Univerza v Mariboru

FRAMEWORK PROGRAMME OF EARLY STAGE RESEARCHER TRAINING[1]

1. BASIC DATA

Mentor's name and surname	**Mojca Škerget**	Mentor's register number at ARIS (SICRIS)**:**	**11865**
Mentor's e-mail:	mojca.skerget@um.si	Mentor's tel. no.:	+386 2 22 94 463
Research programme (RP) leader's name and surname:	Lidija Čuček	RP leader's register number at ARIS (SICRIS):	30944
Title of research programme:	Sustainable technologies and Circular Economy	RP's Register number at ARIS (SICRIS):	P2-0421
Research organisation (RO) of University of Maribor, where training shall be conducted:	Faculty of Chemistry and Chemical Engineering	RO Register number at ARIS (SICRIS):	0552-0794
Research field according to ARIS classification:	2.02.08	Research field according to Ortelius classification (EURAXESS)	15.5

2. DEFINITION OF RESEARCH PROBLEM AND GOALS OF DOCTORAL RESEARCH[2]

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:

Starting point and its position in the research programme: The aim of the research programme is to develop an integrated systems approach to advance the sustainability of modern industries by intensifying the use of renewable energy resources, waste management, climate change mitigation and the discovery of new materials and technologies that can transform waste into a resource, and to close the loops for waste materials. The research tasks therefore focus on recycling and the possible processing of waste products or materials into

[1] *Term early stage researcher (ESR) is written in male form and used as neutral for women and men.*

[2] *Research and study programme of training have to harmonise with contents of the research programme, where the mentor is a member.*

products with added value or the energy recovery of waste and waste materials at the end of their life.
Plastic is one of the most widely used materials in the world. Its favourable mechanical and thermal properties, its flexibility and its price make it a material that is used in industry and in everyday life. The accumulation of plastic waste presents a serious threat to ecosystems and human health. Recycling of plastics has long been seen as a potential solution to alleviating the plastic waste crisis, but traditional recycling methods face a number of challenges. Mechanical recycling methods, which are the most commonly used, are limited by the reducing of plastic quality through repeated processing, which reduces the value and applicability of the recycled material. Another problem is mixtures of different types of plastics and rubber (PE, PP, PET, PVC, PLA, PC, PS, PAN, PU) and composite plastics (metal, ceramic, etc.). One of the promising alternative, environmentally friendly technologies for recycling plastic waste is hydrothermal treatment, in which water is used as a reaction medium under supercritical and subcritical conditions. Water under subcritical and supercritical conditions can effectively break down a wide range of organic compounds without the need for additional solvents. The use of subcritical and supercritical water for the recycling of plastics and rubber has several advantages. Firstly, it enables complete depolymerisation, producing monomers or basic chemicals as products that can then be used to make new products or other valuable chemicals, or to produce oils or gases, which are alternative fuels with a similar energy value to fossil fuels. Secondly, the process is environmentally friendly as it avoids the use of hazardous solvents. This innovative and environmentally friendly technology has the potential to change the way we tackle plastic pollution, promote a circular economy and pave the way to a more sustainable future.

Working hypotheses and research goals:
As an alternative to conventional plastic recycling methods, hydrothermal degradation in subcritical and supercritical water can be used to break down plastics and convert them into secondary raw materials or alternative fuels. The course of the reaction pathways and the proportion and composition of the products depend on the type of plastic material and on process parameters such as temperature, pressure, material/water ratio, ratio of the different types of material and the presence of different catalysts. Therefore, in order to develop efficient hydrothermal recycling processes for different types of plastics, further fundamental and systematic research is needed to investigate the material properties, reaction mechanisms and process conditions and to discover their interactions. This knowledge is crucial for the successful conversion of waste into secondary raw materials and alternative fuels.
The objectives of the research are:
1. To develop new environmentally friendly hydrothermal processes for the recycling of plastic waste, to study reaction pathways and degradation kinetics, and to determine the optimal process parameters.
2. To study the applicability and commercial interest of the degradation products.
3. To assess the environmental impact, safety and economic viability of the developed recycling processes.

Expected results with an emphasis on original contribution to science:
The research tasks are in line with the strategic development goals, as new methods are being developed for waste management, recycling, the production of new raw materials, energy production and the transition to a circular economy. New fundamental knowledge will be gained about the reaction mechanisms and kinetics of the degradation reactions of plastics in subcritical and supercritical water without and in the presence of catalysts. Important new insights will be gained about the relationships between the properties of plastic materials, the parameters of the degradation process and the products generated, the effects on the environment, safety and the economic viability of hydrothermal processes. The results of the research will constitute new findings that will be published in high-ranking (IF) scientific journals and presented at international and national conferences.

3. STUDY PROGRAMME

Foreseen study programme, to which early stage researcher shall be enrolled in academic year 2024/2025:

Chemistry and Chemical Engineering

4. DESCRIPTION OF WORK AND TASKS

Implements scientific and research projects. Participates in design of research programmes. Works professionally with research clients. Prepares research reports and studies. Monitors and coordinates research work in accordance with funding agreements. Ensure safe and healthy working conditions. Organises and instructs staff and students in the use of personal protective equipment and other safety measures. Performs other related duties as directed by employee's line manager. Participates in working and standing committees of the UM and its members. Replaces colleagues and supervisor in their absence (by mandate). Participates in annual and other inventories. Performs other related work as assigned by superiors.

5. REQUESTED LEVEL OF EDUCATION

VII/2. tariff group

6. REQUESTED FIELD OF EDUCATION

Tehnical, Natural science

7. KLASIUS SRV

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

8. KLASIUS P

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

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11. REQUESTED LANGUAGES

Active knowledge of English language

12. REQUESTED WORK EXPERIENCE

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13. FORESEEN POSTDOCTORAL TRAINING

Yes

Mentor's signature:

Mojca Škerget Digitally signed by Mojca Škerget Date: 2024.02.26 11:12:40 +01'00'

Research programme leader's signature:

Lidija Čuček Digitally signed by Lidija Čuček Date: 2024.02.26 12:53:56 +01'00'

Name and surname of Dean or authorised person[3]:
Full prof. dr. Zoran Novak, dean

Signature of dean or authorised person:

ZORAN NOVAK Digitally signed by ZORAN NOVAK Date: 2024.02.28 21:22:44 +01'00'

Place and date:

Maribor, 26. 02. 2024

Stamp:

[3] The training program is signed by the dean of the member where the ESR's employment and training will take place.