

# FRAMEWORK PROGRAMME OF EARLY STAGE RESEARCHER TRAINING<sup>1</sup>

# 1. BASIC DATA

Mentor's name and surname	Doc. dr. Manja Kurečič	Mentor's register number at <u>ARIS</u> ( <u>SICRIS):</u>	24332
Mentor's e-mail:	manja.kurecic@um.si	Mentor's tel. no.:	00386 2 220 7926
Research programme (RP) leader's name and surname:	Prof. dr. Lidija Fras Zemljič	RP leader's register number at <u>ARIS</u> ( <u>SICRIS</u> ):	19753
Title of research programme:	Textile Chemistry and Advanced Textile Materials	RP's Register number at <u>ARIS</u> (SICRIS):	P2-0118
Research organisation (RO) of University of Maribor, where training shall be conducted:	Faculty of Mechanical Engineering	RO Register number at <u>ARIS</u> (SICRIS):	0552-0795
Research field according to <u>ARIS classification</u> :	2.14.02 - Tekstilstvo in usnjarstvo	Research field according to Ortelius classification (EURAXESS)	Materials Engineering

## 2. DEFINITION OF RESEARCH PROBLEM AND GOALS OF DOCTORAL RESEARCH<sup>2</sup>

Starting point of research task of the early stage researcher and its position in the research programme, where the mentor is included, work hypothesis, research goals and foreseen result with emphasis on an original contribution to science:

Microplastic pollution and its impact on health are among the most pressing environmental challenges of our time, as chronic exposure to microplastics has become a hallmark of life in the 21st century. These microscopic particles have infiltrated every corner of the biosphere, integrated into food chains and ecosystems, and pose risks to organisms ranging from oceanic plankton to humans. Among the various types of microplastics, microfibers originating from textiles constitute a significant proportion of pollution, with an estimated annual release of approximately 0.48–4.28 million tons of microfibers into the environment. Microfibers are defined as natural or synthetic

<sup>&</sup>lt;sup>1</sup> Term early stage researcher (ESR) is written in male form and used as neutral for women and men.

<sup>&</sup>lt;sup>2</sup> Research and study programme of training have to harmonise with contents of the research programme, where the mentor is a member.

microscopic fibers released from textiles or related fibrous products, with a diameter of less than 50 µm, a length ranging from 1 µm to 5 mm, and a length-to-diameter ratio greater than 100. The term "microfibers" encompasses particles released from natural fibers (of plant or animal origin, e.g., cotton, wool), chemically regenerated natural fibers – semi-synthetic (e.g., viscose, lyocell), and synthetic textiles (e.g., polyester, acrylic). Synthetic microfibers degrade very slowly, if at all, under natural conditions, leading to their accumulation in the environment, with estimates suggesting that the microfiber content in the environment has already exceeded 5.6 million metric tons. Although natural and semi-synthetic fibers degrade more quickly, they often undergo chemical treatments with dyes, flame retardants, and antimicrobial agents, which may be harmful to the environment or act as carriers of toxic/hazardous compounds in aquatic ecosystems. Despite the concerning properties of microfibers, such as persistence, high specific surface area, and small size, microfiber pollution remains largely unregulated. The anticipated increase in textile consumption is likely to exacerbate this problem further.

Household textile laundering is frequently cited in both media and scientific literature as one of the primary sources of microfiber pollution. During washing and drying, textiles undergo chemical and mechanical wear, leading to fiber damage, the formation of cracks, and fiber detachment from fabrics. Without effective capture or removal mechanisms, these fibers, along with contaminants, are ultimately discharged into the natural environment, where they pose significant and long-term risks to ecosystems and biodiversity. Washing machine filters represent one of the most promising technologies for reducing microfiber release into wastewater, with manufacturers reporting removal efficiencies of up to 98%. Despite their potential, these filters are not yet standardized, highlighting the need for broader adoption and effective implementation strategies. The EU has set a goal to mandate these filters in household washing machines by 2027; however, slow progress in standardizing test methods for determining microfiber release rates, both qualitatively and quantitatively, hinders timely implementation. The lack of standardized analytical procedures, combined with the complexity of textile materials, has led to inconsistencies and non-comparability of published methodologies, data formats, and result presentations. Developing reliable and straightforward methods for microfiber quantification is thus crucial for policy formulation and monitoring, fostering innovation, and enabling effective responses to this pressing environmental issue. The research to be conducted within this doctoral dissertation is part of the Research Program on Textile Chemistry and Advanced Textile Materials. WORKING HYPOTHESIS:

By understanding the mechanisms of microfiber release during textile care and the influence of household washing and drying parameters, as well as developing analytical procedures for microfiber determination (qualitative and quantitative), we can improve the ability to remove microfibers from wastewater.

As part of the research project, the candidate for the young researcher position will focus on understanding the mechanisms of microfiber release during textile care processes (machine washing and drying), analyzing the impact of washing conditions (temperature, time, kinetics, detergent, etc.), different textile material compositions, textile finishing treatments, and more. The doctoral candidate's training will include studying filtration methods and modern analytical techniques for microfiber quantification and qualification. Special emphasis will be placed on the validation of analytical methods and the development of procedures for determining the composition and morphology of filter cakes.

## EXPECTED OBJECTIVES OF THE RESEARCH PROJECT:

- Training in analytical, organic, and polymer chemistry, independent interpretation of results, scientific research, and academic writing
- Understanding the mechanisms of microfiber release from textile materials during textile care processes
- Development and validation of methods for determining microfibers (qualitative and quantitative) in wastewater and filter cakes
- Assessment of the impact of various factors, such as temperature, washing time, detergent type, and presence of contaminants, on the quantity of released microfibers
- Understanding fiber-detergent-contaminant interactions and their influence on the microfiber release mechanism during washing
- Development and testing of new technologies/materials to reduce wastewater contamination from washing processes

## ORIGINAL CONTRIBUTION TO SCIENCE:

Since the environmental issue of microfibers generated during textile care processes is relatively new, the literature provides a limited number of sources, all of which share a common drawback: the lack of standardized analytical methodes (methodological approaches) that would enable comparability and relevance of data for understanding the microfiber release process in qualitative and quantitative terms. A significant gap exists in understanding fiber damage due to thermal and mechanical stress, as well as the consequent microfiber release mechanisms depending on textile care conditions and raw material composition, requiring a systematic approach. The doctoral student, within the scope of this dissertation, will aim to fill these gaps.

## 3. STUDY PROGRAMME

Foreseen study programme, to which early stage researcher shall be enrolled in academic year 2025/2026:

Doctoral Study Programme UM FS

## 4. DESCRIPTION OF WORK AND TASKS

Implementing projects of scientific research.
Taking part in the design of research programmes.
Cooperating with research sponsors.
Drawing up research and other reports.
Monitoring and coordinating research work according to the grant agreement.
Ensuring safety and health at work.
Organising and instructing employees and students on using personal safety equipment and other safety measures.
Performing other tasks at the behest of the superiors.
Participating in ad-hoc and permanent committees of university or faculty bodies.
Acting on behalf of colleagues and superiors during their absence (upon authorisation).
Participating in annual and other inventories.
Performing other related tasks delegated by superiors.

## 5. REQUESTED LEVEL OF EDUCATION

# VII/2. tariff group

#### 6. REQUESTED FIELD OF EDUCATION

Technical, Natural sciences

#### 7. KLASIUS SRV

Seventh level: Second cycle of higher and similar education/Second cycle of higher and similar education

## 8. KLASIUS P

- 145 Education of teachers of individual subjects
- 4 Natural science, mathematics and computing
- 5 Engineering, manufacturing and construction

## 9. REQUESTED KNOWLEDGE

Computer skills: MS Windows, Word, Excel, Internet, e-mail, e-commerce

## **10. REQUESTED SPECIAL REQUIREMENTS**

/

## **11. REQUESTED LANGUAGES**

Active knowledge of one world language

## 12. REQUESTED WORK EXPERIENCE

1

## 13. FORESEEN POSTDOCTORAL TRAINING

1

Mentor's signature:

Research programme leader's signature:

Name and surname of Dean or authorised person<sup>3</sup>: red. prof. dr. Matej Vesenjak

<sup>&</sup>lt;sup>3</sup> The training program is signed by the dean of the member where the ESR's employment and training will take place.

Signature of dean or authorised person:

Place and date:

Maribor

3. 02. 2025

Stamp: