units represent entire chemical groups, our results can be extrapolated to the degradation processes of other thermoplastics with some limitations. In particular, we can apply the results to polypropylene because its aging process is similar to that of polyethylene.

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## O-04 INTELLIGENT ANALYSIS OF MICROPLASTIC SPECTRAL DATA

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The growing problem of microplastic pollution calls for reliable methods to detect and classify polymer types in environmental samples. Recent work has shown that deep learning models applied to Fourier-transform infrared (FTIR) spectra can achieve promising results in identifying plastics. In this study, we evaluate the performance of deep neural networks for microplastic classification using both an open dataset and our proprietary collection obtained within the Megagrant project. We employed DenseNet121\_1D as the backbone model and systematically investigated preprocessing strategies, including baseline correction and spectral blending for data augmentation. Comparative analysis of iModPoly and arPLS baseline correction methods demonstrated that arPLS provides more robust and artifact-free preprocessing, improving classification performance. To interpret model predictions, we applied explainable AI techniques such as Grad-CAM, which highlighted relevant absorbance bands characteristic of polyethylene, polypropylene, and polystyrene. Furthermore, we tested a novel training approach based on spectral mixing, which yielded improved classification accuracy compared to the original pipeline. Our results confirm that deep learning can serve as a powerful tool for microplastic identification, provided that preprocessing and data augmentation are carefully optimized.

## O-06 MICROPLASTICS FROM COSMETICS AND MEDICAL DEVICES: ISOLATION AND ANALYSIS

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Currently, two types of microplastics are distinguished by origin: primary, i.e. specially obtained particles of synthetic polymers that are added to various industrial products, and secondary, i.e. particles formed as a result of the destruction of plastic items. In the case of secondary microplastics, the result of the gradual destruction of polymer waste and the result of abrasive wear of plastic products that remain in active use should be considered separately. This is especially important in relation to products that come into contact with foods, drinking water and medical products. There are a lot of publications on the detection of microplastics in bottled water[1,2] and various tissues of the human body. The topic of the origin and ways of penetration of these particles is less widely covered.

One of the possible ways of penetration of micro/nanoparticles of synthetic polymers into the tissues of the human body is direct introduction as a result of medical manipulations, such as injections with a polypropylene syringe or blood transfusion, when blood is stored in polymer containers. In this work, we attempted to evaluate the formation of microplastics as a result of abrasive damage to disposable polypropylene injection syringes. According to our estimates, the number of microparticles generated during a single injection is relatively small, but not equal to zero.

Another class of products that are known to contain microplastics and are in direct contact with the human body is cosmetics. Skin care products – scrubs, peels – often contain microparticles of polyethylene or cellulose as a soft abrasive in an amount of several percent. The champion in microplastic content is decorative cosmetics – glitters, sparkles based on PET, in which the content of microparticles reaches 30-35%. It is unlikely that microparticles of polymers from cosmetics will enter the body through the skin, but cosmetics are always washed off and after that all microplastics will go to the sewer, and then to the environment. Therefore, cosmetics containing microplastics, on the one hand, should be the focus of attention of regulatory authorities, and, on the other hand, these are a potentially convenient object of research of the transfer and circulation of microplastics in natural and anthropogenic systems. In this report, we show an example of the detection of microplastics in cosmetics and outline some problems with the attribution of polymers contained in these microparticles [3].

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## O-08 HYDROGEL MICROPARTICLES FOR SORPTION OF MODEL POLLUTANTS

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The problem of microplastics and recycling of polymer waste has been worrying humanity for the last few decades. There is a lot of noise about it in the media. Often, experts who are far from polymer chemistry express their expert opinions on this issue. However, how scary is microplastic as it is portrayed on the covers of magazines and newspapers? Recently, ideas have been expressed that microplastic particles can potentially absorb persistent organic pollutants on their surface and act as a kind of mediator in their transport in the environment. This statement is controversial and not enough proven by experiments. We investigated the sorption capacity of specially synthesized particles based on modified hydrogels to various cationic and anionic dyes under model conditions in this study. Hydrogels formed from acrylamide networks modified with ionic monomers are found in everyday human life. These are various diapers and nappies, feminine hygiene pads. It is disposable hygiene products that, after use, enter the environment and are a source of microplastics. In this study, we intentionally created model acrylamide particles a priori capable of sorbing pollutants from the environment. For this purpose, surface-active monomers containing cationic groups were introduced into the structure of the acrylamide network. Such a powerful micro-sized sorbent interacted with a solution of model dyes: anionic (congo red), cationic (methylene blue) and potentially non-ionic (antibiotic rifampicin) nature. The key points of sorption of these dyes on hydrogel particles are discussed in the report. An interesting fact turned out to be that the presence of the same charge on the gel and dye is not a negative factor, the sorption capacity of such a hydrogel reaches high values. Thus, we can state that model microplastic particles are capable of absorbing pollutants of any ionic nature, but the question of how harmful this is for the environment remains open.

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## **O-09 COMPARATIVE GENOTOXICITY OF POLYDISPERSE SUBMICRON PARTICLES OF TWO TYPES OF POLYMERS: PLASTIC VS ORGANIC POLYMER**

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The genotoxicity of polydisperse submicron particles of two types of polymers was investigated using chromosome aberration analysis and Comet Assay. The object of study was fish *Nothobranchius rachovii*, a convenient model for laboratory studies of genotoxicity. The polymers studied were nylon-66 (polyhexamethylene adipamide), used, in particular, for the manufacture of tea pyramids, and alpha-keratin, which forms the basis of mammalian hair. The concentrations of the polymers studied were 10 and 100 mg/l. Submicron particles were obtained by cryogenic grinding followed by filtration and centrifugation with final sizes of the submicron polymer particles ranged from 96 to 200 nm. The fish were kept in all-glass aquariums with weak aeration at a temperature of 26°C for 96 hours. The light regime was 14/10 day/night. They were fed daily with *Artemia nauplii*. Chromosome preparations from fish anterior kidneys were obtained using a standard method and analysed under a light microscope. The frequency of aberrant cells at a concentration of 10 mg/L was 6.4±2.9 for nylon-66 and 5.4±1.8 for keratin. At a polymer concentration of 100 mg/L, the frequency was 5.8±1.8 for nylon-66 and 9.0±3.4 for keratin. In the control group, the frequency of aberrant cells was 2.2±1.2. The main types of chromosome aberrations were fragments and chromatid breaks. In all cases, the differences were significantly different from the control. When studying the genotoxic effect using Comet Assay in liver cells, no significant differences from the control values (1,8±0,2% tail DNA) were found. Thus, polydisperse submicron particles of different types of polymers showed similar effects when exposed to fish. The chronic effects of these polymers will be studied in future works, as well as analysis of meiotic abnormalities, to assess risks to reproduction, will also be added to the set of genotoxicity tests.

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## O-10 MULTICOMPONENT PA/PP/CLAY NANOCOMPOSITES

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The increasing accumulation of microplastics in the environment has raised global concern, highlighting the urgent need for sustainable strategies in polymer design, recycling, and waste reduction. One promising approach is the development of high-performance polymer blends that extend product lifetimes and enhance recyclability, thereby reducing secondary microplastics formation.

In this study, polypropylene (PP) and polyamide-6 (PA) blends with weight ratios of 20:80, 50:50, and 80:20 were prepared by melt mixing, with and without clay nanofillers and compatibilizer. Multi-component systems were produced by combining PP and PA nanocomposites in different configurations. Rheological and morphological analyses revealed that clay improved interfacial adhesion, while XRD and DSC confirmed its nucleating effect on crystallization. Mechanical testing showed that the PP/PA (80:20) blend with clay exhibited the most favorable balance of strength and toughness.

By improving compatibility and durability through nanofiller-assisted strategies, this work contributes to the design of more reliable and recyclable polymer blends. Such approaches can reduce the generation of microplastics from polymer degradation and support industrial efforts toward sustainable materials engineering.

# O-11 QUANTITATIVE ASSESSMENT OF THE NUMBER AND MASS OF POLYETHYLENE TEREPHTHALATE MICROFIBERS RELEASED INTO THE SEWAGE DURING THE WASHING OF POLYESTER SPORTSWEAR

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Microfibers of synthetic textiles, referred to as microplastics (MPs), are released into wastewater during the washing of clothing and other textiles based on fibers of polyethylene terephthalate (PET), polyamide, polyacrylonitrile [1–3]. These particles then enter surface water bodies with discharges from municipal treatment facilities that are not designed to completely remove MPs [4]. Textile washing is currently recognized as the leading source of ocean pollution with primary MP, of which PET fibers are the most common [1, 5]. Several published studies on the quantitative assessment of fiber release during washing (e.g., [3], [6]) use a variety of methodologies and different units of measurement of fiber release, leading to poor data comparability.

This study aims to quantify the release of PET microfibers during the washing of polyester products while simultaneously developing a methodology that would ensure the reliability and versatility of the data. A quantitative accounting protocol was developed for this purpose, and the number and mass of PET microfibers released during the washing of 100% polyester textiles (sports fleece sweatshirts) were determined. Washing with washing powder (in 10 consecutive cycles) and without detergents were tested, and the particles were concentrated on glass fiber filters with 1  $\mu\text{m}$  pores. To ensure the applicability of the data for modeling MP flows into the environment, the assessment was performed in nominal terms and in mass units.

Significantly more ( $p < 0.05$ ) PET fibers are released in the washing cycle of a new sweatshirt with washing powder than when washing without the use of detergents, both by mass ( $5.43 \pm 0.58$  versus  $2.82 \pm 0.42$  g/kg) and in numerical terms ( $15.3 \pm 1.12$  versus  $8.98 \pm 2.18$  million items/kg). The average weighted content of PET microfibers in wastewater during the first wash with powder reaches  $17.9 \pm 2.67$  mg/L or  $50.4 \pm 2.24$  thousand items/L. Repeated washing of fleece sweatshirts decreases the mass and number of PET microfibers in the wastewater. After the 6<sup>th</sup> washing cycle, the number of released fibers stabilized and remained at 227–267 thousand items/kg without significant differences. Stabilization of the particle mass occurs after the 3<sup>rd</sup> cycle at an average level of 205 mg/kg. Average length of released fibers increased in successive washing cycles with a maximum of  $1519 \pm 1285$   $\mu\text{m}$  after the 8<sup>th</sup> cycle.

The obtained results can be used to assess hydrosphere pollution quantitatively. Numerical data and the developed protocol for quantitative assessment are important for monitoring pollution and developing technologies to minimize environmental pollution by plastic microfibers.

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## O-12 ALL-ATOM MOLECULAR DYNAMICS SIMULATION OF ANTIBIOTIC ADSORPTION ON MICROPLASTICS SURFACES

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Antibiotic adsorption on microplastic (MP) surfaces is associated with environmental and health problems. The presence of microplastics in oceans and rivers poses a risk due to pollutant transport, including antibiotics (AB). These interactions between MPs and Abs can affect antibiotic toxicity. The adsorption of Abs onto MPs can lead to the development and spread of antibiotic-resistant bacteria. The consumption of water and food contaminated with MPs can adversely affect the health of humans and animals. Therefore, studying the adsorption of Abs on MPs is important for understanding and reducing their environmental and health impacts. Molecular simulations play a key role in unraveling the molecular mechanisms underlying adsorption interactions.

All-atom molecular dynamics (MD) simulations were performed to investigate the interactions between the seven MPs polymers and five Abs molecules in an aqueous environment. Seven MPs based on polar (polyethylene terephthalate (PET), nylon 6 (NYL6), and polylactic acid (PLA)) and non-polar (polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), and atactic polystyrene (aPS)) polymers, and five antibiotic molecules (amoxicillin (AMO), ciprofloxacin (CIF), doxorubicin (DOX), sulfadiazine (SUL), and tetracycline (TET)) were chosen for the computer simulations. This study explored the interactions between Abs molecules and different surface forms of MPs (polymer layer or polymer particles) in an aqueous environment at room temperature (298 K). The adsorption of Abs onto the surface of MPs is determined by the strength of electrostatic and van der Waals interactions. For the MPs surfaces, the interaction energy is strongly dependent on the type of MPs (polar or non-polar) and the chemical structure of the Abs. The Abs molecules interact more strongly with the polar MPs surfaces and show increased energy interactions. The adsorption of Abs molecules onto the surfaces of MPs, regardless of their surface form, did not result in a significant difference in interaction energy.

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## O-13 SPECIFICITY OF ENVIRONMENTAL SAMPLES PRETREATMENT FOR THE ANALYSIS OF MICROPLASTIC CONTAMINATION

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Microplastic (MP) – plastic particles less than 5 mm in size – are found everywhere both in the environment and in living organisms. According to research, the intake of MP by the body can lead to serious negative health consequences, therefore, it is essential to determine and monitor its content in the environment. The analysis of environmental samples for MP contamination includes sampling, drying and sieving, separation of MP from the inorganic matrix and natural organic material (NOM), filtration, identification and quantification of MP particles. Advanced instrumental methods such as scanning electron microscopy, IR and Raman spectroscopy, and chromatography are very sensitive and, consequently, demanding the volume and composition of the analyzed sample. Therefore, sample preparation is the most responsible, and at the same time the most laborious and time-consuming step in the process of MP investigation, which directly affects the quality of the analysis results obtained.

Usually, environmental samples are complex objects consisting of many phases and components, so, depending on the type of matrix, purpose and capabilities of researchers, various methods of sampling, MP isolation and instrumental analysis are currently used. In this regard, the comparison and generalization of literature data on the topic of MP is difficult and the overall level of pollution is still unclear. The development of a universal and effective method for determining MP is necessary to obtain accurate results, understand the overall level of contamination, and identify ways for MP to enter the environment and its control.

This paper presents the results of a comparative analysis of various methods of sample preparation of environmental objects (water, sediments, agricultural soils) and methods for determining MP. Based on the information received, a unique approach to MP isolation has been developed. The features of this approach are 1) effective two-stage oxidation of NOM using peracetic acid and Fenton reaction; 2) the use of a non-toxic heavy liquid with a density of 1.7 g/cm<sup>3</sup> to separate an inorganic matrix and specially designed glassware that minimizes MP losses during pretreatment. The efficiency of this method of sample preparation has been proven using test samples. The approach we developed with minor modifications allowed us to isolate MP from samples of natural water taken on Lake Baikal, and samples of sediments of various morphologies taken on Lake Baikal and in the Barents and Azov Seas, and agricultural soils of the Novosibirsk region. The prepared samples were examined by pyrolytic gas chromatography-mass spectrometry to determine the qualitative and quantitative analysis of MP.

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## O-14 MODELLING OF MICROPLASTICS PARTICLES FORMATION AND ADSORPTION OF MACROMOLECULAR POLLUTANTS

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Accumulation of microplastics (MP) in aqueous environments is one of the serious ecological problems nowadays. MP can appear as vectors for various pollutants such as heavy metals, antibiotics, and polyaromatic hydrocarbons driving the transfer of the latter throughout the food chain and accumulation within various biosomes [1, 2]. MP particles “decorated” by pollutants can be absorbed into cells and bio-accumulated due to the size similar to cellular components, leading to biotoxicity. Therefore, investigation of adsorption of low- and high-molecular weight pollutants onto MP particles is a challenge in this field of research. The specific feature of MP particles is that its surface is not an ideal sharp solid-liquid interface, but has a diffuse boundary layer of finite thickness which affects adsorption of pollutants onto them.

In present work we employ the Scheutjens-Fleer self-consistent field (SF-SCF) method [3] to study formation of model MP particles consisting of homopolymer macromolecules under thermodynamically poor solvent conditions. We consider MP particle formation from a solution of monodisperse linear macromolecules and from a solution of bidisperse mixture of linear macromolecules. It is shown that in both cases the macromolecules form particles of a spherical shape, with a constant polymer density inside the particle and a diffuse boundary layer at its periphery. The size of forming MP particle and the thickness of the boundary layer decrease with a deterioration in the solvent quality. On the other hand, in moderately poor solvent the MP particle becomes unstable and disintegrates into separate macromolecules. To exclude this effect, we consider MP particle formation via collapse of a single multi-arm star polymer which remains stable at any solvent quality. In the poor solvent limit, the MP particles formed by linear macromolecules and by the star molecule of the same total molecular weight have identical size and boundary layer thickness. Finally, we consider adsorption of pollutant macromolecules onto MP particles and focus on the effect of the boundary layer on the adsorption.

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## **O-15 PERFORMANCE PARAMETERS OF FLUORESCENT MICROSCOPIC QUANTIFICATION OF MICROPLASTICS IN NATURAL WATERS**

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Freshwater reservoirs (rivers, lakes, bogs) located near large industrial cities are exposed to microplastics resulting from the discharge of industrial and domestic wastewater into natural reservoirs. The main source of microplastic formation in water bodies is household laundry, due to that municipal wastewater treatment plants are not designed to completely remove microplastics. To obtain reliable data on the content of microplastics in natural waters, careful validation of the methodology used to determine it is required. In addition, it is important to evaluate not only the amount of microplastics in natural waters, but also the amount of solid particles of other origin in order to avoid false positive results. Fluorescence microscopy is widely used as a tool for visualization and quantitative analysis of microplastics, but its metrological characteristics depend on many parameters, such as sample preparation, choice of fluorescent dye, visualization conditions, and image processing algorithms. Additionally, thermogravimetry can be used to estimate the total mass content of solid particles of both natural and synthetic origin. Thus, the aim of this study was to develop an approach for determining microplastics by combining fluorescence microscopy with thermogravimetric analysis to estimate the mass and quantity of microplastics among solid particles recovered from natural waters with high precision and accuracy.

In this work, several methods of sample preparation of natural water samples, obtained from river and bogs from Moscow region have been tested. As a result, an approach providing the highest degree of microplastics recovery has been chosen. The microplastic content in the recovered solid particles was assessed using thermogravimetric analysis. For selective visualization microplastics isolated from natural water samples were stained with a commercially available fluorescent dye, giving the opportunity to distinguish polymer particles from mineral ones and organic matter residues. The shooting conditions, providing high-quality microscopic photographs, were selected using both model objects and real samples of natural waters. The correctness of the measurements obtained using the proposed approach was assessed by spiked recovery tests. The results showed that the proposed method provides conditions for quantitative determination of microplastics in natural waters.

## **O-16 MICROPLASTIC PARTICLES IN THE ARCTIC MARINE ENVIRONMENT: MICROSCAN DATABASE OF IR SPECTRA AND ITS VERIFICATION BY MACHINE LEARNING METHODS**

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The first spectral database of Arctic microplastics, MICROSCAN (MICROplastics Spectroscopy for Contamination Annalysis), containing 2010 ATR FTIR spectra of three polymer types (PE, PP, and PS) and PE/PP copolymers is presented and described in this study. Microplastics samples ranging in size from 0.5 to 5 mm were collected in the Eastern Arctic Seas during expeditions in 2020-2021. The database is freely available and open-access (<https://doi.org/10.5281/zenodo.15277130>). Multiple annotation approaches were applied to annotate MICROSCAN, including traditional spectral matching, expert analysis, and the use of the convolutional neural network model CNN1D from the recently developed open-source mPSAT package (*Environ. Sci. Technol.* 2023, 57, 6656). The combination of these efforts allowed us not only to thoroughly verify the MICROSCAN database, but also to evaluate the efficiency of microplastics classification with CNN1D using MICROSCAN as unseen data. Obtained results demonstrate that deep neural networks can be effective for database annotation under certain conditions but still require manual expert verification. This necessity largely stems from the assignment of “additional” polymer classes to the analyzed spectra. Identifying such classes was often redundant due to the absence or poor differentiation of the characteristic bands, discrepancies in the relative intensities of the bands, and the difficulty of identifying characteristic bands within broad peaks caused by biofouling or degradation. Addressing these challenges is essential for improving the performance of emerging neural network models for microplastic classification. In this regard, the MICROSCAN database may serve as a valuable resource for further developments and studies in the field of microplastics pollution.

## O-17 THE SIGNIFICANCE OF SOIL IN THE FATE OF MICROPLASTICS

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The increasing interest in the fate of microplastics (MPs) in soil can be attributed to the fact that soil is a complex, polydisperse system that can both accumulate and transmit microplastic particles through its depth into adjacent environments. This issue is particularly concerning due to the various ways plastic microparticles may enter soil ecosystems, given the lack of sufficient data on their subsequent transformation and etabolo in the environment.

It should be noted that there are variations in the sources of MPs, depending on land use practices, which necessitates the development of both general methodological approaches for studying microplastic migration in soil and tailored approaches specific to the functional use of the area under study. It is also important to note that microplastics in soil environments are a physically active component, due to their small particle size and high specific surface area. This can lead to transformation of soil properties through the accumulation of these particles. It is possible that such changes would include alterations in the structure and hydraulic conductivity of soil matrices.

This study focuses on soils in urbanized areas, which are actively polluted and directly interact with humans. Microplastic pollution can have complex effects on urban ecosystems: a) directly, through inhalation of particles into the respiratory system, and b) indirectly, through modification of physico-chemical and biological soil characteristics, leading to a range of environmental consequences. The paper presents the findings of a study on the migration potential of microplastic particles (MP) in urban soil environments. It has been determined that the behavior of MP in soils is highly complex and depends on both their own properties and those of the soil. The contaminant can penetrate into the soil structure by incorporating itself into soil aggregates or forming film coatings on soil particles, and it can also cross the boundaries between different soil horizons, migrating into deeper layers and groundwater.

These findings indicate the intricate nature of the interactions between MP and soil components, which is significant for understanding long-term changes in soil quality.

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## **O-18 FIELD STUDIES OF PLASTIC FRAGMENTS FROM DIFFERENT GEOGRAPHICAL REGIONS**

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With the continuous growth of global plastic production and consumption, beach plastic pollution has emerged as a significant environmental challenge. This study is focused on large plastic fragments and meso-plastics (0.5–2.5 cm). Mesoplastics play a crucial role in the plastic degradation process. They are produced mainly by weathering and fragmentation processes of larger plastic items, but also serve as a potential source and precursor of micro/nano plastics. Understanding their physical and chemical characteristics, as well as their distribution patterns, is critical for uncovering the full life cycle of plastic pollution. However, existing research on meso-plastics faces significant challenges due to substantial differences in sampling methods, classification standards, and data recording techniques across countries. It hinders the comparability of the data and complicates the monitoring activities and further development of possible measures to prevent plastic pollution at different levels. In the frame of the joint Russian-Chinese project “Aging and fragmentation of plastic wastes on marine beaches across latitudes” harmonized monitoring protocols were established for macro and mesoplastics and the fragments were investigated on the beaches of different areas on the Baltic, White, Barents, Kara and Japan seas. This study represents the results of the field studies including densities, size distribution and types of fragments and also gives the perspective on further laboratory studies of degradation mechanisms of different plastics in different geographical regions.

## O-19 STRATEGIES OF MICROPLASTIC CONSUMPTION BY ORGANISMS WITH DIFFERENT TROPHIC SPECIALIZATIONS (OXYRRHIS MARINA AND ARCTODIAPTOMUS SALINUS) AND ITS IMPACT ON THEIR FUNCTIONAL CHARACTERISTICS

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Microplastics (MPs) are major aquatic pollutants with high trophic availability, capable of causing cascading effects from individual organisms to entire ecosystems. Limited data on their impact across diverse biological and trophic types hinders accurate ecological forecasting.

This study presents a comparative analysis of MP ingestion by two planktonic organisms differing in biological organization and trophic strategies: the unicellular predatory dinoflagellate *Oxyrrhis marina* and the multicellular copepod *Arctodiaptomus salinus* with a mixed feeding type. *O. marina* actively consumes phytoplankton and bacteria, linking the microbial loop to the classical food chain and participating in carbon redistribution. *A. salinus* plays a key role in the diet of planktivorous fish and benthic organisms, ensuring vertical transfer of matter. For this experiment, *O. marina* and *A. salinus* were subjected to three dietary regimes: microalgae (*Isochrysis galbana*), their mixture with MPs (6 µm), and MPs exclusively. In addition, starvation was tested for copepods. Trophic parameters, survival, reproduction, and physiological stability were assessed. *O. marina* was incubated under limited (1:3) and excess (1:30) substrate ratios for 5 hours. Cell and MP concentrations were measured using a flow cytometer Cytomics™ FC 500. Results revealed differences in MP consumption strategies and organismal responses. *A. salinus* initially preferred MPs but later switched to *I. galbana*, demonstrating adaptability and the ability to recognize food quality. Under food deficiency, *O. marina* consumed MPs on par with algae, including repeated capture of excreted plastic—indicative of low selectivity. Under excess food, selectivity towards *I. galbana* was observed. The physiological consequences of MP consumption were particularly pronounced in *A. salinus*: mortality reached 27% after 48 hours and 33% after 24 hours under mixed feeding, likely due to intestinal damage, toxicity, and energy depletion. *O. marina* showed resilience, indicating its potential as a plastic vector within microbial food webs. Remarkably, mortality in *A. salinus* when consuming MPs exceeded that during starvation, suggesting potential toxicity. An especially notable finding was the initiation of reproductive processes in *A. salinus* when fed MPs (~4 eggs/female/day), despite their lack of nutritional value—higher than on a natural diet (2–2.5). Differences in trophic and physiological processes between *O. marina* and *A. salinus* reflect their specific interactions with MPs. The former exhibits tolerance and stable abundance, while the latter shows dietary selectivity and high sensitivity. These traits may influence MP trophic transfer routes and the structure of plankton communities. They highlight the importance of species-specific approaches in ecological monitoring and risk assessment of biomagnification.

*The study was conducted within the framework of the Russian Federation State Assignment No. 124022400152-1.*

## O-20 POLYHYDROXYALKANOATES (BIOPOLYMERS) WERE SYNTHESIZED FROM FATTY WASTE FROM FISH PROCESSING

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The development of a consumer society provokes an increase in the production of synthetic polymers, which leads to an increase in the risks associated with their disposal and, as a consequence, to environmental problems and negative impacts on human health. The difficult situation associated with plastic waste management can be improved by using biodegradable polymers (Jaffur 2023).

Polyhydroxyalkanoates (PHAs) are biopolyesters that are synthesized by many microorganisms. Depending on the presence of substituents, these biopolymers can change their properties from thermoplastics (scl-PHA short polymer chain length) to elastomers (mcl-PHA, 1c1-PHA biopolymers with medium and long chains). A typical representative of scl-PHA is poly-3-hydroxybutyrate. The main disadvantage of these biopolymers is their high cost compared to traditional polymers.

Biowaste can pose a serious threat to the environment and health. However, waste such as fats, oils and fatty acids can be processed into products with high added value.

In our work, we used Waste Fish Oil (WFO) as a carbon substrate for PHA biosynthesis by *C. necator* B-10646 bacteria. At the first stage, the fatty acid composition of WFO and the completeness of its utilization by bacteria were studied. Optimal concentrations of WFO were determined, as well as conditions that allow obtaining the maximum concentration of PHA in cells (Zhila, 2023).

At the second stage, the scaling of PHA biosynthesis processes in Bio-Flo 115 fermenters was implemented. Two types of WFO were used as substrates: WFO – Smoked sprat heads (*Sprattus balticus*) and WFO – Fresh mackerel heads (*Scomber scombrus*). Two methods were used for fat isolation: thermal and enzymatic. As a result of the experiments, it was found that the productivity of the PHA biosynthesis process is affected by both the type of WFO and the method of isolation from fish waste. The highest biomass yield and polymer concentration were obtained using WFO – Smoked sprat heads (*Sprattus balticus*) isolated by the enzymatic method, 109.7 g/L and 81%, respectively. The productivity of the process for biopolymer was 2.9 g/L\*h. The production indicators of the biosynthesis process on WFO – Fresh mackerel heads (*Scomber scombrus*) were slightly lower, the biomass yield was 87.8 g/l, the PHA concentration in the cells was 78%. The productivity of the process for the biopolymer was 2.3 g/L\*h (Kiselev, 2024).

The synthesized PHAs are three-component in chemical composition with the predominance of the monomer 3-hydroxybutyrate (96.7–97.2 mol.%). In all samples, inclusion of the monomers 3-hydroxyvalerate 2.0–2.7 mol.% and 3-hydroxyhexonoate 0.5–0.6 mol.% was found. The molecular weight of the obtained biopolymers was 471–491 kDa. Melting point was 167–169 °C.

The research has shown that WFOs can act as a promising substrate for the biosynthesis of PHA, which will significantly reduce the cost of these biopolymers.

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## **O-21 STRUCTURAL STABILITY OF NANOSIZED POLYETHYLENE PARTICLES IN AQUEOUS ENVIRONMENT: ALL-ATOM COMPUTER SIMULATIONS**

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Plastics are indispensable materials in everyday life; however, their massive consumption has contributed significantly to the pollution of aquatic ecosystems. Once released into the aquatic environment, plastics are subjected to multiple external factors, which lead to their degradation, fragmentation, and the formation of so-called microplastics (MP).

One of the main mechanisms of MP formation in aquatic media is photocatalytic degradation. At present, the smallest MP particles detectable experimentally are typically no smaller than 100 nanometers. Controlled experimental investigation of degradation processes in such small particles and in even smaller ones is an extremely challenging task. However, such a problem may be effectively addressed through computer modeling.

In this study, we present the results of simulations of the initial stages of degradation of nanosized polyethylene particles of different diameters (2.5 and 5 nm) in a water on the microsecond timescale. The particles were modeled with varying degrees of aging, which was modelled by modifying the macromolecular structure with different numbers of oxygen-containing functional groups (COOH, CO, or OH), as well as by accounting for chain fragmentation within the particles.

As the main characteristic describing the degradation rate, we selected the desorption time for a first detached chain (or several chains) as a whole to a distance of 1 nm from the particle surface. It was found that with increasing degree of aging, the desorption time decreases following near-exponential dependence. Furthermore, modification of particles with hydroxyl (OH) groups results in slower degradation compared to carbonyl (CO) groups. Visual analysis of the simulation trajectories revealed several distinct scenarios of particle fragmentation.

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## O-22 PERFORMANCE PARAMETERS OF FLUORESCENT MICROSCOPIC QUANTIFICATION OF MICROPLASTICS IN CHICKEN EGGS

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Microplastics are increasingly detected in diverse food matrices, raising questions regarding their reliable quantification [1–2]. Recent studies have reported the presence of small-size microplastics in agricultural and livestock products, such as milk, honey, and meat [3–5]. Among such products, chicken eggs represent a nutritionally valuable but analytically challenging biological matrix, combining lipid-rich yolk and protein based white, which complicates isolation and quantification of microplastics. Currently, there are no studies on the methodology of sample preparation of chicken eggs for microplastics. Thus, the aim of this study was to develop performance parameters for the quantitative determination of microplastics in chicken eggs using fluorescence microscopy as a reliable and sensitive method for small size microplastics.

Several digestion protocols were tested to achieve effective degradation of eggs while preserving polymer particles. The most efficient protocol was found to be alkaline hydrolysis at elevated temperature, followed by neutralization of the digested egg solution. This procedure ensured minimal matrix interferences and high reproducibility of subsequent microplastics detection.

For selective visualization, microplastics isolated from egg samples were stained with a commercially available fluorescent dye, enabling reliable recognition of polymer microparticles among other organic residues. The trueness of the proposed analytical method was assessed through several spike and recovery experiments.

The developed approach was applied to eggs from several commercial producers. The results demonstrated that the proposed method provides accurate and reproducible quantification of microplastics in chicken eggs, presenting a valuable analytical tool for monitoring microplastic contamination in food products.

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## O-23 3D-PRINTABLE ALGINATE NANOCOMPOSITE GELS

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Due to the increasing levels of pollution caused by plastic waste on our planet, the development and utilization of biodegradable polymer materials and waste-free manufacturing processes have become increasingly significant. One promising example of a waste-free technique is 3D printing, which enables the creation of objects utilizing polymer gels. These gels can be employed to produce soft products compatible with biological tissues, such as flexible manipulators for robotic systems or “intelligent” sensors that may be fixed to the skin to monitor movement or detect the presence of specific substances within the body.

3D extrusion printing holds great potential for manufacturing products from hydrogels. This technique is well-suited for creating network structures that can deform under significant stress and quickly recover their initial mechanical properties after extrusion. Non-covalently crosslinked networks are ideal for this application. However, such structures often lack the necessary rheological and mechanical properties. To overcome this limitation, we propose integrating two types of networks: one with increased rigidity to provide high mechanical stability at rest and another one with increased flexibility to allow for deformation during extrusion and rapid recovery of properties following 3D printing.

A percolation network of branched sodium alginate fibers, obtained using a specifically developed method, was utilized as a rigid network. These fibers are formed by polymer chains linked with calcium ions. A network of topologically interconnected sodium alginate macromolecule networks was employed as a soft network. Two-component networks such as these had not been previously investigated. Our research has demonstrated that these network materials exhibit high mechanical properties and the ability to flow during deformation, rapidly restoring their structure and characteristics when the load is removed, in other words, forming thixotropic gels. We also obtained branched fibers of sodium alginate ranging in size from hundreds of nanometers to several microns and investigated them. Patterns of variations in the elasticity modulus and yield strength of the gels were determined depending on their composition. It has been shown that the gels can be utilized as an ink for three-dimensional extrusion printing.

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## **O-24 ASSESSMENT OF MICROPLASTIC CONTENT IN RIVERS IN THE EUROPEAN PART OF RUSSIA: RESULTS OF EXPEDITION STUDIES**

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The problem of microplastics in the natural ecosystem is becoming increasingly acute, and their pollution of the world's oceans is the focus of attention of the scientific community. Rivers are the main means of transporting microplastics from land into the ocean, as in most cases the density of the particles is lower than that of water. However, there are not many studies devoted to microplastics in river systems, especially in Russia. Since 2020, employees of the non-profit foundation “Without Rivers Like Without Hands” and the Department of Land Hydrology of the Faculty of Geography of Lomonosov Moscow State University have been conducting expeditionary research to assess the content of microplastics in rivers in the European part of Russia.

The main tool chosen for sampling microplastics was the LEI-MANTA300 sampling device manufactured by EcoInstrument LLC with a 100-micron mesh for use in water bodies with a low trophic index or a 300-micron mesh for rivers with a high microalgae content. The device is towed behind a vessel for 30-60 minutes, which is sufficient to filter 20 to 50 m<sup>3</sup> of water. The net was then washed and the sample was preserved for subsequent removal of organic matter in the laboratory. The microplastic particles were counted and classified visually using a stereomicroscope.

The main object of the study was the Volga, the largest river in Europe and the largest river on the planet not connected to the world's oceans. In 2020, research was conducted in all major settlements from the upper reaches of the river (Selizharovo town) to its mouth (Astrakhan city) to collect microplastic samples. Particular attention was paid to cities with a population of over one million, namely Kazan, Samara, and Volgograd. According to the results obtained, the inflow of microplastics into the water is estimated at 213, 480, and 641 tons/year, respectively. As a result of laboratory tests of samples, all microplastic particles found were divided into three fractions: fragments, fibers, and films. In the selected samples, the ratio between the fractions was approximately the same: the share of fragments, fibers, and films was 45%, 39%, and 16%, respectively. It was also noted that the number of fragments decreases with increasing depth: for example, in samples from the surface layer of water, the average proportion of fragments is 52%, and at a depth of 1-2 meters, it is 40%. At the same time, the proportion of fibers increases from 29% to 47%.

From 2022 to 2025, samples were taken in the Volga Delta in collaboration with the Astrakhan Reserve. On average, the concentration of microplastics in the closing section varied from 0.28 to 0.64 particles per m<sup>3</sup> according to laboratory analysis results.

In addition to the studies conducted on the Volga River, expeditionary studies were organized in 2021 on the rivers of the Russian North: the Northern Dvina and Onega

Rivers. The average concentration of microplastics in the Northern Dvina River is 0.42 pieces/m<sup>3</sup>, with concentrations ranging from 0.09 pieces/m<sup>3</sup> to 0.96 pieces/m<sup>3</sup>. The results obtained allow us to conclude that the microplastic pollution of the Northern Dvina and Onega rivers is at a relatively low level – less than 1 piece/m<sup>3</sup>. At the same time, the role of the cities of Arkhangelsk and Onega as sources of microplastics entering river waters is insignificant. The average concentration of microplastics in the Onega River is 0.67 pieces/m<sup>3</sup>, and among the samples taken, the concentration of microplastics varies from 0.47 pieces/m<sup>3</sup> to 1.03 pieces/m<sup>3</sup>. The maximum concentrations of microplastics were recorded upstream from the city of Onega (1.02 pieces/m<sup>3</sup>), while within the city limits and in the Onega Bay of the White Sea, the values are approximately halved.

## O-25 MICROPLASTIC CONTAMINATION IN NORTHERN FUR SEALS (CALLORHINUS URSINUS): DETECTION AND QUANTIFICATION

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**Introduction.** Currently, microplastics (MPs) have been found virtually ubiquitously in the environment and even in animal and human tissues [1, 2]. Pinnipeds are susceptible to ingesting MPs from the environment, both through direct consumption and trophic transfer. This presentation reports results from a study dedicated to determining and quantifying MP ingestion by a representative of the eared seal family (*Otariidae*), the northern fur seal (*Callorhinus ursinus*), based on the analysis of 15 scat samples.

### Materials and Methods.

1) Northern fur seal (*Callorhinus ursinus*) scat samples were collected at rookeries on Tyuleniy Island (Sea of Okhotsk) in July-August 2024.

2) A bioprotocol for extracting MPs from excrement, regurgitation, and gastrointestinal contents adapted from Lusher, Hernandez-Milian, 2018 [3] was used to process the 15 samples.

3) Particle identification and measurement were performed using a Leica DM750P stereomicroscope with a Leica MC170 HD camera.

Contamination control methods were implemented at all stages to minimize external MP contamination.

**Results.** A total of 996 particles were identified and classified as suspected MPs. MPs were detected in each of the 15 samples, with occurrences ranging from 16 to 137 particles per gram of wet weight ( $\text{g}^{-1}$ ). The morphology of MPs was predominantly fibrous ( $n = 823$ ; 83%). Fragments were also found ( $n = 173$ ; 17%). The most common MPs colors were black ( $n = 420$ ; 42.17%), blue ( $n = 329$ ; 33.03%), and transparent ( $n = 108$ ; 10.84%); purple, red, brown, pink, yellow, green, and crimson MPs were also observed. The length of all particles ranged from 8.083 to 4326.800  $\mu\text{m}$ .

Raman spectroscopy will be used to obtain results describing the types of polymers encountered.

**Conclusions.** This study provides the first evidence of MPs particles in the scat of northern fur seals (*Callorhinus ursinus*) from rookeries on Tuleny Island (Sea of Okhotsk). MPs fibers and/or fragments were detected in all analyzed scat samples from the studied animals. The obtained results provide an important baseline for future MPs pollution research in the region. To fully assess the impact of MPs on pinnipeds, continued evaluation of MPs ingestion is needed, but research on potential trophic transfer and toxicological effects of MPs on marine mammals is also necessary.

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## **O-26 DISTRIBUTION OF MICROPLASTICS IN BOTTOM SEDIMENTS OF THE COAST OF THE SPIT KRIVAYA OF THE SEA OF AZOV**

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Continuing research on modern sedimentogenesis in the Sea of Azov and the influence of climatic and anthropogenic factors on it is a fundamental task for further understanding the influence of microplastics and polymers in general in answering future questions that may be posed to the scientific community in various fields of science.

The spits of the Sea of Azov are unique natural monuments that allow us to answer many questions about the formation of the Sea of Azov and identify the impact of these changes on sedimentation, including new man-made particles, which are various polymers, as a factor in changing the types and scales of anthropogenic pollution of sediments in the last decade. In particular, the increase in plastic pollution of the Sea of Azov. To understand the distribution of microplastics in bottom sediments, a number of samples were taken in September 2025 during expeditionary work on the Krivaya Spit in the Sea of Azov.

The samples were taken with a Van Winn dredger with a capture area of 0.1 m<sup>2</sup> to a depth of 0.2 m. In total, 5 samples of bottom sediments were taken. This analysis will reveal a more detailed picture of the previously studied 20 points in the Sea of Azov, especially those where the polymer level is increased by about 4 times, just near the Spit of the Curve. Bottom sediment studies were carried out using various methods. The size and variety of bottom sediment particles were analyzed using a LASKA-TD laser microparticle analyzer, and the quantitative distribution of MP was carried out using pyrolysis gas chromatography with mass spectrometry (pyrolysis GC–MS, PyrGC–MS). At early points, the granulometric composition was dominated by clay silts with a fraction of <0.1 mm, among which particles with a size of 0.002–0.05 mm were most often found. In general, the microplastic content ranged from 19 to 195 mgs/g.

The highest concentrations of 195 mgs/g were recorded in the plume of the Kerch Strait, 167 micrograms/g near the Berdyansk Spit, 139 and 164 micrograms/g in the estuary of the Don. The distribution can be influenced by a number of factors, such as the runoff of the Don and Kuban, the outflow of waters from the Kerch Strait, runoff from large coastal settlements (Taganrog, Berdyansk, Kerch), as well as shipping, since the points with high concentrations correspond to the location of the shipping channel. The average microplastic content in the bottom sediments of the Sea of Azov is 61.7 mg/g.

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## O-27 MOLECULAR MECHANISMS OF PESTICIDE ADSORPTION ON MICROPLASTICS: RESULTS OF MICROSECOND SIMULATION

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This study, using molecular dynamics simulations, identifies the key molecular factors governing the adsorption and absorption of pesticides (DDT, PCB-169, Cypermethrin and its two metabolites: DCVA and PBA) onto microplastics (linear PE, isotactic PP, atactic PS, atactic PVC). We demonstrate that a pesticide's adsorption process is governed by a complex dynamic interplay of conformations and energies, not merely static attraction [1].

Segmental mobility of polymer chains plays important role. This mobility allows some pesticides, such as DDT and PCB-169, to diffuse into the bulk area (~ 1.3 nm depth) of PE and PP and compensates their low binding energies. This *absorptive* property of PE is consistent with experimental findings [2].

In contrast, PS, with the highest binding energy and surface roughness (0.235 nm), acts as a "trap": it strongly retains pesticides but severely restricts their mobility. The time for conformational rearrangements and lateral diffusion on PS reaches a 153.8 ns (PP – 69.8 ns, PE – 91.0 ns, PVC – 146.1 ns), necessitating microsecond simulation times.

The binding energy between the pesticide and polymer has a decisive influence on its mobility. The electrostatic contribution of PS and PVC is small compared to the dispersion component but is critical for retaining pesticides at the interface and slowing adsorption time by reducing water mobility via coulombs interactions.

Throughout the 1  $\mu$ s simulation, no full desorption of pesticides back into the aqueous phase was observed.

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## O-28 STUDYING MICROPLASTIC TOXICITY USING IN VITRO MODELS: FROM PBMC VIABILITY TO LYSOSOMAL DYSFUNCTION

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**Introduction.** The pervasive environmental contamination by microplastics (MPs) has raised significant concerns regarding their impact on human health. A critical knowledge gap exists in understanding the fate and biological consequences of MP particles upon internalization. Current data on their effects, particularly on subcellular compartments like the lysosomal system, remain controversial, with studies reporting conflicting results on oxidative stress and enzymatic activity. This study aims to address this ambiguity by employing a dual-model approach to characterize the early biochemical and cytotoxic responses to polystyrene MPs, investigating both direct cellular viability and specific organelle-level dysfunction.

**Methods.** Two complementary in vitro models were utilized: 1) Human Immune Cell Model: Peripheral blood mononuclear leukocytes (PBMCs) were isolated from 6 healthy volunteers. Cells were incubated with 1.7–2.2  $\mu\text{m}$  fluorescent polystyrene MPs (25  $\mu\text{g}/\text{ml}$ ) for 1, 2, and 4 hours. Viability was assessed using imaging flow cytometry (Cytex  $\text{\textcircled{R}}$ Amnis  $\text{\textcircled{R}}$ Flowsight) with 7-AAD and CD45 PE staining, analyzing 10,000 events per sample to quantify viability loss and particle-cell interactions. 2) Isolated Rat Liver Lysosome Model: Lysosomes were isolated from male Wistar rat livers and exposed to 1  $\mu\text{m}$  amine-modified polystyrene MPs at concentrations of 5 and 25  $\mu\text{g}/\text{ml}$  for 2 and 4 hours. Post-incubation, the sedimentable (SF) and non-sedimentable (NSF) fractions were analyzed. In both fractions, the following parameters were quantified: lysosomal membrane stability (labilization coefficient, Klab), the activities of cathepsins B, L, H, and acid phosphatase, and the levels of oxidative stress markers (protein carbonyl groups (PCG) and malondialdehyde (MDA)).

**Results.** A consistent, time-dependent toxicological profile emerged across both models. MP exposure (25  $\mu\text{g}/\text{ml}$ ) significantly reduced PBMCs viability after 2 hours. The most profound decrease occurred at 4 hours, specifically in cells that had contacted two or more MP particles, demonstrating a clear dose-response relationship at the cellular interaction level. A significant oxidative response was detected in the lysosomal model by the 4-hour mark. Statistically significant increases in PCG were observed at both MP concentrations (5 and 25  $\mu\text{g}/\text{ml}$ ), while MDA levels were significantly elevated at the higher 25  $\mu\text{g}/\text{ml}$  concentration. The activity of the proteolytic enzymes cathepsin B and L was significantly increased in the SF at 25  $\mu\text{g}/\text{ml}$  by 4 hours, with an early rising trend noted at 2 hours. Crucially, the Klab for these cathepsins decreased at the 2-hour mark, indicating no leakage and suggesting the observed proteolytic activation is a contained, intralysosomal process rather than a result of membrane rupture.

**Conclusion.** This integrated investigation demonstrates that polystyrene microplastics induce a rapid, time- and dose-dependent cytotoxic and oxidative-proteolytic response. In human immune cells, cytotoxicity is directly correlated with the number of particles per cell highlighting imaging flow cytometry as a powerful tool for quantifying these interactions. At the subcellular level, this manifests as significant oxidative damage (increased PCG and MDA) and the activation of key lysosomal proteases within intact lysosomes.

## O-29 STUDY OF THE FRASS OF ULOMOIDES DERMESTOIDES (COLEOPTERA, TENEBRIONIDAE) LARVAE DURING BIOCONVERSION OF POLYSTYRENE-BASED PLASTIC

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Plastic manufacturers often resort to minor changes in the composition and formulation of plastics. For example, ABS plastic is often found under the PS brand. During the analysis of the polystyrene (PS) sample used in the bioconversion experiment with larvae, it was revealed that the pyrolyzate contained 1,2-Diphenyl-1-isocyanoethane  $C_{15}H_{13}N$ , a compound with an isocyanate group ( $-N=C=O$ ), which is a classical marker of acrylonitrile pyrolysis. Its content was 8.35% of the total ion current (TIC), confirming the incorrect labeling of the material as PS.

Pyrolytic gas chromatography was performed using a Maestro gas chromatograph with a mass-selective detector and a Frontier Lab pyrolysis attachment, utilizing the manufacturer's software. The column used was Ultra Alloy by Frontier Lab. The pyrolyzer temperature was 600°C.

PS is used in various sectors of the national economy, including as packaging material for food products. After use, it is disposed of with food waste, either for recycling, processing, or sent to landfills for solid household waste. Like most organic compounds, under terrestrial conditions, it is thermodynamically unstable and prone to oxidation. Polystyrene can serve as an energy source for various living organisms. One such organism is the beetle *Ulomoides dermestoides*, whose larvae can affect plastic, breaking it down when maintained on PS-marked polystyrene as the sole source of nutrients (Figure 1).

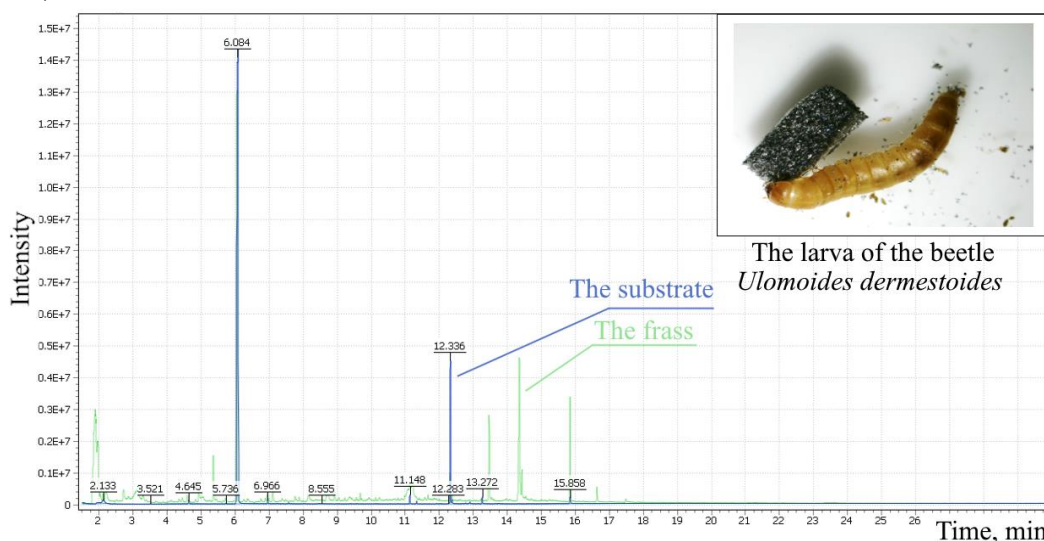


Figure 1 — Chromatogram of the plastic substrate, frass, and photograph of the *Ulomoides dermestoides* beetle larva

During the experiment, it turned out that up to 30% of the larvae did not affect the plastic substrate, up to 20% destroyed it very actively and rapidly, and the remaining 50% were able to break down polystyrene to varying degrees. Biotransformed microplastics are excreted in the frass. In the frass, the intensity of plastic peaks decreased tens of times compared to the initial sample, and products of larval metabolism and their microbiome appeared.

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## O-30 SYNTHESIS AND PROPERTIES OF BIODEGRADABLE POLYMERS BASED ON L-LACTIDE, $\epsilon$ -CAPROLACTONE AND ALIPHATIC POLYCARBONATES

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Biodegradable aliphatic polyesters (polylactide, PLA; poly- $\epsilon$ -caprolactone, PCL) and aliphatic polycarbonates (poly(trimethylene carbonate), PTMC; poly(tetramethylene carbonate), PTEMC) are of significant interest for the development of environmentally friendly packaging materials and biomedical applications. However, their widespread use is often limited by several drawbacks, including high brittleness (PLA), low glass transition temperature (PCL), and excessive elasticity (PTMC). One of the key approaches to modifying properties is the copolymerization of various cyclic monomers, which enables obtaining materials with tunable degradation characteristics and mechanical properties.

The present study demonstrates the synthesis and characterization of homo- and copolymers of L-lactide (L-LA),  $\epsilon$ -caprolactone ( $\epsilon$ -CL), as well as new substituted cyclic carbonates using catalytic systems based on complexes of zinc, aluminum, gallium, and titanium with nitrogen-containing ligands. It has been established that the developed catalysts enable efficient homo- and statistical copolymerization of monomers under mild conditions.

The properties of the obtained copolymers were characterized by GPC, DSC, and NMR spectroscopy. The study shows that varying monomer ratios and polymerization conditions allows for precise control of molecular weight, polydispersity, and glass transition temperature of the resulting materials. It was found that the incorporation of  $\epsilon$ -CL or carbonate units into the polylactide chain significantly enhances material elasticity while maintaining biodegradability.

This work was supported by a grant of the Ministry of Science and Higher Education of the Russian Federation for large scientific project in priority areas of scientific and technological development (grant number 075-15-2024-553).

## O-31 TACTICS SOLUTIONS: TACTICS OF BUSINESS FOR MICROPLASTICS SOLUTIONS

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In 2018, I met Mr. Marco Simeoni who is a successful entrepreneur who made the foundation called “Race for Water”. He bought a ship which moves by solar, wind and hydrogen of 100% renewable energy. He wanted to make a campaign of Ocean Plastic Pollution during Tokyo Olympic which was supposed to be herald in 2000. The campaign was failed because Tokyo Olympic was postponed to 2021 and nobody came to see the exhibition on the boat during the COVID.

I saw the exhibit and found that ocean is very much polluted by plastics, and this plastic pollution continues to increase very much. I also find that the pollution in Japan in Tushima Island which is very severe because the sea current brings the garbage from Southeast Asia as well as China on Korea. The pollution was caused only from household chores but also by fishing and other industries. The garbage from other countries must be moved away from the ocean but it is hard to find the initiative to do so by the private initiatives.

I decided to make a campaign in the EXPO which is supposed to be held in 2025 in Osaka, which is my hometown. I decided to make a pavilion and named it “Blue Ocean Dome” We decided to make the theme of the exhibition such as ① ocean plastic pollution ② the sustainable use of the ocean ③ the climate change with the ocean.

There are challenges to recover plastics from the ocean for example by Ocean Voyage in the USA, The Ocean Cleanup in the Netherland and many beach-clean activities in the many local areas in the world. I think we may need to support them, but they are mainly nonprofit organizations and very unstable in the operations, since they mainly depend on the charity of corporations or by the individuals.

I wonder if we could do this operation on a business basis so that we could make the process rather wide, continuous and sustainable. We may need to ask the Governments to change the rules of collection or support such operations. We may need to expand the use of the collected plastics for materials or at least for making energy. We may need to make the process from linear to circular in material use.

In Tushima, we will make an experiment to collect plastics from the ocean and utilize them to recycle the materials or for energy. We plan to decrease the import of oil from outside to the island. After making energy by the collected plastics we’ll use it to create local business. I will show the example challenge in the lecture. This Tushima model May be applied to the islands of Indonesia or Philippines. By connecting several sectors of businesses, we will make some value in the throughput. This is the theory of ZERI (Zero Emission Research Initiatives) by learning from nature.

In SARAYA’s business we use our plastics in 3R models such as Reduce, Reuse and Recycle. We decrease the volumes of plastics, by making thinner bottles, using more vinyl bags for refill, or mix recycled plastics into the new regime. At the same time, we have our customers to collect and recover the plastics after the use. It is an effort to make the process circular from production to the end use by circular use, at least by the mass balance.

Another tactic of business is to utilize bioplastics. For example, one company in Indonesia makes biodegradable plastics from cassava. They are trying to make films, package material for food and agricultural businesses. They also make some additives to polyethylene or other plastics to help the decomposition of plastics in the nature.

In recent days the health hazard issues of micro plastics or nano plastics have getting much more attention. It will be appreciated if this Microplastic Society can certify or identify those health problems so that business also can focus on the direction of the whole issues and plastics.

I do not deny plastics but rather we need to appreciate the invention of 20st century. Now it is time to correct and coordinate how we could live along with plastics in a better way.

## POSTER PRESENTATIONS

### **P-01 SYNTHESIS AND PROPERTIES OF BIODEGRADABLE POLYMERIC MATERIALS BASED ON POLYVINYL ALCOHOL AND POLYSACCHARIDES**

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The rapid growth in plastic consumption and their low recycling rate have led to large-scale accumulation of plastic waste and the formation of microplastics, which pose a serious threat to the environment and human health. One of the promising approaches is the development of biodegradable materials that can replace traditional packaging types. In this study, synthesis and comprehensive investigation of film materials based on polyvinyl alcohol (PVA) and natural polysaccharides (starch, apple pectin) with the addition of glycerol were carried out. It was found that the obtained compositions possess high tensile strength (up to 47.8 Mpa) and simultaneously demonstrate the ability to biodegrade: under soil and compost conditions they completely decompose within 2–3 months without the formation of toxic products.

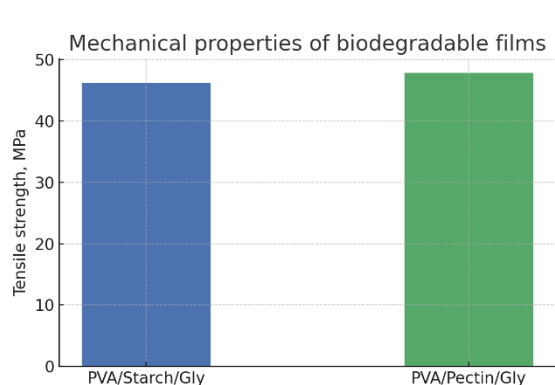


Figure 1. Tensile strength of biodegradable films based on PVA and polysaccharides. (PVA/Starch/Gly – 46.2 Mpa; PVA/Pectin/Gly – 47.8 Mpa)

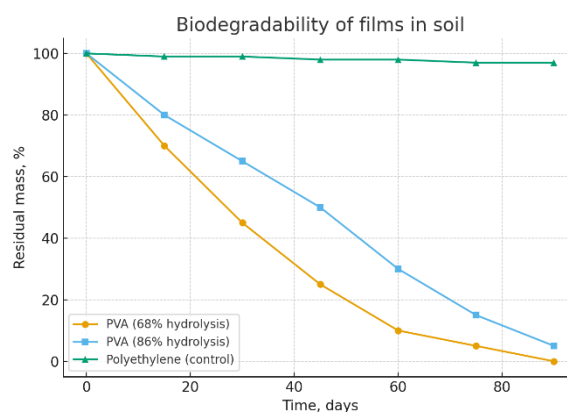


Figure 2. Biodegradability of films compared to polyethylene. (PVA with 68% degree of hydrolysis fully decomposes within ~90 days; PVA with 86% hydrolysis degrades more slowly; polyethylene shows almost no degradation)

For the first time, the dependence of properties on the molecular weight and degree of hydrolysis of PVA has been shown: with increasing molecular weight, the strength increases, while the biodegradation rate decreases. The materials were tested in industry (JSC “Nikol-Pack”) and demonstrated efficiency as an alternative to polyethylene packaging. The obtained results confirm the possibility of widespread application of such biodegradable compositions in the packaging industry and highlight their importance in reducing microplastic pollution in Uzbekistan.

## P-02 CHARACTERIZATION OF LUBRICANT WASTE FROM STEEL WIRING INDUSTRY AND ITS POTENTIAL INCLUSION IN A POLYMERIC MATRIX, WITHIN A CIRCULAR ECONOMY APPROACH

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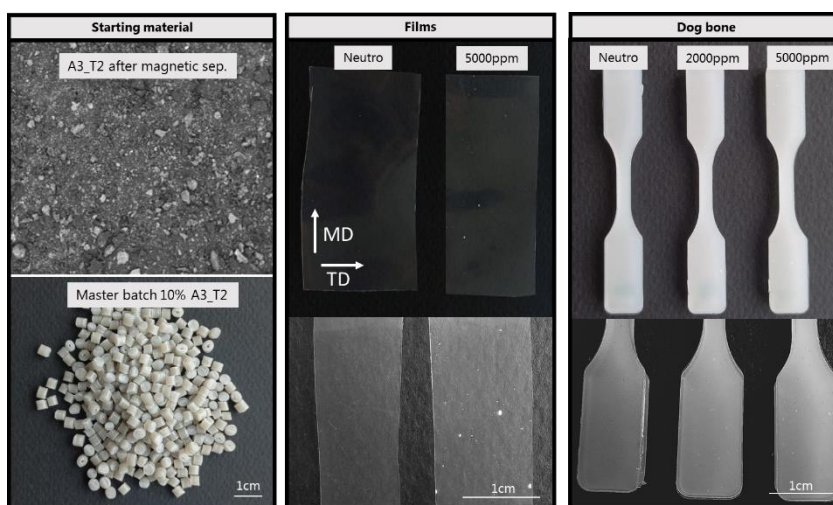
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The steel wire drawing industry generates large amounts of solid lubricant waste, primarily composed of sodium and calcium stearates. Managing this waste is becoming increasingly challenging due to stricter regulations and rising costs, urging for sustainable strategies. This study investigates the composition, variability, and potential reuse of lubricant waste from two industrial sites in Northern Italy (Lecco), aiming to reintroduce the material into polymeric matrices in line with circular economy principles.

Waste samples were characterized by proximate analysis, FTIR, XRD, XRF, DSC, and SEM-EDS techniques. Results revealed that the waste exhibits high ash (>50%) and low volatile solids content. FTIR and DSC confirmed the persistence of stearate components in the spent lubricants. Magnetic separation proved effective in removing iron, with SEM-EDS confirming final Fe content <1%. A selected waste sample, after pre-treatment, was used to produce LDPE-based masterbatches and composites containing 2000 and 5000 ppm of waste. Mechanical tests on the resulting materials showed promising processability, opening the path for potential industrial applications of these composites. This work demonstrates the feasibility of incorporating stearate-based lubricant waste into polymeric matrices after minimal treatment. Such a valorization route not only reduces the environmental pressure of disposal but also contributes to resource efficiency in material production.



## P-03 DRINKING WATER PURIFICATION FROM MICROPLASTICS

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Drinking water has been identified as one of the major sources of human exposure to micro- and nanoplastics. Current evidence demonstrates that conventional water treatment facilities are unable to effectively remove these particles from drinking water. Although a variety of purification methods have been proposed, they are generally multistage, energy-intensive, and costly, while still failing to achieve complete removal of micro- and nanoplastics. Alarmingly, studies have revealed that a single one-liter plastic bottle of drinking water may contain up to 100,000 submicron plastic particles. These particles are predominantly derived from widely used bulk polymers such as polyethylene, polypropylene, polyvinyl chloride, polystyrene, polyethylene terephthalate, polyamide, and others.

To date, the toxicity of micro- and nanoplastics to the human body has not been conclusively proven. However, it is highly probable that they exert adverse effects through their cumulative accumulation in tissues and their persistence due to slow degradation under natural conditions. For this reason, micro- and nanoplastics in water are considered among the most hazardous emerging contaminants and represent a serious environmental challenge.

Several biological, chemical, electrochemical, and physical methods have been investigated for the removal of micro- and nanoplastics; however, their large-scale application and economic feasibility remain questionable. The aim of the present study was to develop a simple and accessible method for removing micro- and nanoplastic particles from drinking water.

Boiling water has been a traditional practice across many cultures. In addition to disinfection, boiling eliminates certain pollutants such as by-products, microorganisms, bacteria, and multivalent metal ions ( $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Cu}^{2+}$ , etc.). When water of varying hardness is boiled, scale is formed, predominantly consisting of insoluble calcium and magnesium carbonate salts. Experimental evidence indicates that during boiling, micro- and nanoplastic particles become encapsulated by these insoluble carbonate salts, which significantly reduces their presence in boiled water. The reduction in polymeric micro- and nanoparticles is influenced by water temperature, heating duration, and the hardness of the original water.

In experiments where water of different hardness was boiled for 30 minutes, a clear dependence was observed between polymer particle reduction and initial water hardness. It was found that the efficiency of micro- and nanoparticle removal increased with water hardness in the range of 60–300 mg/L. At a hardness of  $80 \pm 5$  mg/L, the reduction of micro- and nanoplastic content ranged from 30% to 75%, whereas at higher hardness levels of 180–300 mg/L, removal reached 80–90%.

These findings demonstrate the potential of boiling as a practical household-level intervention for reducing micro- and nanoplastic contamination in drinking water. Nevertheless, further research is ongoing to better understand the mechanisms and optimize the efficiency of this process.

## **P-04 COMPUTATIONAL INSIGHTS INTO PROTEIN–MICROPLASTIC INTERACTIONS USING MOLECULAR DOCKING AND SHORT MD SIMULATIONS**

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Microplastics are increasingly recognized as emerging contaminants capable of interfering with biological systems. Their nanoscale fragments can interact with proteins and potentially disrupt essential physiological functions. Although large-scale molecular dynamics (MD) simulations are often too resource-intensive, molecular docking combined with short MD trajectories provides a cost-effective strategy for probing protein–microplastic interactions.

In this study, we explored model fragments of polystyrene (PS, 5–10 monomer units) and polyethylene terephthalate (PET, 3–5 monomer units) as representatives of plastic surfaces. Two model proteins were selected: human serum albumin (I), a transport protein in blood plasma, and lysozyme, an enzyme responsible for antibacterial defense. Protein–polymer binding was first investigated using AutoDock Vina, and then validated by 10–20 ns MD simulations in explicit water (GROMACS, CHARMM36 force field).

Docking results revealed distinct binding preferences.

**PS–I:** PS oligomers preferentially occupied hydrophobic cavities of albumin (binding energy  $\approx -6.5$  kcal/mol). They aligned along  $\alpha$ -helical bundles, displaced water molecules, and mimicked fatty acid or drug ligands. This suggests that PS could interfere with I's transport functions.

**PET–lysozyme:** PET oligomers interacted with polar residues near the catalytic Glu35 and Asp52 (binding  $\approx -5.2$  kcal/mol), forming stable hydrogen bonds. Such interactions may perturb enzymatic activity by altering conformational flexibility around the active site.

Short MD simulations confirmed the stability of these complexes and revealed structural changes. In the PS–I system, the backbone RMSD increased by  $\sim 2$  Å relative to unbound protein, accompanied by partial  $\alpha$ -helix unfolding and an  $\sim 8$ – $10\%$  rise in solvent-accessible hydrophobic surface area. For PET–lysozyme, the RMSD shift was smaller ( $\sim 1.3$  Å), but fluctuations in loop regions near the catalytic residues increased, with transient  $\beta$ -sheet disruptions observed around residues 40–50. PET maintained 2–3 hydrogen bonds throughout the trajectory, stabilizing alternative conformations of the active site.

Together, these results indicate two distinct mechanisms of potential toxicity: PS binding destabilizes hydrophobic  $\alpha$ -helical regions of albumin, whereas PET perturbs lysozyme by modifying  $\beta$ -sheet stability and active-site dynamics. Importantly, these insights were obtained using only modest computational resources, demonstrating that docking combined with short MD is sufficient to reveal mechanistic aspects of protein–microplastic interactions. Such approaches may serve as valuable tools for predicting microplastic toxicity and guiding further experimental studies.

## P-05 METABOLOMICS FOR ASSESSING THE CONDITION OF WHITEFISH FRY UNDER THE INFLUENCE OF MICROPLASTICS

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It is known that the accumulation of micro- and nanoplastics causes biomorphometric and behavioral changes, affects the processes of development and reproduction of aquatic organisms. Metabolomics is promising for a comprehensive assessment of a living organism, which allows us to assess changes and identify indicators (metabolites) reflecting the state of the object under study under the influence of various factors [1]. NMR spectroscopy is a generally recognized analytical method in metabolomics studies, as it makes it possible to identify and quantify low-molecular organic compounds in body fluids and tissues [2]. The aim of the work was to study the metabolic profile of whitefish fry using NMR spectroscopy under the influence of polyethylene terephthalate in the habitat. For testing, we used polyethylene terephthalate (PET) with a size of 0.4 to 1.4 mm, which was added to two 100-L aquariums with the following concentrations: experiment No. 1 – 1 g PET per 100 L of water (about 2 million PET particles) and experiment No. 2 – 5 g PET per 100 L (about 10 million PET particles), and we also used an aquarium without adding PET – experiment No. 3. Each aquarium was filled with 30 fry of the common whitefish subspecies – Baltic whitefish *Coregonus lavaretus pallasi*, with an average length of  $9.20 \pm 0.45$  cm and a weight of  $4.89 \pm 0.85$  g. The fish were fed commercial trout food with a fraction of 1.4-1.8 mm in an amount of 1% of the fish weight daily. The total duration of the experiment was 30 days.

The main metabolites were determined in aqueous extracts of fish muscle tissue by NMR spectroscopy at the M. M. Shemyakin and Yu. A. Ovchinnikov State Research Center of the Institute of Bioorganic Chemistry of the Russian Academy of Sciences. NMR spectra were recorded on a Bruker Avance III instrument (Bruker Biospin GmbH, Germany) with an operating proton frequency of 800 MHz. The spectra were processed using TopSpin 3.6.1, Chenomx NMR Suite 9.02 software.

The principal component analysis was used to analyze the differences in the data set of identified compounds for three groups of fish and to clarify the role of PET on their metabolic profile. It was shown that the studied fish samples form separate clusters, with the most pronounced cluster noted for the fish of experiment No. 2. The results of assessing the graph of the loads of the dynamics of metabolites made it possible to assess the biochemical changes in the body of fish. It was found that for fish that were in an aquatic environment with 10 million PET particles (experiment No. 2), in comparison with whitefish in experiment No. 1 and experiment No. 3, changes in metabolites were observed that characterize a violation of energy metabolism, oxidative stress, and the osmoregulation process. Consequently, significant changes in the body of whitefish fry depend on the concentration of PET in the environment.

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## **P-06 CELLULOSE PARTICLES AS A MODEL FOR BIODEGRADABLE MICROPLASTICS: COMPLEXES WITH POLYCATIONS AND THEIR CYTOTOXICITY**

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The accumulation of microplastics (MPs) is a growing problem. When polymeric materials decompose in the environment, stable MPs particles are formed, which can accumulate in ecosystems, creating potential risks for living organisms. One of the key concerns is their ability to adsorb various toxic substances such as heavy metals, pesticides and organic pollutants, and act as carriers in the environment and biological systems. This effect may increase their harmful impact on organisms. In recent years, biodegradable polymers have been proposed as environmentally friendly alternatives to conventional plastics. However, during degradation they can also release particles classified as MPs. Therefore, it is important to understand how such biodegradable particles interact with pollutants and whether these interactions affect their cytotoxicity. Among such pollutants, cationic polymers are of interest due to their use in water treatment, industry and biomedicine.

In this work, cellulose particles (200 – 250 nm in size) were used as a model of biodegradable MPs, since cellulose is a widely available natural and biocompatible polymer. Their interaction with three cationic polymers was studied: kaustamin (used in wastewater treatment), poly-L-lysine (applied in food industry and biomedicine), and poly(N-ethyl-4-vinylpyridinium) bromide (a synthetic polycation with well-known properties).

The results show that complex formation is followed by neutralization of the cellulose charge and subsequent surface recharging. The contact is found to be reversible: complexes can dissociate into individual components when salt is added, which confirms the electrostatic nature of the interaction. Cytotoxicity was evaluated for cellulose particles, individual polycations and their complexes using the MTT assay on fibroblast cells. Pure cellulose particles showed no toxicity. However, the complexes with polycations had cytotoxicity similar to the individual polycations at the same concentration. These results highlight the potential risks of complexes of biodegradable particles with pollutants for ecosystems.

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## **P-07 INFLUENCE OF MICROPLASTIC ADDITION ON SOIL HYDROPHYSICAL PROPERTIES**

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The scale of microplastic contamination of soils is extremely high and continues to grow, becoming a global environmental and food problem. According to FAO (2021), soils contain more microplastics than oceans, and agriculture is one of the main sources of plastic entering the soil. The presence of microplastics can lead to changes in the key physical properties of the soil, affecting its biological activity, structure and fertility. Microplastics can reduce the ability of the soil to form stable water-resistant aggregates, which leads to a loss of structural stability and a decrease in hygroscopicity (Lozano et al., 2021). It is noted that with a high concentration of microplastics (1-2% by weight) in sandy soils, a significant decrease in moisture retention was noted (Wang et al., 2023). Thus, the purpose of our study was to determine the effect of microplastics on the physical properties of soils: hygroscopic moisture and maximum moisture capacity with different particle-size distribution.

For the study, samples were taken from the surface horizons of soils of fallow agricultural lands of the Leningrad region with different particle-size distribution: sandy, sandy loam and loam. For laboratory studies, samples were prepared without the addition of microplastics and with its addition (polystyrene latex, particle diameter = 0.55 microns) at a concentration of 0.1% by weight, which corresponds to the average concentration of microplastics in uncontaminated soils (Vainberg et al., 2025). Hygroscopic moisture (HM) was determined by drying to an absolutely dry suspension at 105 °C, and maximum moisture capacity (MMC) was determined by holding the soil in a desiccator over a saturated solution of K<sub>2</sub>SO<sub>4</sub> until an equilibrium between soil moisture and vapor, followed by determination of soil moisture. The Tukey criterion was used to determine significant differences between samples without microplastic and with its addition.

The study demonstrates that the addition of polystyrene microplastics at a concentration of 0.1% of the soil mass does not lead to statistically significant changes in physical properties such as hygroscopic moisture and maximum moisture capacity, regardless of the particle-size distribution. This indicates that low concentrations of microplastics, corresponding to background pollution, do not significantly affect the key hydrophysical characteristics of soils under these conditions. The main reason is the insufficient mass of added particles to modify the total surface and hydrophilic properties of soil particles. Preliminary data were also obtained on the absence of an effect of this concentration of microplastics on the total specific surface area of soils, which, however, require clarification. At the same time, the results obtained do not exclude the potential negative effects of microplastics at higher concentrations or under different conditions, which requires further study.

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## **P-08 MAGNETIC EXTRACTION OF POLYETHYLENE TEREPHTHALATE MICROPARTICLES FROM WATER BY USING COMPOSITE MAGNETITE NANOPARTICLES WITH SILICON DIOXIDE, CHITOSAN AND GELATINE COATINGS**

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The active use of polyethylene terephthalate (PET) packaging inevitably leads to the spread of its small fragments in the environment. The amount of small PET particles accumulated and continuously entering the ground and water bodies cannot be quantified because of underdevelopment of methods for their collection and separation. The magnetic separation process can promote a selective extraction of dispersed micro- and nanoparticles from water under the influence of a non-uniform magnetic field.

In this study, the seeded magnetic sedimentation was used as a method for PET micro particles (MPET, 5–30  $\mu\text{m}$ ) extraction from aqueous media. For this, new magnetic composite nanoparticles were designed, characterized and explored as magnetic seeds which were able to aggregate with MPET. The engineered seeds had a complex structure, with magnetic cores of  $\text{Fe}_3\text{O}_4$  dispersed in polymer matrix of silicon dioxide with attached amino groups, chitosan and gelatine. Mechanisms of the  $\text{Fe}_3\text{O}_4@\text{SiO}_2\text{-NH}_2$ ,  $\text{Fe}_3\text{O}_4@\text{chitosan}$  and  $\text{Fe}_3\text{O}_4@\text{gelatine}$  particles heteroaggregation with MPET are van der Waals and electrostatic interactions, consequently, the heteroaggregates sizes and their sedimentation in water were influenced by the pH and by dissolved salts ions. The magnetic seeds had different morphology depending on the covering layer, which was reflected in the aggregation and sedimentation features.

To perform magnetic sedimentation of the heteroaggregates in water, a magnetic system assembled from the permanent  $\text{Sm}_2\text{Co}_{17}$  magnets was used, The system generated magnetic fields up to  $B_z \text{ max}=0.44$  T and  $(B_z \cdot \text{grad}B)_{\text{max}}$  up to 90  $\text{T}^2/\text{m}$ . which was sufficient for the high efficient magnetic sedimentation of MPET together with magnetic seeds.

It was found that at the starting concentration of MPET in water of  $c_0 = 0.1$  g/l the mass concentration of magnetic nanoseeds for the capture of 95% of MPET from distilled water and from the NaCl aqueous solution (600 mM) was 0.002 g /l. Both the polyethylene terephthalate microparticles and the magnetic nanoseeds can be extracted from the aquatic environment after 30 minutes of magnetic sedimentation.

*The work was carried out within the framework of the state assignment of the Ministry of Science and Higher Education of the Russian Federation for the IMP UB RAS («Magnet» № 122021000034-9, «Pressure» № 122021000032-5).*

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## **P-09 EVALUATION OF POLYSTYRENE MICROPARTICLES EFFECTS ON RABBITS (*ORYCTOLAGUS CUNICULUS*): A PILOT STUDY**

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The study of microplastic effects on biological systems is becoming increasingly important in light of the rapid rise in environmental pollution by plastic particles, which can be found in ecosystems and even in food products. Experimental studies on rodents and *Danio rerio* (zebrafish) have demonstrated that prolonged consumption of microplastics (particle diameter <5 mm) can disrupt intestinal barrier integrity, induce dysbiosis, cause metabolic disorders and neurotoxic effects, accumulate in various organs and tissues, and provoke a range of other pathological changes. However, such models have several limitations, including technical difficulties in working with small sample volumes, which may lead to artifacts and incorrect data extrapolation. These limitations can be overcome by using rabbits (*Oryctolagus*) in experimental studies. However, there are currently no data confirming the validity of the oral administration method for microparticles in this model system. Therefore, the aim of this study was to conduct a pilot experiment evaluating the effects of chronic oral administration of polystyrene latex at various doses on the biochemical and physiological parameters of rabbits (*Oryctolagus cuniculus*).

The impact of microplastics was studied in sexually mature female *Oryctolagus cuniculus* rabbits. A polystyrene latex solution with a concentration of 1 mg/ml and particle diameter of 5 µm was used as the orally administered microplastic. Two different doses, 5 mg/kg and 1 mg/kg of body weight, were analyzed over an 8-day period. Biochemical blood analysis (ALT, AST, urea, creatinine, phosphorus, amylase, total calcium) was performed on the first and last day of the experiment. Throughout the study, body weight, rectal temperature, and the condition of visible mucous membranes (oral cavity and sclera) were monitored. The comparison groups consisted of the same animals before and after chronic microplastic administration.

The study revealed that body weight remained stable (approximately  $5.0 \pm 0.6$  kg,  $p=0.75$ ), while rectal temperature and visual mucous membrane indicators (sclera and oral cavity) showed no significant changes and did not differ between groups ( $p>0.5$ ). Only in the 5 mg/kg group was a decrease in ALT observed following prolonged particle administration ( $p=0.034$ ). In the combined group (5 mg/kg and 1 mg/kg), ALT decreased by 27% by the end of the experiment ( $p=0.003$ ), while serum phosphorus levels increased by 10% ( $p=0.027$ ), and total calcium decreased by 4% ( $p=0.047$ ) by day 8 compared to baseline values.

Thus, the developed microplastic exposure model in *Oryctolagus cuniculus* can be considered effective, as no acute or pronounced pathological toxic effects of polystyrene microparticles were detected overall, including hepatic and renal parameters.

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## **P-10 AGING OF MODEL POLYSTYRENE MICROPARTICLES UNDER UV IRRADIATION**

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Polystyrene (PS) microplastics are widespread in the environment (degradation products of packaging materials, polymeric foams, etc.). All of them are simultaneously exposed to various factors (UV light, humidity, heat and cold, etc.). PS aromatic structure makes it especially sensitive to UV irradiation, since the benzene ring absorbs light in this wavelengths range. Thus, PS microplastics attract the attention of scientists, as they serve as an ideal model for studying the fundamental mechanisms of photoaging and the potential adverse consequences arising from this process. It is well-known that UV aging dramatically changes physico-chemical properties and structure of PS microparticles, as well as their chemical activity and ecological impact.

In this study, we simulated the process of natural UV aging by exposing the synthesized PS microspheres to controlled UV irradiation during different periods of time. A number of analytical techniques were used to elucidate the extent and depth of the changes that occurred. FTIR spectra revealed fundamental chemical changes on the surfaces of the microparticles. The peaks corresponding to C=O and COO<sup>-</sup> appeared and gradually increased. This directly confirms that photooxidation took place, with the PS aromatic structure degrading and new, more polar and reactive compounds being formed. This leads to a more negative surface charge on PS particles, which is reflected in a more negative zeta potential. The latter indicates increased surface acidity and greater potential for electrostatic interaction with various species in solution, including cells or contaminants. We studied the adsorption of Rhodamine B on the surface of both virgin and UV-aged PS microparticles and found differences in adsorption characteristics, with the aged PS showing gradually enhanced adsorption capacity due to increased surface functionalization.

Based on the results obtained, UV irradiation drastically alters PS microplastics, with the extent of change depending on the exposure duration. After UV exposure, the microparticles represent a fundamentally different material – more reactive and exhibiting larger specific surface area and sorption capacity. Thus, they can have a damaging effect by delivering adsorbed hazardous particles to living organisms. Therefore, to accurately estimate the impact of microplastics on the environment, one should use materials that have been preliminarily subjected to UV irradiation under conditions as close as possible to natural conditions.

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## P-11 THE EFFECT OF DIFFERENT DOSES OF MICROPLASTICS ON THE RESULTS OF STANDARD AGROCHEMICAL METHODS FOR MONITORING SOIL QUALITY

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Microplastic (MP) contamination of agricultural soils is becoming critically significant amid the global increase in the use of polymer materials in the agro-industrial complex. Over 400 million tons of plastic are produced worldwide annually, a significant portion of which (including mulching films, fertilizer packaging, and drip tapes) enters the soil. However, current laboratory methods used in agro-ecological monitoring are not adapted to MP contamination, and the impact of MP on such measurement results remains unclear. This contamination could potentially distort the obtained data, leading to incorrect interpretation of agricultural soil quality.

The aim of the study is to establish patterns of changes in key agro-ecological indicators of agricultural soils under the influence of microplastics within a concentration range of 0.0 to 0.1% of soil mass when applying standard laboratory methods. This gradient of MP concentrations (0.0-0.1%) corresponds to real contamination scenarios observed in agricultural lands where plastic mulches are used (according to FAO data, background concentrations in agricultural soils range from 0.01% to 0.08%). Soil organic carbon (SOC) content was determined using the Walkley-Black method as revised by FAO (2019) and on a CHN analyzer (LECO TruSpec MICRO, NY, USA). pH values were measured in aqueous suspension according to the FAO (2021) method. Total nitrogen content was determined using the Kjeldahl method as revised by FAO (2021). Clay content (<0.001 mm) in the granulometric composition was determined by sedimentation method. Polystyrene latex particles with a particle size of 0.51  $\mu\text{m}$  were used as the model contaminant.

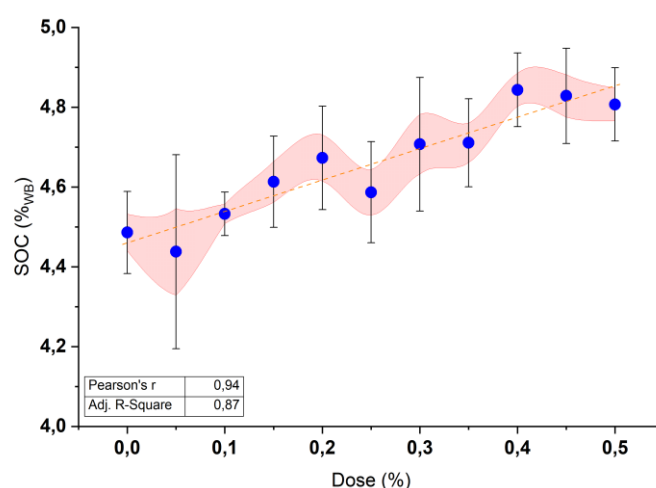


Figure 1. Changes in SOC concentrations (by Walkley-Black method) at different MP doses (mean  $\pm$  SD, 95% CI shaded,  $n = 5$ ).

It was found that among all tested soil quality assessment methods, statistically significant differences in measured parameters were obtained only when measuring SOC

by the Walkley-Black method (Figure 1). With increasing MP dose, SOC content significantly increased from  $4.48 \pm 0.10\%$  to  $4.80 \pm 0.10\%$  (Pearson's  $r = 0.94$ ,  $R^2 = 0.87$ ). For all other tested methods, no statistically significant differences in measurements at different MP doses were detected (pairwise comparison of results consistently showed that  $p > 0.05$ ).

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## P-12 SAMPLE PREPARATION OF RAT HEART SAMPLES TO DETECT MICROPLASTICS

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Environmental pollution by microplastic (MP) is raising increasing concerns about human health. Despite numerous claims regarding its toxicity, there is still no convincing evidence of direct harm at concentrations found in the environment. MP likely has a negative impact on health during prolonged exposure, but it is difficult to isolate its effects from those of many other environmental factors. Laboratory animals are used to better understand how MP accumulates in the body and affects health.

The present study aimed to develop an integrated approach to assess the accumulation of MP in rat organs. Two rat strains were used: Wistar and OXYS – a unique model of premature ageing. For this purpose, a method was developed to produce polyethylene terephthalate (PET) microparticles measuring 2–5 µm in size. Starting at 1.5 months of age, the animals were administered MP at two doses: 10 and 100 mg/kg of PET particles, given orally with food (Fig. 1). Wistar and OXYS rats that did not receive MP were used as controls.

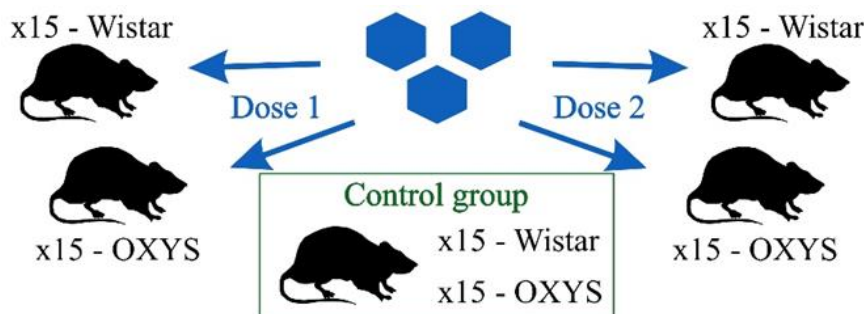


Fig. 1. Feeding scheme for rats

After two months, the animals were removed from the experiment in order to analyze the microplastic content in their organs (brain, heart, kidneys, liver, intestines, testes). Using the heart as an example, several sample preparation methods – including those described in the literature – were compared. However, these methods have several disadvantages that prevent further analysis by pyrolysis gas chromatography-mass spectrometry. For instance, certain reagents degrade MP particles, most organic components fail to dissolve and so on. Therefore, a new method for organ tissue digestion was developed, using formic acid and peracetic acid. The developed method of sample preparation was confirmed not to affect MP particles. The limit of detection and the lower limit of quantification of PET in the samples were also determined.

## **P-14 STUDY ON THE ADSORPTION OF METAL IONS ONTO MODEL POLYSTYRENE PARTICLES**

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To assess the risk of microplastics, it is necessary to study not only the impact of the particles themselves but also their adsorption properties to understand which toxicants can enter the organism along with these particles. In recent years, pollution of ecosystems with heavy metals due to anthropogenic activities has increased. Heavy metals are capable of bioaccumulation, and prolonged human exposure to these pollutants can lead to neurological disorders, liver and kidney diseases, and cardiovascular system damage. Moreover, arsenic, cadmium, chromium, and nickel are Group 1 carcinogens (Gao Xing, et al., 2021). Given these facts, sufficient attention must be paid to studying the adsorption properties of microplastics toward heavy metal ions.

Polystyrene particles with sizes of 150 nm, 300 nm, and 2  $\mu\text{m}$ , synthesized via emulsifier-free emulsion polymerization and dispersion polymerization, were used as model particles to study adsorption properties. The influence of variable synthesis parameters (mass ratio of components, temperature, synthesis time, stirring speed) on the size of the resulting particles was preliminarily described. The adsorption of cadmium (II) and copper (II) ions from solutions was investigated using a potentiometric method for ion concentration determination. The adsorption kinetics at 20°C and 40°C were described using the diffusion models of Boyd and Morris-Weber, as well as pseudo-first-order and pseudo-second-order models. Adsorption isotherms were constructed to describe the equilibrium adsorption of Cu (II) and Cd (II) ions by polystyrene particles, and the Langmuir, BET polymolecular adsorption, and Freundlich equations were applied.

For the adsorption of Cd (II) ions on polystyrene particles of different sizes, intraparticle diffusion predominates, and the adsorption follows a mixed physicochemical mechanism. For copper ion adsorption, external mass transfer contributes more significantly, and the adsorption mechanism is physical, driven by weak interactions between copper ions and surface groups.

Polystyrene particles demonstrate significantly higher adsorption capacity for Cd (II) ions compared to Cu (II) ions across all particle sizes. This may be due to differences in the chemical nature of the ions, their affinity for the functional groups of polystyrene, and the sizes of the hydrated ions. Adsorption occurs on an energetically heterogeneous surface (with functional groups acting as active centers). For both ions (Cu (II) and Cd (II)), a decrease in maximum adsorption capacity is observed with increasing polystyrene particle size.

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## **P-15 NANOMETER-SIZED PARTICLES OF HYDROGEL AS MODEL MICROPLASTICS: INTERACTION WITH POLYCATION IN SOLUTION AND PRECIPITATE**

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Recently, the problem of microplastics (MPs) – polymer particles 5 mm in size and less, which are divided into primary and secondary MPs, has become relevant. The primary MPs are specially prepared polymeric pellets and beads, which are used in medicine, cosmetics, household chemicals. The secondary MPs are formed as a result of the degradation of polymer products or wastes and particles of the primary MPs under different environmental conditions.

Synthetic microspheres are often used when studying biological and physico-chemical properties of MPs. Such model particles with a dense core and a smooth surface with functional groups on it adequately imitate the properties of the initial or primary MPs but cannot reproduce the structure of the aged or secondary MPs. The real MPs undergo aging under the influence of the environment. As a result, their aggregate stability and porosity change, sorption capacity to different substances including toxic ones (heavy metals, cationic polymers – polycations, antibiotics, etc.) increases. Subsequent contact of these particles with different organisms can cause various negative consequences.

In this work, the interaction of polycations with two types of model MPs: anionic polystyrene microspheres (PMs) with a size of 380 nm and anionic particles of microgel (MGs) with a size of 570 nm (copolymer of acrylic acid, N-isopropylacrylamide and a crosslinker) has been studied. The first type reproduced the structure of dense particles of initial MPs, the second type of particles, which are loose and permeable for the solvent and dissolved substances, imitated the structure of aged MPs. The interaction of model MPs with polycations was accompanied by neutralization of particles charge and aggregation of resulting complexes. When adding free MGs to the precipitate of MG-polycation complex polycations retained their mobility and redistributed between all MG particles in the system, that resulted in dissolution of the complex sediment and formation of the small negative MG-polycation complex particles in solution. Whereas no noticeable changes were observed in the system involving PMs and the precipitate preserved.

The results obtained indicate that the structure of MP particles influences their interaction with polycations and subsequent behavior of resulting complexes. MGs (model of aged MPs) are able to exchange of polycation macromolecules that promotes the spread of toxins in the environment. The role of MPs as a vector of toxic substances should be taken into account when discussing the environmental and biological impact.

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## **P-16 MICROPLASTIC FATE IN ARCTIC COASTAL WATERS: ACCUMULATION HOTSPOTS AND ROLE OF RIVERS IN SVALBARD**

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Little is known about the role of remote and sparsely populated Arctic coastal zones in the microplastic cycle. Distribution of microplastics was studied in the Svalbard fjords in June – July 2022 with the main goal of assessing rivers role in the fate of microplastic in Arctic coastal waters. Surface microplastics (0 – 20 cm depth, 500 – 5000 µm size) were sampled with a neuston net in triplicate per study site in parallel with sampling of subsurface microplastics with a pump system (1.5 m depth, 100 – 5000 µm size). The central part of Isfjorden and its several branches covering populated and unpopulated fjords were studied; the sampling was conducted during an intense riverine discharge in all studied sites. Maximum abundance of surface microplastics (71,400 items/km<sup>2</sup> or 0.19 items/m<sup>3</sup>, 0.19 mg/m<sup>3</sup>) was found along the river plume border in the middle of populated Adventfjorden indicating importance of both local sources and surface hydrodynamics in the formation of microplastics accumulation hotspots. All other unpopulated fjords were free of the floating on the sea surface microplastics as river discharge prevented transport of microplastics inside the fjords. The highest concentration of subsurface microplastics was found in the central part of Isfjorden and the lowest – in river plume waters, which also indicates the removal of microplastics from the inner part of fjords during an intensive river discharge. Our results may suggest that Arctic rivers flowing through unpopulated areas bring clean water and thereby reduce level of microplastic pollution in the coastal waters. In contrast to the rest of the world's ocean, rivers are not the main source of microplastic pollution in the Arctic Ocean.

## P-19 MOLECULAR DYNAMICS SIMULATIONS OF BISPHENOL A RELEASE FROM POLYVINYL CHLORIDE MICROPLASTICS

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Plastics based on polyvinyl chloride (PVC) represent one of the most widely used polymers in industry. A wide range of plastic materials based on PVC characterized by a large number of different additives. To reduce the fragility of PVC, various plasticizers are added to the polymer matrix, in particular bisphenol A (BPA)<sup>1</sup>. It is worth noting that the rate of release of plasticizers into the environment strongly depends on the size of the plastic particle<sup>2</sup>. Environmental conditions, particularly, water temperature, can further accelerate this process. This issue constitutes a substantial concern in practical applications such as PVC piping systems, where the leaching of plasticizing compounds may pose a significant environmental threat. A fundamental understanding of the leaching mechanisms at the atomic level is critical for developing safer and more stable polymeric materials.

In this study, we employed all-atom molecular dynamics simulations using the GROMACS software and the CHARMM36 force field to investigate the leaching of BPA from a PVC matrix into an aqueous environment. A model microplastic particle (surface) of 29 PVC molecules with polymerization degree of  $N_p=128$  in water with a density close to the experimental values was created for validating the system. The influence of 179 BPA molecules (18 wt.%) randomly distributed within the polymer volume on PVC chain dynamics was examined. During a 1-microsecond simulation at 298 K, we observed an increase in PVC chain mobility compared to pure PVC. Moreover, a slight redistribution of BPA in the system was observed: BPA molecules tended to move to the PVC/water phase interface. To accelerate the leaching process, the temperature was increased to 350 K. The results showed that during 500-nanosecond simulations, significant change in the structure of the system and the redistribution of BPA in PVC were observed. 30% of BPA molecules were desorbed at the phase separation region (water/PVC), while the remaining molecules predominantly aggregated with each other in the volume of PVC, which is consistent with the similar literature data<sup>3</sup>.

Thus, the study revealed the effect of plasticization of PVC with the addition of BPA, the process of leaching BPA from PVC into the water was investigated, and the redistribution of plasticizer in the polymer during the simulations was observed.

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## **P-20 THEORETICAL STUDY OF HOMOPOLYMER ADSORPTION ONTO MODEL MICROPLASTIC PARTICLES**

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Microplastics (MPs) are plastic particles smaller than 5 mm generated by chemical weathering, ultraviolet radiation, and physical fragmentation of larger plastic materials. Despite the active development of experimental studies on the adsorption of various macromolecules onto microplastics, which is associated with its widespread distribution in the environment and potential impact on ecosystems and living organisms, theoretical studies of adsorption of homo- and heteropolymers onto microplastic particles are also of great importance. Such studies not only deepen our understanding of the mechanisms of adsorption but also predict the behaviour of polymers under real conditions, which is important for assessing environmental risks and developing strategies to minimize the negative impact of microplastics.

The present work is devoted to the theoretical study of the adsorption of macromolecular pollutants — homopolymers — on model microplastic particles (MPs) by using the Scheutjens–Fleer self-consistent field (SF-SCF) numerical method. SF-SCF modelling was carried out in two stages: first, a certain number of polymer chains were put into a solvent to form a MP particle under poor solvent condition. In the second stage, a soluble polymer at a given concentration was added to the solution containing the MP particle. The interaction parameters between the polymers and the solvent and between the polymers themselves were chosen to keep the MP particle stable, so that the interaction of the dissolved polymer with the particle cannot break its integrity.

We investigated the effects of the homopolymer chain length, the homopolymer concentration in the solution, and the interaction parameters (homopolymer–solvent, homopolymer–microplastics, and microplastics–solvent) on the adsorption. It is shown that with an increase in the length of the dissolved polymer chains, the adsorbed amount and the number of monomer units in direct contact with the particle both increase. The number of adsorbed macromolecules shows a decrease at high polymer concentrations in the solution and non-monotonic behavior at moderate and low concentrations. An increase in the polymer concentration in solution leads to the growth in the amount of adsorbed polymer, but at the same time, the fraction of adsorbed monomer units in each macromolecule decreases. This indicates that increasing polymer concentration enhances competition for sites on the MP particle surface, and the adsorption of new chains leads to the partial desorption (that is, the decrease of the fraction of adsorbed units) of already adsorbed chains.

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## **P-23 MICROPLASTICS IN CRIMEAN GROUNDWATER: OCCURRENCE, IDENTIFICATION, AND TRANSPORT PATHWAYS**

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Water samples from the spring waters of the Crimean Mountains were analyzed to determine the abundance of microplastic particles. Despite low anthropogenic pressure, the Upper Jurassic fissure–karst aquifer is highly vulnerable to contamination. This study detected and characterized microplastic particles in mountain springs to outline their potential sources and transport pathways within a protected natural area.

In summer 2024, two one-liter samples were collected from each of three springs—Pania, Skelsky, and Demerdzhi—using pre-rinsed glass bottles. Microplastics were extracted by filtration through a syringe holder with a 1 µm glass-fiber filter. Retained particles were examined under 20× magnification using a Nikon Eclipse LV100N POL polarizing microscope, and images were processed in Helicon Focus. Polymer composition was identified by PY-GC-MS (Maestro GC–MSD, EI mode). Spectra were interpreted with Search-MPs Frontier Lab; matches above 50% confirmed polymer presence.

All springs contained polymeric particles, represented by fibers, films, and fragments, while microbeads were absent. Polystyrene was detected in all samples. Spring water from Pania also contained styrene–butadiene rubber; water from spring Demerdzhi additionally showed polypropylene, polyethylene, and nylon-66. Total concentrations reached 0.36–0.42 µg/L in Pania and Skelsky, and 3.34 µg/L in Demerdzhi.

Although composed of terrigenous rocks with inferior hydrodynamic characteristics (i.e., slower water exchange) compared to the karstic Ai-Petri Massif, the Demerdzhi spring exhibited higher polymer particle concentrations. This paradox is resolved by the significantly shorter flow pathways for microplastics from the source of contamination to the discharge point.-

Despite the area’s protected status, nearest potential microplastic sources are tourist sites and roads, while remote sources include plastic waste in the Black Sea, agricultural mulch, and municipal solid waste landfills. Microplastics can enter the aquifer through precipitation, surface runoff into karst sinkholes, and recharge through fissured rocks.

Even in nature reserves, groundwater contains microplastic particles of different shapes and chemical types. The results highlight the capacity of karst and fissure systems to transport particles during recharge and emphasize the need for standardized monitoring of mountain aquifers.

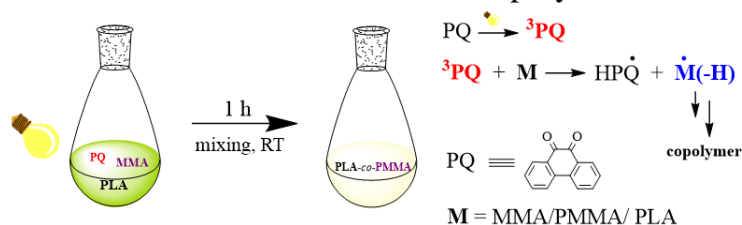
## P-24 SYNTHESIS OF HYBRID COPOLYMERS OF LACTIDE AND METHYL METHACRYLATE BY RADICAL PHOTOPOLYMERIZATION

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Due to the growing volume of annual production and disposal of plastic products, limited recycling and reuse, and the long-term degradability of materials, pollution is a serious environmental problem whose solution requires a systematic and high-quality approach. Most plastics are typically petroleum-derived polymers. These polymers (polystyrene, polyvinyl chloride, etc.) are not biodegradable. One solution to this problem is the use of biodegradable plastics such as polylactide (PLA). Since the mechanical and physical properties of PLA are well comparable to those of synthetic polymers, PLA and its copolymers are an environmentally friendly alternative to plastics made from petrochemical feedstocks. The primary methods used to modify PLA with vinyl polymers are atom transfer radical polymerization, reversible addition-fragmentation chain transfer, and ring-opening polymerization [1]. This study examines a method for producing lactide-methyl methacrylate (MMA) copolymers based on radical photopolymerization using a photoactivator 9,10-phenanthrenequinone (PQ). Due to its ability to undergo photoreduction via C-H bonds in monomers and/or polymers, PQ facilitates the formation of radical centers that lead to polymer adducts (Scheme 1) [2].



**Scheme 1**

A series of PLA-co-PMMA copolymers with varying MMA contents were synthesized. The amount of MMA was varied in molar ratios relative to the lactate moiety: 1:1, 1:5, 1:10, 1:15, 1:20, and 1:30 mol. The chemical structure of the copolymers was confirmed by  $^1\text{H}$  NMR and IR spectroscopy. The thermal properties of the obtained copolymer samples were studied.

*This work was completed as part of the Russian Ministry of Education's State Assignment No. 073-00056-25-00 to complete research in 2025 on the topic "New Hybrid Biocompatible (Co)Polymers for Medicine."*

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## P-25 LACTIDE POLYMERIZATION ON GROUP II METAL ALKOXIDES

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$[(\text{dpp-bian})^{2-}\text{Mg}^{2+}(\text{thf})_3]$  (**1**) ( $\text{dpp-bian} = 1,2\text{-bis}[(2,6\text{-diisopropylphenyl)imino}]$  acenaphthene; thf = tetrahydrofuran) represents highly active catalyst for ROP of lactide. Till now a nature of catalytic all active species has not been elucidated. In order to confirm that alkoxide species serve actually as catalytic species we have prepared magnesium and calcium isopropoxides,  $[(\text{dpp-bian})^{1-}\text{Mg}^{2+}(\mu\text{-OPr}^i)]_2$  (**3**) and  $[(\text{dpp-bian})^{1-}\text{Ca}^{2+}(\mu\text{-OPr}^i)_2\text{Ca}^{2+}(\text{thf})(\text{dpp-bian})^{1-}]$  (**4**) and studied their catalytic activity. We have found that catalytic activity of compounds **3** and **4** is similar to that of the complex **1**, which, in contrast of **3** and **4**, consists of dpp-bian dianion, but not its radical-anion. This is indirect confirmation of the formation of alkoxide derivatives in the course of the reaction of **1** with lactide.

*This work was completed as part of the Russian Ministry of Education's State Assignment No. 073-00056-25-00 to complete research in 2025 on the topic "New Hybrid Biocompatible (Co)Polymers for Medicine."*

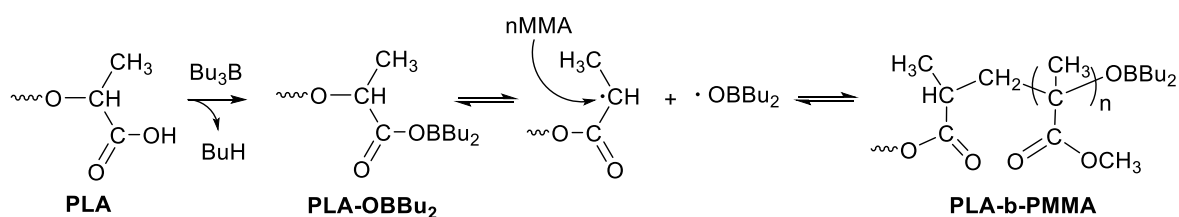
## P-26 NEW APPROACH TO BIODERADABLE BLOCK PLA-PMMA COPOLYMERS

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Two approaches for the preparation of polylactide-polymethylmetacrylate (PLA-PMMA) copolymers in the presence of tributylborane in tetrahydrofuran solution have been elaborated. The first one includes of a simultaneous treatment of a mixture of PLA and PMMA with  $n\text{Bu}_3\text{B}$ . The formation of both grafted as well as block copolymers has been observed besides a PMMA homopolymer. The second approach foresees an initial boration of PLA at the end-chain OH group to afford PLA-OBBu<sub>2</sub> species that dissociate to C-centered radical and Bu<sub>2</sub>BO• radical. The former initiates the polymerization of MMA to afford desired material PLA-block-PMMA.



*This work was completed as part of the Russian Ministry of Education's State Assignment No. 073-00056-25-00 to complete research in 2025 on the topic "New Hybrid Biocompatible (Co)Polymers for Medicine."*

## **P-27 THE CRITICAL ROLE OF PARTICLE SIZE IN MICROPLASTIC-POLLUTANT STABILITY: INSIGHTS FROM ATOMISTIC SIMULATIONS**

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The adsorption of pollutants onto the surfaces of micro- and nanoplastics particles in the environment, their bioavailability, and the potential for subsequent release are currently considered as one of the major health risks associated with microplastics [1].

The stability of contaminant adsorption can play an important role in assessing the impact of microplastics as carriers of contaminants in the environment. Molecular dynamics simulation is a powerful tool for studying the adsorption mechanism on the surface of microplastic particles [2]. However, the sizes of polymer particles in simulations vary widely [3]. This work investigates the influence of particle size in simulations on the stability of pesticide adsorption.

Reproducing the simulation [3] for a 1.5 nm diameter PS nanoparticle with ibuprofen moving for 100 ns of simulation confirmed the presence of a desorption process, which is fully consistent with the results of the referenced article and verifies our methodology.

When simulating particles of a similar size (1.5 nm) with pesticide molecules (DCVA, PCB), it was found that the desorption trend holds for this class of compounds. At the same time, there is a relationship: the lower the binding energy between the polymer and the pesticide, the more often desorption occurs (2-20 acts per 100 ns).

To test the hypothesis about the effect of the carrier size, a series of simulations were conducted with a particle with a diameter of 5 nm. No desorption was detected during 100 ns simulations. Increasing the simulation time from 100 ns to 1000 ns made it possible to observe desorption, but its frequency decreased to a single act per microsecond. Upon transition from a nanoparticle to a continuous polymer layer, the desorption process disappears completely during 1000 ns simulation.

The particle size strongly affects the stability of adsorption. This indicates the need for careful selection of models and a specific modeling time.

*This study was supported by the Ministry of Science and Higher Education of the Russian Federation (state contract no. 075-15-2025-016, MegaGrant).*

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## SOURCES OF MICROPLASTIC SUPPLY TO THE SEA OF AZOV

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The Sea of Azov is enclosed body of water, which, due to its limited coastline, is subject to high anthropogenic stress, and is also characterized by a complex circulation pattern. According to the research conducted by the SSC RAS and SFU, microplastics are found in all natural matrices of the sea – both in water and in bottom sediments and beach sand. Both anthropogenic and natural factors are important in the distribution of particles. The former act as sources of synthetic polymers, the latter ensure the movement of particles, acting as both natural barriers and transport routes.

The direct sources of microplastics entering the Sea of Azov are wastewater from urbanized territories, individual enterprises, and, mainly, sediment runoff from river basins. Large urban agglomerations are located directly on the coast – Mariupol, Taganrog, Berdyansk, Yeysk. In addition to factors such as population density and industrial activity, tourism is developed to varying degrees in large and small settlements, ports are also located and shipping is active, which, however, according to literature data, is considered the least source of microplastic pollution of natural waters.

The main impact on the pollution of the Sea of Azov by microplastics is exerted by the runoff of the Don River, where concentrations from 62 to 132 pcs/m<sup>3</sup> with an average value of 94 pcs/m<sup>3</sup> are recorded in the lower reaches. Thus, the number of particles entering the sea by river runoff is estimated at 203.8 tons/year. The runoff of the Kuban River, with the cities of Krasnodar, Maikop, Cherkessk, can also be attributed to a major source, but at the moment there is no data on the level of microplastic content in this facility. A significant contribution to the flow of microplastics into the Sea of Azov and small rivers is very likely, which also needs to be investigated. For example, the Yeya, Mius, Molochnaya and others rivers, especially worth noting is the Kalmius, which flows through the large cities of Donetsk and the aforementioned Mariupol, as well as a number of industrial centers.

These factors and patterns are reflected in the distribution of microplastic particles in the Sea of Azov and the location of "hot spots" of its concentrations. The effect of natural factors on the distribution is more complicated, for example, the relationship of its concentrations in bottom sediments with their granulometric composition, as well as benthic organisms at these stations, is being investigated.

*The work was carried out with the financial support of the Ministry of Education and Science of the Russian Federation (Agreement No. 075-15-2024-528 dated 04/24/2024 for the implementation of CIP in priority areas of scientific and technological development)".*

# ASSESSMENT OF MICROPLASTIC POLLUTION IN RIVER ESTUARINE ZONES: FIELD WORK EXPERIENCE IN THE PREGOLYA RIVER (BALTIC SEA), THE VOLGA DELTA, THE SEFID-RUD RIVER AND ANZALI LAGOON (CASPIAN SEA)

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The question of the presence of a zone of accumulation of microplastic particles in the estuarine areas of rivers (Schmidt et al., 2017) does not lose its relevance in connection with the practical issues of its collection on the way from the catchment area to the open space of the receiving reservoir. It is assumed that the estuarine microplastic maximum is apparently a common phenomenon in tidal estuaries (Jalón-Rojas et al., 2024). A similar phenomenon for non-tidal estuaries, typical for the Baltic and Caspian Seas, remains poorly understood.

Direct field research methods remain the only reliable tool for studying the mechanisms of microplastic retention and their manifestations in various conditions (Chubarenko et al., 2025). The study was carried out as part of the joint Russian-Iranian project "Biotic and abiotic zones of microplastic retention in the river-sea contact area" (2024-2026) funded by the Russian Science Foundation (Grant No. 24-44-20027, <https://rscf.ru/en/project/24-44-20027/>) and the Iranian National Science Foundation (Grant No. 4023398).

The project aims to investigate river-sea interfaces where particular matter, like suspended matter, sediments and other pollutants, should be retained and accumulate on their way from land-based sources to the ocean. The main working hypothesis is that the location and efficiency of microplastics retention zones are determined by the same external factors as for natural sediments or pollutants, but differ from them because plastic particles have specific physical properties that can also be changed over time depending on local environmental conditions and chemical-biological processes. Despite the abundance of publications, the questions about retention of microplastics at the river-sea interfaces is not well addressed.

The project assesses the level of microplastics pollution in the estuarine zones of the Prgolia River (Baltic Sea), the western segment of the Volga Delta within the Astrakhan State Nature Biosphere Reserve (Russia), as well as coastal waters in the south of the Caspian Sea within specially protected natural areas, namely, the corresponding parts of the mouth area of the Sefid-Rud River and the Anzali Lagoon (Iran). The report presents the first data from screening monitoring surveys (2024-2025) that showed a significant dependence of the distribution of microplastic particles on regime-forming factors that have a seasonal course. In this regard, it was decided to conduct screening work in each of the listed water areas in opposite hydrological seasons - low-water and high-water considering the temperature variations and its influence on biota.

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# WHAT IS THE DIFFERENCE? THE BEHAVIOUR AND PROPERTIES OF MICROPLASTICS PARTICLES IN AQUATIC ENVIRONMENTS IN COMPARISON WITH OTHER CONTAMINANTS

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Prediction of transport, fate, and distribution of microplastics particles (MPs, < 5 mm) in aquatic environments is still a very challenging task. Wide variety of particle properties (shape, size, material density) leads to substantial differences in their behaviour, while tremendous longevity (hundreds of years) under natural environmental conditions suggests variations of those properties with time and external forcing. As a result, modelling efforts have to be limited either to MPs subclasses (e.g., only floating MPs), or particular tasks (e.g., biofouling of certain shapes), or certain processes (e.g., beaching). To overcome these difficulties and streamline the efforts at this stage, an effective way is (i) to apply existing knowledge gained with transport and distribution of other particles/pollutants under natural conditions, exactly realizing the specific features of MPs, and (ii) to be based on the properties of MPs, their behaviours and distributions really observed in field studies.

This talk will provide an overview of the diversity of physical and dynamical properties of MPs particles in aquatic environments, such as material density range, shape, size, manner of sinking, threshold conditions for initiation of movement (Shields and Hjølström diagrams), behaviour under propagating wave and in swash zone, beaching, etc. (Chubarenko et al., 2024). Special attention will be paid to questions on where the classical approaches should be applied to MPs with certain caution. These investigations are currently supported by the Russian Science Foundation (RSF) in frames of the project 24-17-00099.

The concept of the Marginal Filter for sediments and contaminants, transported from land to the ocean, was applied to field studies worldwide, reporting on MPs contamination in rivers and estuaries (Chubarenko et al., 2025). Obviously, field data is very fragmentary up to now, however, laboratory experiments, in-situ, ex-situ studies with “natural” MPs confirm an importance of gravitational sedimentation, coagulation, flocculation, bio-assimilation processes also for MPs (RSF, Russian-Iranian project 24-44-20027).

Distribution of MPs *in natural sea ice* is merely characterized in field studies as “chaotic”, often with prevalence of larger (1-2 mm) MPs and relative deficit of fibers (in comparison with under-ice water). This is different from distributions of sediments, biota, or oil products (Chubarenko, 2022). Laboratory experiments revealed four mechanisms responsible for re-distribution of MPs within the ice: moving downwards with brine, upwards with air bubbles, and in the both directions - due to convection in ice mushy layer and variations in the density difference between plastic and brine.

*These investigations are supported by RSF via Russian-Chinese project 25-47-00030.*

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# MISCLASSIFICATION OF MICROPLASTICS IN DRINKING WATER: METHODOLOGICAL CAUSES

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The content, composition, and structure of microplastics in drinking water remain the subject of active environmental and hygienic research, which has gained particular significance in the context of implementing the United Nations Environment Assembly Resolution (UNEA 5/14, 2022). There are clear methodological biases, which become especially evident when analyzing large-size particles (0.1–1 mm) [1]. Such particles would inevitably be perceptible to consumers, yet this aspect is rarely mentioned in scientific publications. This indicates two systematic sources of error: on the one hand — false-positive results, when residues of biogenic origin — cellulose fibers, chitin fragments, organogels — are misidentified as synthetic polymers; on the other — false-negative results, when synthetic particles, covered by biofilms or organic shells, or modified through aging, are mistakenly excluded as “natural.” Pigments and dyes cause fluorescence and peak broadening in Raman spectra, masking polymer signals and lowering library match scores [1]. Similarly, surface modifications complicate the interpretation of IR spectra [3]. Together, these factors reduce comparability between studies and may lead to overestimation or underestimation of microplastic content in drinking water samples.

Based on the analysis of numerous sources [1–3], it seems advisable to develop a combined particle verification approach that minimizes both types of errors. The proposed sequential algorithm is as follows: a) primary classification using vibrational spectroscopy (micro-IR/micro-Raman) with expanded libraries (including dyes and biopolymers) and explicit quality control of matches; b) confirmatory thermal degradation analysis (pyrolysis–GC/MS) to determine the chemical nature of questionable particles and to distinguish synthetic polymers from biogenic materials; c) morphological diagnostics (optical/SEM, with optional staining or biomarkers) to account for shape, rigidity, fouling, and sample preparation artifacts. For the 0.1–1 mm fraction, it is additionally proposed to record the sensory “detectability” indicator (in model conditions) as an indirect marker of rigidity or fouling, followed by instrumental verification.

This approach would enable obtaining more comparable data on the concentration and composition of microplastic particles. Such methodological refinement is critical for accurate environmental and hygienic assessment and for developing realistic sanitary recommendations regarding microplastics in drinking water. Unfortunately, no analogous three-step protocol is proposed in the reviewed literature.

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# COMPARING THE ADSORPTION OF A MODEL POLAR POLLUTANT TO POLYSTYRENE MICROPARTICLES AND MICROPARTICLES FROM NATURAL SOURCES

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Polymer materials are important synthetic materials with a range of advantages such as low cost, low thermal conductivity, and water resistance; these properties contribute to their widespread use in daily life. When polymer materials are exposed to environmental conditions, various degradation mechanisms come into action. Microplastics (MPs) are the polymer particles with a size of 1  $\mu\text{m}$  to 5 mm. MPs can adsorb heavy metals, persistent organic pollutants, and other harmful substances in the environment, forming complex pollutants whose combined effects on organisms are significantly greater than those of a single pollutant [1]. Up to now scarce experimental data on the absorption of persistent chemical pollutants by microplastic particles are available, therefore, our study aims to answer the following question: what is the difference in the amount of persistent chemical pollutant sorbed by model microplastic particles made of polystyrene and microparticles of natural origin (silicon dioxide and cellulose)? Spherical and non-spherical cross-linked polystyrene microparticles with a diameter from 3 to 5  $\mu\text{m}$  were synthesized as model microplastic particles and compared with silicon dioxide microparticles with a size of 10 to 150  $\mu\text{m}$ , cellulose microparticles with a size of 10 to 50  $\mu\text{m}$  (Fig.1). Rhodamine B was selected as a persistent chemical pollutant. It was shown that the sorption capacity depended on the degree of aging of the model polystyrene microparticles.

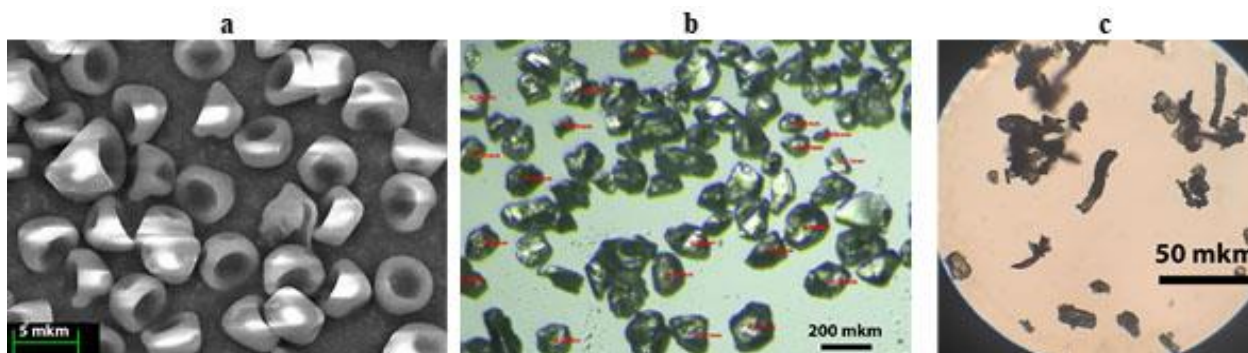


Fig.1 SEM of non-spherical cross-linked polystyrene microparticles (a), optical microscopy of silicon dioxide microparticles (b) and cellulose microparticles (c).

*This study was supported by the Ministry of Science and Higher Education of the Russian Federation (state contract no. 075-15-2024-629, MegaGrant).*

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# DIURNAL DYNAMICS OF ATMOSPHERIC MICROPLASTIC CONTENT IN THE CENTRAL REGIONS OF UZBEKISTAN

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Microplastics (MPs), defined as plastic particles smaller than 5 mm, have emerged as ubiquitous environmental contaminants (Zhang et al., 2020). While their occurrence in aquatic and soil systems has been extensively documented, the atmospheric transport and deposition of MPs remain an evolving research frontier (Shao et al., 2022). Recent advances highlight that atmospheric microplastics can travel long distances and deposit in remote regions, contributing to global plastic pollution cycles (Allen et al., 2019). Uzbekistan, located in Central Asia, represents an underexplored region regarding airborne microplastic pollution. This study aims to fill that gap by assessing the concentration, morphology, and temporal distribution of airborne MPs in Navoi (40°07'13"N, 65°22'40"E) and Bukhara (40°06'14"N, 64°42'17"E).

Atmospheric microplastic sampling was conducted using a Lanzoni VPPS2010 volumetric pollen trap mounted at a height of 25 meters. The device operates by drawing air through a narrow slit, where airborne particles adhere to a sticky tape mounted on a rotating drum. The drum rotates at a constant speed of 2 mm/h, allowing continuous collection over 24 hours. Samples were collected every two hours from 9:00 AM to 9:00 AM the following day, yielding 12 subsamples per site.

Collected tapes were examined under a BioBlue BB-4253 stereomicroscope equipped with a ToupView USB 2.0 CMOS digital camera and ToupView software (v4.12.29030). Suspected microplastic particles were visually identified based on color, shape, and surface texture. To confirm their synthetic nature, the 'hot needle test' was applied following established methodologies.

Preliminary analysis revealed the presence of multiple microplastic morphotypes, including fibers and fragments. In the samples collected from traps installed in Navoi and Bukhara,  $0.42 \pm 0.5$  and  $0.35 \pm 0.46$  units of microplastic per cubic meter of air, respectively, were detected. Higher MP counts were observed during the morning and early afternoon, followed by a decline toward evening and night hours.

## DIURNAL VARIATION OF AIRBORNE MICROPLASTICS, AUGUST 25

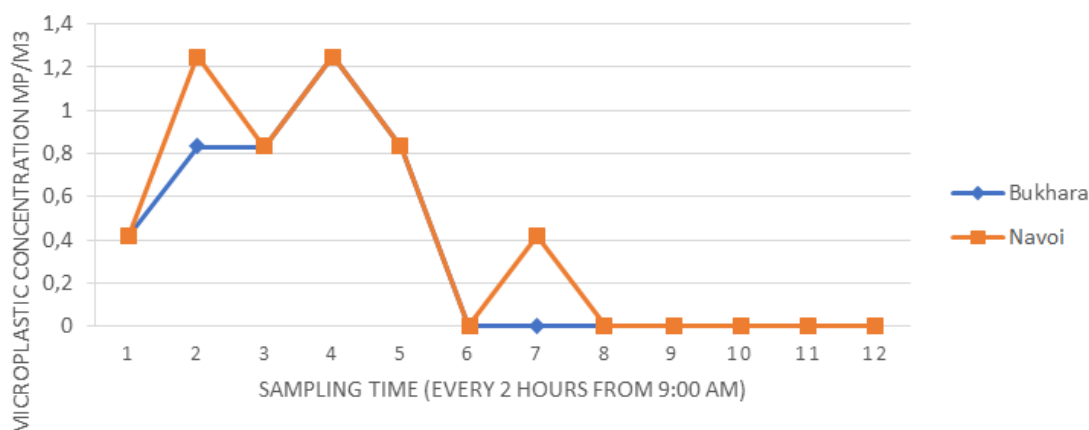


Figure 1. Diurnal variation of airborne microplastic concentrations in Bukhara and Navoi (August 25, 2025).

This pattern may be associated with increased human activity and wind turbulence during daytime hours. The concentration peaks correspond to the morning and afternoon periods, reflecting urban activity cycles such as transportation, construction, and surface wind resuspension. The lower night values suggest decreased emission and settling of particles. Bukhara, being more densely populated and located in a semi-arid steppe with active traffic, showed higher concentrations than Navoi, which is characterized by a more open landscape and moderate anthropogenic load.

These findings align with recent international studies reporting that microplastic deposition is influenced by local meteorological conditions, urbanization degree, and wind patterns.

The study confirms the presence of atmospheric microplastics in both Navoi and Bukhara regions of Uzbekistan. Temporal variations in MP concentrations over a 24-hour period highlight the importance of continuous monitoring to capture diurnal patterns. These findings contribute to the growing global dataset on airborne microplastic pollution and provide a scientific basis for future environmental management policies in Central Asia.

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