

## Opis raziskovalnega dela (Research work description)

1. Članica UL (UL member):

Fakulteta za kemijo in kemijsko tehnologijo

2. Ime, priimek in elektronski naslov mentorja/ice (Mentor's name, surname and email):

Rok Ambrožič, [rok.ambrozic@fkkt.uni-lj.si](mailto:rok.ambrozic@fkkt.uni-lj.si)

3. Raziskovalno področje (Research field):

Kemijske znanosti – kemijsko inženirstvo

4. Opis raziskovalnega dela (Research work description):

Vključuje morebitne dodatne pogoje, ki jih mora izpolnjevati kandidat/ka za mladega raziskovalca/ko, ki niso navedeni v razpisu za mlade raziskovalce (It includes any additional conditions that the candidate for a young researcher must meet, which are not listed in the call to tender for young researchers.).

*Slov.:*

*Predvideno raziskovalno delo bo osredotočeno na razvoj in pripravo naprednih (elektro)odzivnih hidrogelov, zamreženih s kovinskimi ioni, s posebnim poudarkom na trajnostnih in zelenih rešitvah. Raziskava bo obravnavala ključne izzive pri širši uporabi hidrogelov, zlasti njihovo mehansko trdnost ter natančno nadzorovano morfološko in strukturno prilagodljivost.*

*Raziskovalec bo odgovoren za optimizacijo mehanskih lastnosti hidrogelov s pomočjo naprednih tehnik, kot so elektrodepozicija, ki omogoča natančen nadzor nad sol-gel pretvorbo in depozicijo hidrogela, ter anizotropno sušenje in naknadno zamreženje, kar bistveno izboljša strukturno stabilnost in mehansko odpornost materiala. Posebna pozornost bo namenjena oblikovanju hierarhičnih poroznih struktur, ki omogočajo izboljšano difuzijo reagentov in ionov, kar je ključno za njihovo uporabo v različnih aplikacijah.*

*Tako razvite hidrogelske sisteme bo raziskovalec integriral v mikropretočne naprave ter s pomočjo matematičnega modeliranja in numeričnih simulacij optimiziral njihove strukturno-mehanske lastnosti. Kombinacija eksperimentalnega in modelnega pristopa bo omogočila globlje razumevanje mehanizmov formiranja in prilagoditve hidrogelne strukture.*

*Razviti materiali bodo imeli širok spekter potencialnih aplikacij, vključno z:*

- *Sistemi za shranjevanje energije (npr. kot trdni elektroliti v baterijah in superkondenzatorjih),*
- *(Bio)katalizatorji za organske reakcije (z osredotočenjem na klik reakcije, temelječe na cikloadiciji),*
- *Antimikrobni materiali, primerni za biomedicinske in okoljske aplikacije.*

*Raziskovalna vsebina predstavlja pomemben prispevek k kemijskemu inženirstvu, saj združuje inovativne pristope vede o materialih in procesnega inženirstva z uporabo sodobnih eksperimentalnih in računalniških metod. Poleg tega je tematika relevantna tudi za lokalni razvoj, saj ponuja priložnosti za prebojne tehnološke inovacije na področjih zelene kemije, shranjevanja energije in bioaktivnih materialov.*

*Od kandidata se pričakuje visoka motivacija za raziskovalno delo ter sposobnost samostojnega in kritičnega razmišljanja. Predhodno znanje ali izkušnje s področja polimernih materialov, elektrokemije ali numeričnega modeliranja so zaželene, vendar niso nujne. Prav tako se pričakuje pripravljenost za delo v interdisciplinarnem okolju ter zmožnost nadgrajevanja eksperimentalnih in teoretičnih pristopov.*

*Eng.:*

*The proposed research will focus on the development and preparation of advanced (electro)responsive hydrogels crosslinked with metal ions, with a particular emphasis on sustainable and green solutions. The study will address key challenges in the broader application of hydrogels, particularly their mechanical strength and precisely controlled morphological and structural adaptability.*

*The researcher will be responsible for optimizing the mechanical properties of hydrogels using advanced techniques such as electrodeposition, which enables precise control over the sol-gel transformation and hydrogel deposition, as well as anisotropic drying and subsequent crosslinking, significantly improving the structural stability and mechanical durability of the material. Special attention will be given to the design of hierarchical porous structures, which enhance the diffusion of reagents and ions, a crucial factor for their application in various fields.*

The researcher will integrate these hydrogel systems into microfluidic devices and optimize their structural-mechanical properties through mathematical modeling and numerical simulations. The combination of experimental and modeling approaches will provide deeper insights into the formation mechanisms and adaptability of the hydrogel structure.

The developed materials will have a broad range of potential applications, including:

- Energy storage systems (e.g., as solid electrolytes in batteries and supercapacitors),
- (Bio)catalysts for organic reactions (with a focus on click reactions based on cycloaddition),
- Antimicrobial materials, suitable for biomedical and environmental applications.

The research represents a significant contribution to chemical engineering, combining innovative approaches from materials science and process engineering with the application of modern experimental and computational methods. Furthermore, the topic is relevant for local development, offering opportunities for breakthrough technological innovations in green chemistry, energy storage, and bioactive materials.

The candidate is expected to demonstrate strong motivation for research work and the ability for independent and critical thinking. Prior knowledge or experience in polymer materials, electrochemistry, or numerical modeling is desirable but not mandatory. Additionally, the candidate should be prepared to work in an interdisciplinary environment and contribute to the advancement of both experimental and theoretical approaches.

5. Priloge, ki jih kandidat priloži k prijavi (Documents that the candidate submits with the application):

☒ **diplomska listina/potrdilo o zaključku študijskega programa** (diploma certificate for study programme, with which the candidate has enrolled/ will enroll in a doctoral degree programme)

☐ **priloga k diplomii/ potrdilo o opravljenih obveznostih** (official transcript of all the grades for study programme, with which the candidate has enrolled/will enroll in a doctoral degree programme)

☒ **potrdilo o do sedaj opravljenih obveznostih z ocenami študijskega programa, s katerim se bo kandidat prijavil na študij** (official transcript of all the grades the candidate has received so far for the study programme, with which the candidate will enroll to a doctoral degree programme)

☒ **nagrade** (awards (e.g. Prešeren Prize of the University of Ljubljana, Prešeren Prize of a University of Ljubljana member and/or another equivalent award))

☒ **bibliografija** (bibliography)

☒ **življenjepis** (CV)

☐ **motivacijsko pismo** (motivation letter)

☐ **opis dosedanjega sodelovanja pri raziskovalnem delu** (description of the candidate's research work)

☐ **osnutek idejne zasnove raziskovalnega dela** (preliminary research proposal)

☐ **priporočilno pismo** (letter of recommendation)

☐ **druge priloge** (other attachments)

## Opis raziskovalnega dela (Research work description)

1. Članica UL (UL member):

|                                                                                            |
|--------------------------------------------------------------------------------------------|
| Fakulteta za kemijo in kemijsko tehnologijo (Faculty of Chemistry and Chemical Technology) |
|--------------------------------------------------------------------------------------------|

2. Ime, priimek in elektronski naslov mentorja/ice (Mentor's name, surname and email):

|                                                    |
|----------------------------------------------------|
| Nataša, Čelan Korošin; natasa.celan@fkkt.uni-lj.si |
|----------------------------------------------------|

3. Raziskovalno področje (Research field):

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|--------------------|
| Kemija (Chemistry) |
|--------------------|

4. Opis raziskovalnega dela (Research work description):

Vključuje morebitne dodatne pogoje, ki jih mora izpolnjevati kandidat/ka za mladega raziskovalca/ko, ki niso navedeni v razpisu za mlade raziskovalce (It includes any additional conditions that the candidate for a young researcher must meet, which are not listed in the call to tender for young researchers.).

*Slov.: Glavni cilji raziskovalnega dela mladega raziskovalca so:*

- i) razviti model za analiziranje različne vrste odpadkov reciklabilne plastike in opredeliti posebne značilnosti le-teh, kot je razlikovanje po izvoru, številu ciklov recikliranja in stopnji onesnaženja;
- ii) razviti model, ki omogoča določitev vsebnosti reciklirane plastike v novih izdelkih na podlagi njihovih fizikalnih, kemijskih lastnosti;
- iii) oceniti morebitno okoljsko tveganje mikroplastike in nanoplastike iz recikliranih plastik;
- iv) razviti način za recikliranje plastike z uporabo fotokatalizatorjev;
- v) opraviti doktorski študij.

Naučil se bo ustreznih, sodobnih tehnik za karakterizacijo takšnih materialov; za vrsto polimera, odkrivanje onesnaževalcev in razgradnih produktov ter površinske spremembe s FTIR spektroskopijo, masno spektrometrijo z induktivno sklopljeno plazmo (ICP-MS) in za elementno analizo ICP-OES (optična emisijska spektrometrija) ali ICP-AES (atomska emisijska spektroskopija).

Predvsem pa se bo kandidat usposobil za delo v sodobno opremljenem laboratoriju za termično analizo, kjer se bo osredotočil na analizo termičnih in mehanskih lastnosti materialov. Eksperimente bo izvajal na najnovejših aparaturah za diferenčno dinamično kalorimetrijo (DSC), termomehansko analizo (TMA) in termogravimetrično analizo (TGA) s sklopitvenimi tehnikami MS, FTIR ali GC-MS ter termooptometrijo. Uporabljal bo tudi tehnike in postopke, povezane s katalitsko/fotokatalitsko aktivnostjo.

Kandidat mora izkazati zelo dobro pisno in govorno znanje angleščine, zelo dobro pisno in govorno znanje slovenskega jezika ali se zavezati, da se ga nauči. Kandidat mora biti ustvarjalen in inovativen ter imeti visoko stopnjo motivacije za samostojno delo v laboratoriju kot tudi v skupini. Usposabljal se bo za pisanje člankov in predstavitev na mednarodnih konferencah.

*Eng.: The main objectives of a young researcher's research work are:*

- (i) to develop a model to analyse the different types of recyclable plastic waste and identify their specific characteristics, such as differentiation by origin, number of recycling cycles and degree of contamination;
- ii) develop a model to determine the proportion of recycled plastic in new products based on their physical and chemical properties;
- iii) assess the potential environmental risk of microplastics and nanoplastics from recycled plastics;
- iv) develop a way to recycle plastics using photocatalysts;
- v) to write a doctoral thesis.

The candidate will learn appropriate state-of-the-art techniques for the characterisation of such materials: for polymer type, detection of contaminants and degradation products and surface modifications by FTIR spectroscopy, Inductively Coupled Plasma Mass Spectrometry (ICP-MS) and for elemental analysis by ICP-OES (Optical Emission Spectrometry) or ICP-AES (Atomic Emission Spectroscopy).

In particular, the candidate will be trained to work in our state-of-the-art thermal analysis laboratory, which focuses on analysing thermal and mechanical properties of materials. Experiments will be performed on state-of-the-art equipment for Differential Scanning Calorimetry (DSC), Thermomechanical Analysis (TMA) and Thermogravimetric Analysis (TGA) with coupling techniques MS, FTIR or GC-MS and Thermo-Optometry. He/she will also apply techniques and procedures related to catalytic/photocatalytic activity.

The candidate must have a very good command of written and spoken English and a very good command of written and spoken Slovenian or have the intention to learn it. The candidate must be creative and innovative and have a high level of motivation to work independently in the laboratory as well as in a team. He/she will be trained to write papers and present them at international conferences.

5. Priloge, ki jih kandidat priloži k prijavi (*Documents that the candidate submits with the application*):

- ☒ **diplomska listina/potrdilo o zaključku študijskega programa** (*diploma certificate for study programme, with which the candidate has enrolled/ will enroll in a doctoral degree programme*)
- ☒ **priloga k diplomii/ potrdilo o opravljenih obveznostih** (*official transcript of all the grades for study programme, with which the candidate has enrolled/will enroll in a doctoral degree programme*)
- ☒ **potrdilo o do sedaj opravljenih obveznostih z ocenami študijskega programa, s katerim se bo kandidat prijavil na študij** (*official transcript of all the grades the candidate has received so far for the study programme, with which the candidate will enroll to a doctoral degree programme*)
- ☒ **nagrade** (*awards (e.g. Prešeren Prize of the University of Ljubljana, Prešeren Prize of a University of Ljubljana member and/or another equivalent award)*)
- ☒ **bibliografija** (*bibliography*)
- ☒ **življenjepis** (*CV*)
- ☐ **motivacijsko pismo** (*motivation letter*)
- ☒ **opis dosedanjega sodelovanja pri raziskovalnem delu** (*description of the candidate's research work*)
- ☐ **osnutek idejne zasnove raziskovalnega dela** (*preliminary research proposal*)
- ☒ **priporočilno pismo** (*letter of recommendation*)
- ☒ **druge priloge** (*other attachments*)

## Opis raziskovalnega dela (Research work description)

1. Članica UL (UL member):

Fakulteta za kemijo in kemijsko tehnologijo

2. Ime, priimek in elektronski naslov mentorja/ice (Mentor's name, surname and email):

Marjan Jereb; [marjan.jereb@fkkt.uni-lj.si](mailto:marjan.jereb@fkkt.uni-lj.si)

3. Raziskovalno področje (Research field):

Organska kemija

4. Opis raziskovalnega dela (Research work description):

Vključuje morebitne dodatne pogoje, ki jih mora izpolnjevati kandidat/ka za mladega raziskovalca/ko, ki niso navedeni v razpisu za mlade raziskovalce (It includes any additional conditions that the candidate for a young researcher must meet, which are not listed in the call to tender for young researchers.).

Slov.: Usposabljanje mladega raziskovalca bo potekalo v okviru raziskovalnega programa P1-0230 Organska kemija: sinteza, struktura in aplikacija. Izhodišče izobraževanja bo usmerjeno v razvoj novih transformacij širšega seta organskih spojin. Kandidat bo pri svojem eksperimentalnem delu raziskoval vpliv strukture različnih tipov organskih spojin na potek pretvorbe z N-halogenirnimi reagenti. Značilnost N-halogenirnih reagentov je, da so relativno dobri oksidanti, tako da lahko pride do kompeticije med uvedbo halogenskega atoma in oksidacijo molekule, izključen ni niti kakšen drugačen tip pretvorbe. Pretvorbe bodo najprej testirane v manjšem merilu, nato pa še v večjem. Po analizi reakcijskih zmesi bodo izolirani produkti in ustrezno fizikalno-kemijsko in spektroskopsko karakterizirani. Mladi raziskovalec se bo v času trajanja izobraževanja seznanil z relevantno literaturo s področja raziskovanja, pri svojem delu bo usvojil spretnosti sinteznega dela od priprave eksperimenta, spremljanja reakcije, izolacije, metod čiščenja in spektroskopske identifikacije produktov. Cilj, ki ga želim izpolniti kot mentor mlademu raziskovalcu, je, da bi se v času trajanja podiplomskega študija razvil v odličnega raziskovalca na področju organske kemije.

Eng.: The training of young researcher will take place within the framework of the research program P1-0230 Organic Chemistry: Synthesis, Structure and Application. The starting point of the education will focus on the development of new transformations of a broader range of organic compounds. In the experimental work, the candidate will study the influence of the structure of different types of organic compounds on the course of transformation with N-halogenation reagents. It is characteristic of N-halogenation reagents that they are relatively good oxidizing agents, so that competition between the introduction of the halogen atom and the oxidation of the molecule can occur and another type of conversion is not excluded. The conversions will be first tested on a small scale and then on a larger scale. After analyzing the reaction mixtures, the products will be isolated and characterized by physico-chemical and spectroscopical methods. In the course of the training, the junior researcher will be familiarized with the relevant literature in the field of research and will acquire the skills of synthetic work from the preparation of experiments to reaction monitoring, isolation, purification methods and spectroscopic identification of the products. The goal that I would like to fulfill as a mentor of a young researcher is the development into an excellent researcher in the field of organic chemistry during the duration of the postgraduate studies.

5. Priloge, ki jih kandidat priloži k prijavi (Documents that the candidate submits with the application):

☒ **diplomska listina/potrdilo o zaključku študijskega programa** (diploma certificate for study programme, with which the candidate has enrolled/ will enroll in a doctoral degree programme)

☒ **priloga k diplomi/ potrdilo o opravljenih obveznostih** (official transcript of all the grades for study programme, with which the candidate has enrolled/will enroll in a doctoral degree programme)

☒ **potrdilo o do sedaj opravljenih obveznostih z ocenami študijskega programa, s katerim se bo kandidat prijavil na študij** (official transcript of all the grades the candidate has received so far for the study programme, with which the candidate will enroll to a doctoral degree programme)

☒ **življenjepis (CV)**

☒ opis dosedanjega sodelovanja pri raziskovalnem delu (*description of the candidate's research work*)

## Opis raziskovalnega dela (Research work description)

1. Članica UL (UL member):

FKKT UL

2. Ime, priimek in elektronski naslov mentorja/ice (Mentor's name, surname and email):

Prof. dr. Mitja Kolar, mitja.kolar@fkkt.uni-lj.si

3. Raziskovalno področje (Research field):

Analizna kemija

4. Opis raziskovalnega dela (Research work description):

Vključuje morebitne dodatne pogoje, ki jih mora izpolnjevati kandidat/ka za mladega raziskovalca/ko, ki niso navedeni v razpisu za mlade raziskovalce (It includes any additional conditions that the candidate for a young researcher must meet, which are not listed in the call to tender for young researchers.).

*Slov.:* Cilj raziskovalnega dela v sklopu izobraževanja mladega raziskovalca (MR) na področju analize kemije bodo globoka evtektična topila ali »deep eutectic solvents – DES«. DESi so zmes dveh ali več organskih ali anorganskih spojin, ki se pod optimalnimi pogoji utekočinijo in tvorijo stabilno topilo. Spojine v DES so povezane z vodikovimi vezmi, ena komponenta v DES deluje kot akceptor vodikove vezi druga pa kot donor vodikove vezi, evtektik pa ima nižje tališče kot posamezna spojina. Iz različnih kombinacij spojin, v različnih molskih razmerjih lahko pripravimo DESe relativno enostavno in hitro s segrevanjem, mešanjem, uporabo UZ, izparevanjem ali liofilizacijo. Glavne odlike DESOV so netoksičnost, biološka razgradljivost, DESi pa omogočajo tudi precej selektivno ekstrakcijo tarčnih analitov. V preteklosti smo v naši raziskovalni skupini že uspešno uporabili DESe za ekstrakcije fenolnih spojin iz različnih bioloških matric: aronije, hmelja in koriandra. V sklopu raziskovalnega dela MR bo glavni poudarek na uporabi DESov za ekstrakcijo biološko aktivnih in pomembnih analitov iz propolisa ter izbranih kovin in nekovin npr. fosforja iz realnih matric (biomasa, prst, sedimenti, odpadki). Poleg sinteze in uporabe DESov bo MR razvijal in uporabljal vse najsodobnejše pripadajoče analizne metode: HPLC/MS/MS, GC/MS, ICP/MS, ICP/OES itd.

*Eng.:* Deep eutectic solvents, or DESs, will be the target of research work in the training of a young researcher (MR) in the field of analytical chemistry". DESs are mixtures of two or more organic or inorganic compounds that form a stable solvent in a liquid under optimal conditions. The compounds in DESs are linked together by hydrogen bonds, with one component in DES acting as a hydrogen bond acceptor and the other as a hydrogen bond donor, and the eutectic has a lower melting point than the single compound. DESs can be prepared relatively easily and quickly from various combinations of compounds in different molar ratios by heating, mixing, ultrasonication, evaporation or freeze-drying. The key features of DESs are their non-toxicity and biodegradability, and DESs also require quite selective extraction of the target analytes. In the past, our research group has successfully used DESs for the extraction of phenolic compounds from various biological matrices: aronia, hops and coriander. The MR research will focus on the use of DESs for the extraction of biologically active and important analytes from propolis and selected metals and non-metals, e.g. phosphorus, from real matrices (biomass, soil, sediments, waste). In addition to the synthesis and use of DESs, MR will develop and apply all state-of-the-art associated analytical methods: HPLC/MS/MS, GC/MS, ICP/MS, ICP/OES, etc.

5. Priloge, ki jih kandidat priloži k prijavi (Documents that the candidate submits with the application):

☒ **diplomska listina/potrdilo o zaključku študijskega programa** (diploma certificate for study programme, with which the candidate has enrolled/ will enroll in a doctoral degree programme)

☐ **priloga k diplomii/ potrdilo o opravljenih obveznostih** (official transcript of all the grades for study programme, with which the candidate has enrolled/will enroll in a doctoral degree programme)

☐ **potrdilo o do sedaj opravljenih obveznostih z ocenami študijskega programa, s katerim se bo kandidat prijavil na študij** (*official transcript of all the grades the candidate has received so far for the study programme, with which the candidate will enroll to a doctoral degree programme*)

☐ **nagrade** (*awards (e.g. Prešeren Prize of the University of Ljubljana, Prešeren Prize of a University of Ljubljana member and/or another equivalent award)*)

☒ **bibliografija** (*bibliography*)

☒ **življenjepis** (*CV*)

☒ **motivacijsko pismo** (*motivation letter*)

☒ **opis dosedanjega sodelovanja pri raziskovalnem delu** (*description of the candidate's research work*)

☐ **osnutek idejne zasnove raziskovalnega dela** (*preliminary research proposal*)

☐ **priporočilno pismo** (*letter of recommendation*)

☐ **druge priloge** (*other attachments*)



## Opis raziskovalnega dela (Research work description)

### 1. Članica UL (UL member):

Univerza v Ljubljani, Fakulteta za kemijo in kemijsko tehnologijo (University of Ljubljana, Faculty of Chemistry and Chemical Technology)

### 2. Ime, priimek in elektronski naslov mentorja/ice (Mentor's name, surname and email):

Prof. Dr. Janez Košmrlj, janez.kosmrlj@fkkt.uni-lj.si

### 3. Raziskovalno področje (Research field):

Organska kemija (Organic Chemistry)

### 4. Opis raziskovalnega dela (Research work description):

Vključuje morebitne dodatne pogoje, ki jih mora izpolnjevati kandidat/ka za mladega raziskovalca/ko, ki niso navedeni v razpisu za mlade raziskovalce (It includes any additional conditions that the candidate for a young researcher must meet, which are not listed in the call to tender for young researchers.).

#### Slov.:

Kataliza je eno najpomembnejših področij kemijske znanosti, saj ima zaradi okoljskih, ekonomskih in številnih drugih razlogov pomembno vlogo v skoraj vsakem industrijskem procesu. Velik del naših raziskav se osredotoča na razvoj in razumevanje organokovinske homogene katalize (Nat. Commun. 2018, 9, 4814; <https://www.kosmrlj-group.com/>). Organokovinski katalizator je sestavljen iz dveh ključnih elementov, kovine in liganda, ki sta neločljivo povezana. Kovina na poseben način sodeluje z reaktantom, vendar le, če je obdana z ustreznim ligandom. Ligand določa reaktivnost katalizatorja, ga stabilizira in ustrezno aktivira. Ligand določa velikost in obliko aktivnega centra ter zagotavlja ustrezne fizikalne in optične lastnosti ter asimetrijo.

Eden od procesov, ki je močno odvisen od katalize, je devteriranje organskih spojin, zlasti kadar se vključuje pozno v zaporednem nizu reakcij in mora biti proces selektiven. Devterirane organske spojine so vedno bolj zanimive na številnih področjih organske, farmacevtske, ekološke in medicinske kemije. Primerno devterirane zdravilne učinkovine lahko na primer zagotavljajo večjo varnost, toleranco in učinkovitost pri uporabi. Primer je deutetrabenazin, izotopski izomer tetrabenazina, ki ga je FDA leta 2017 odobrila za zdravljenje vrste Huntingtonove bolezni.

Doktorski študent bo aktivno sodeloval pri razvoju homogenih katalizatorjev, ki bodo omogočali nove metode za pretvorbe različnih funkcionalnih skupin, vključno z izmenjavo vodikovega izotopa na tradicionalno nereaktivnih C–H skupinah. Iskali bomo katalitske sisteme in metode, ligande in kovine, ki bodo omogočali visoko kemo- in regio-selektivnost, učinkovitost, atomsko in stroškovno učinkovitost ter ekološko vzdržnost. Doktorski študent se bo naučil samostojno načrtovati in izvajati tudi najzahtevnejše poskuse v organokovinskem laboratoriju ter uporabljati in razvijati sodobne analitske in spektroskopske tehnike. Doktorski študent se bo naučil kritičnega razmišljanja ter objektivnega vrednotenja in predstavljanja rezultatov v raziskovalni skupini, na znanstvenih konferencah in v člankih v uglednih revijah. Kandidat mora tekoče govoriti angleško. Pomembna pogoja sta odlična motivacija in pripravljenost za samostojno in skupinsko delo.

#### Eng.:

Catalysis is one of the most important areas of chemical science as it plays a role in almost every industrial process due to environmental, economic and many other aspects. Much of our research focuses on the development and understanding of organometallic homogeneous catalysis (Nat. Commun. 2018, 9, 4814; <https://www.kosmrlj-group.com/>). The organometallic catalyst consists of two key elements, a metal and a ligand, which are inextricably linked. The metal interacts with the reactant in a specific way, but only if it is surrounded by a suitable ligand. The ligand determines the reactivity of the catalyst, stabilises it and activates it in a suitable way. The ligand determines the size and shape of the active centre and ensures the corresponding physical and optical properties as well as the asymmetry.

One of the processes that is highly dependent on catalysis is the deuteration of organic compounds, especially when the incorporation of deuterium occurs late in the reaction sequence and the process must be selective. Deuterated organic compounds are of growing interest in many areas of organic, pharmaceutical, ecological and medicinal chemistry. In drug design and development, carefully deuterated compounds can offer greater safety, tolerability and efficiency. One example is deutetrabenazine, an isotopic isomer of tetrabenazine, which was approved by the FDA in 2017 for the treatment of Huntington's disease.

The PhD student will actively participate in the development of homogeneous catalysts that provide new tool for the conversion of various functional groups, including hydrogen isotope exchange on traditionally non-reactive C–H groups. We will search for catalytic systems and methods, ligands and metals, that enable high chemo- and

regioselectivity, efficiency, atom- and cost-efficiency and sustainability. The PhD student will learn to independently plan and perform even the most challenging experiments in the organometallic laboratory and apply and develop modern analytical and spectroscopic techniques. The PhD student will learn critical thinking and the objective evaluation and presentation of results in the research group, at scientific conferences and in articles in high-ranking journals. The applicant should be fluent in English. Excellent motivation and the willingness to work independently and in a team are important requirements.

5. Priloge, ki jih kandidat priloži k prijavi (*Documents that the candidate submits with the application*):

☒ **diplomska listina/potrdilo o zaključku študijskega programa** (*diploma certificate for study programme, with which the candidate has enrolled/ will enroll in a doctoral degree programme*)

☒ **priloga k diplomi/ potrdilo o opravljenih obveznostih** (*official transcript of all the grades for study programme, with which the candidate has enrolled/will enroll in a doctoral degree programme*)

☒ **potrdilo o do sedaj opravljenih obveznostih z ocenami študijskega programa, s katerim se bo kandidat prijavil na študij** (*official transcript of all the grades the candidate has received so far for the study programme, with which the candidate will enroll to a doctoral degree programme*)

☒ **nagrade** (*awards (e.g. Prešeren Prize of the University of Ljubljana, Prešeren Prize of a University of Ljubljana member and/or another equivalent award)*)

☒ **bibliografija** (*bibliography*)

☒ **življenjepis** (*CV*)

☒ **motivacijsko pismo** (*motivation letter*)

☒ **opis dosedanjega sodelovanja pri raziskovalnem delu** (*description of the candidate's research work*)

## Opis raziskovalnega dela (Research work description)

1. Članica UL (UL member):

UL Fakulteta za kemijo in kemijsko tehnologijo

2. Ime, priimek in elektronski naslov mentorja/ice (Mentor's name, surname and email):

Marko Novinec, marko.novinec@fkkt.uni-lj.si

3. Raziskovalno področje (Research field):

Biokemija in molekularna biologija

4. Opis raziskovalnega dela (Research work description):

Vključuje morebitne dodatne pogoje, ki jih mora izpolnjevati kandidat/ka za mladega raziskovalca/ko, ki niso navedeni v razpisu za mlade raziskovalce (It includes any additional conditions that the candidate for a young researcher must meet, which are not listed in the call to tender for young researchers.).

Slov.: Plastični odpadki in njihova reciklaža predstavljajo enega največjih okoljskih problemov. Kot način za razgradnjo nekaterih vrst plastike, npr. polietilentereftalata, v koristne produkte se v zadnjem času intenzivno preučujejo različni mikrobní encimi. Mladi\_a raziskovalec\_ka bo v svojem delu z metodami proteinskega inženiringa razvijal\_a nove, izboljšane različice teh encimov. Osnovno izhodišče bo razvoj oligomernih različic teh sicer monomernih encimov ter himernih oblik encimov, ki sodelujejo pri razgradnji iste vrste plastike. Pri delu bo uporabljal\_a širok nabor metod s področja biokemije, molekularne biologije, encimatike in strukturne biologije.

Eng.: Plastic waste and its recycling is one of the biggest environmental problems. In recent years, various microbial enzymes are being intensively studied as a way to break down certain types of plastics, e.g. polyethylene terephthalate, into useful products. The young researcher will use protein engineering methods to develop new and improved versions of these enzymes. The basic starting point will be the development of oligomeric variants of these otherwise monomeric enzymes, as well as chimeric forms of enzymes involved in the degradation of the same type of plastic. The work will include a wide range of methods from the fields of biochemistry, molecular biology, enzymology and structural biology.

5. Priloge, ki jih kandidat priloži k prijavi (Documents that the candidate submits with the application):

- ☐ **diplomska listina/potrdilo o zaključku študijskega programa** (diploma certificate for study programme, with which the candidate has enrolled/ will enroll in a doctoral degree programme)
- ☐ **priloga k diplomi/ potrdilo o opravljenih obveznostih** (official transcript of all the grades for study programme, with which the candidate has enrolled/will enroll in a doctoral degree programme)
- ☒ **potrdilo o do sedaj opravljenih obveznostih z ocenami študijskega programa, s katerim se bo kandidat prijavil na študij** (official transcript of all the grades the candidate has received so far for the study programme, with which the candidate will enroll to a doctoral degree programme)
- ☐ **nagrade** (awards (e.g. Prešeren Prize of the University of Ljubljana, Prešeren Prize of a University of Ljubljana member and/or another equivalent award))
- ☐ **bibliografija** (bibliography)
- ☒ **življenjepis** (CV)
- ☐ **motivacijsko pismo** (motivation letter)
- ☐ **opis dosedanjega sodelovanja pri raziskovalnem delu** (description of the candidate's research work)
- ☐ **osnutek idejne zasnove raziskovalnega dela** (preliminary research proposal)
- ☐ **priporočilno pismo** (letter of recommendation)

☐ **druge priloge** (*other attachments*)

## Opis raziskovalnega dela (Research work description)

1. Članica UL (UL member):

FKKT

2. Ime, priimek in elektronski naslov mentorja/ice (Mentor's name, surname and email):

Matija Strlič, matija.strlic@fkkt.uni-lj.si

3. Raziskovalno področje (Research field):

Analizna kemija

4. Opis raziskovalnega dela (Research work description):

Vključuje morebitne dodatne pogoje, ki jih mora izpolnjevati kandidat/ka za mladega raziskovalca/ko, ki niso navedeni v razpisu za mlade raziskovalce (It includes any additional conditions that the candidate for a young researcher must meet, which are not listed in the call to tender for young researchers.).

Slov.:

Doktorska raziskava se osredotoča na razvoj naprednega, nedestruktivnega orodja na podlagi kalibracije in analize evalvacije kolorimetričnih senzorskih nizov za karakterizacijo materialov v muzejih, knjižnicah in arhivih. Senzorji, ki so že uveljavljeni v kliničnih aplikacijah, kot je analiza dihanja, so se izkazali za obetavne v znanosti o dediščini.

Doktorski raziskovalec bo razvil kolorimetrične senzorce za odkrivanje hlapnih organskih spojin (HOS) za identifikacijo materialov, zlasti za plastiko in dediščinske materiale na osnovi papirja. Na podlagi sond za določene skupine HOS bodo senzori nameščeni v bližini ali v predmetih, za detekcijo emisij. Glede na prehodne raziskave, ki povezujejo emisije HOS ter sestavo in razgradnjo materiala, bodo zbrani podatki omogočili identifikacijo vrst plastike ter oceno lastnosti papirja, kot sta vsebnost lignina in kislost. Metode strojnega učenja bodo v uporabi za analizo senzorskih podatkov, prepoznavanje vzorcev in razvoj napovednih modelov za identifikacijo, klasifikacijo in oceno razgradnje. Referenčne meritve, podprte s poskusi pospešenega staranja, bodo pomagale pri razvoju neporušne identifikacijske metode, ki jo bodo potrdile knjižnične in muzejske zbirke. Dejavniki, kot so lokacija senzorja, občutljivost, natančnost in območje zaznave, se bodo upoštevali pri optimizaciji meritev. Okoljski dejavniki, vključno s temperaturo, relativno vlažnostjo in izpostavljenostjo svetlobi, bodo prav tako predmet raziskave zaradi potencialnega vpliva na kakovost podatkov.

Poleg tega bo razvita metoda zaznavanja sprememb barve z uporabo naprav za slikanje, kot so DSLR kamere, skenerji, hiperspektralne kamere ali mobilne kamere, z validacijo s spektrofotometrijo in uporabo kalibracijskih tarč, kar bo zagotovilo zanesljive in ponovljive rezultate. Algoritmi strojnega učenja bodo lahko v pomoč pri izpopolnjevanju kolorimetrične analize z izboljšanjem natančnosti pri interpretaciji barv.

Uspešni kandidat se bo pridružil naši mednarodni raziskovalni skupini in prispeval k nacionalnim in mednarodnim raziskovalnim projektom, zato je znanje angleščine bistvenega pomena. Idealen kandidat mora imeti močno ozadje v eksperimentalni kemiji ali znanosti o dediščini, zlasti v analitični ali okoljski kemiji ali kemiji materialov. Dobro razumevanje statistike, analize podatkov in tehnik strojnega učenja je bistvenega pomena, skupaj z laboratorijskimi izkušnjami. Zaželeno so izkušnje pri delu z muzeji, knjižnicami ali arhivi, poznavanje programiranja (npr. Python, R ali MATLAB) in metod slikanja pa bi bilo zelo koristno. Kot del prijave se od kandidatov pričakuje, da predložijo kratek opis (največ eno stran) svojih prejšnjih raziskovalnih izkušenj, s poudarkom na strokovnem znanju na področju obdelave podatkov, statistične analize in tehnik modeliranja.

Eng.:

This PhD research focuses on developing an advanced, non-destructive tool by calibrating and assessing colorimetric sensor arrays for material characterization in museums, libraries and archives. These sensors, already established in clinical applications like breath analysis, have shown promise in heritage science.

The PhD researcher will develop colorimetric sensors to detect volatile organic compounds (VOC) for material identification, particularly for plastics and paper-based heritage materials. Equipped with probes for specific VOC groups, the sensors will be placed near objects or inside books to capture emissions over time. Given existing research linking VOC profiles to material composition and degradation, the collected data will enable the identification of plastic types, as well as the assessment of paper properties such as lignin content and acidity. Machine learning methods will be employed to analyze the sensor data, identify patterns, and develop predictive models for material identification, classification and degradation assessment. Reference measurements,

supported by accelerated ageing experiments, will aid in the development of a non-destructive identification method, which will be validated by library and museum collections. Factors such as sensor placement, sensitivity, accuracy, and detection range will be considered to optimize measurements. Environmental factors, including temperature, relative humidity, and light exposure, will also be assessed for their impact on data quality.

Additionally, a colour change detection method will be developed using imaging devices like DSLRs, scanners, hyperspectral imaging cameras, or mobile cameras, with validation through spectrophotometry or spectroscopy and using calibration targets, ensuring reliable and reproducible results. Machine learning algorithms could also aid in refining colorimetric analysis by improving accuracy in colour interpretation.

The successful candidate will join our international research team and contribute to both national and international research projects, so proficiency in English is essential. The ideal candidate should have a strong background in experimental chemistry or heritage science, particularly in analytical or environmental chemistry, or material chemistry. A strong understanding of statistics, data analysis, and machine learning techniques is essential, along with laboratory experience. Experience in working with museums, libraries, or archives is preferred, and familiarity with programming (e.g., Python, R, or MATLAB), and imaging methods would be highly beneficial. As part of the application, candidates are expected to submit a brief description (maximum one page) of their previous research experience, highlighting expertise in data processing, statistical analysis, and modelling techniques.

5. Priloge, ki jih kandidat priloži k prijavi (*Documents that the candidate submits with the application*):

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☐ **osnutek idejne zasnove raziskovalnega dela** (*preliminary research proposal*)

☒ **priporočilno pismo** (*letter of recommendation*)

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