Tomaž BerlecOpis raziskovalnega dela *(Research work description*)

1. Članica UL (*UL member)*:

Fakulteta za strojništvo (Faculty of Mechanical Engineering)

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

Tomaž Berlec tomaz.berlec@fs.uni-lj.si

3. Raziskovalno področje (*Research field*):

Proizvodni inženiring (Production engineering)

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.: Mladi raziskovalec se bo izobraževal na področju proizvodnega inženiringa vezanega na za namen razvoja varne in transparentne implementacije umetne inteligence za organizacijo in optimizacijo materialnega ter informacijskega toka v pametnih tovarnah. V sklopu raziskovanja se bo osredotočil na:

- *razvoj varnih metod z razložljivo umetno inteligenco,*
- *implementacijo mehanizmov sledljivosti odločitev,*
- *inteligentno načrtovanje in usklajevanje materialnih tokov v logistiki, proizvodnji ter distribuciji,*
- *optimizacijo informacijskih tokov za učinkovito vitko komunikacijo in obdelavo podatkov,*
- *avtomatizacijo odločanja z uporabo naprednih analitičnih modelov,*
- *optimizacijo porabe virov za zmanjšanje odpadkov in emisij.*

Raziskave bodo temeljile na več metodah: teoretične, numerične (modeliranje in simulacija) in eksperimentalne.

Mladi raziskovalec bo vpisan v redni doktorski študij na Fakulteti za strojništvo Univerze v Ljubljani s polnim financiranjem v celotnem obdobju usposabljanja. V okviru doktorskega študija bo pridobil in nadgradil teoretična in metodološka znanja, ki so nujna za uspešno samostojno raziskovalno delo.
V sodelovanju z mentorjem in somentorjem bo v prvem letu doktorskega študija na podlagi okvirne tematike varne in transparentne implementacije umetne inteligence za organizacijo in optimizacijo materialnega ter informacijska toka identificiral vrzeli v znanstveni literaturi. Na podlagi te analize bo oblikoval konkretna raziskovalna vprašanja, določil ustrezen metodološki pristop in prijavil temo doktorske disertacije.
V času doktorskega študija bo pod mentorstvom pripravil vsaj dva visoko kakovostna znanstveno-raziskovalna članka, ki bosta temeljila na njegovi disertaciji ter vsebovala jasno opredeljen znanstveni prispevek. Cilj bo objava v visoko rangiranih mednarodnih znanstveno-raziskovalnih revijah.
Mladi raziskovalec mora doktorski študij zaključiti pravočasno, torej pred iztekom obdobja financiranja, in uspešno zagovarjati doktorsko disertacijo.

Od kandidata oziroma kandidatke za mladega raziskovalca se pričakuje:

- *visoka motiviranost za znanstveno-raziskovalno delo,*
- *proaktivnost, ustvarjalnost in vztrajnost,*
- *samostojno, kritično in analitično razmišljanje,*
- *odlično pisno in ustno izražanje v strokovnem angleškem jeziku na raziskovalnem področju,*
- *odprtost v komunikaciji ter sposobnost samostojnega in timskega dela,*
- *zaželeno znanje poznavanja osnov umetne inteligence*

Pogoji:

- *zaključena druga stopnja tehnične smeri,*
- *znanje programiranja v Python programskem jeziku.*

Eng.: A young researcher will be educated in the field of production engineering to develop a safe and transparent implementation of artificial intelligence for organizing and optimizing material and information flow in smart factories. The research will focus on:

- *Developing secure methods using explainable artificial intelligence,*
- *Implementing decision traceability mechanisms,*

- *Intelligent planning and coordination of material flows in logistics, production, and distribution,*
- *Optimizing information flows for efficient lean communication and data processing,*
- *Automating decision-making through advanced analytical models,*
- *Optimizing resource consumption to reduce waste and emissions.*

The research will be conducted using a multi-methodological approach, incorporating theoretical analysis, numerical modelling and simulation, and experimental validation.
The young researcher will be enrolled in a full-time doctoral program at the Faculty of Mechanical Engineering, University of Ljubljana, with full financial support for the entire duration of the training. Throughout the doctoral studies, the candidate will acquire and refine advanced theoretical and methodological competencies essential for conducting independent scientific research.
In collaboration with the supervisor and co-supervisor, the researcher will, during the first year of the doctoral program, identify research gaps in the scientific literature concerning the secure and transparent implementation of artificial intelligence for material and information flow management and optimization. Based on this analysis, the candidate will formulate precise research questions, develop an appropriate methodological framework, and formally propose the doctoral dissertation topic.
Over the course of the doctoral studies, under the mentorship of the supervisor, the researcher is expected to produce at least two high-quality scientific research articles derived from the dissertation, demonstrating a clear scientific contribution. The objective is to publish these articles in high-impact, internationally recognized scientific journals.
The young researcher must ensure the timely completion of the doctoral program, i.e., before the expiration of the funding period, and successfully defend the doctoral dissertation.

The candidate for the young researcher position is expected to demonstrate:
- *Strong motivation and commitment to scientific research,*
- *Proactiveness, creativity, and perseverance,*
- *Independent, critical, and analytical thinking abilities,*
- *Excellent proficiency in written and oral academic English, particularly within the technical and research domain,*
- *Effective communication skills and the ability to work both independently and within a collaborative research environment,*
- *A foundational understanding of artificial intelligence methodologies (preferred).*

Requirements:
- *A completed second-cycle degree in a technical field,*
- *Proficiency in programming with Python.*

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))*

☒ **življenjepis** *(CV)*

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

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

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

Opis raziskovalnega dela *(Research work description*)

1. Članica UL (*UL member)*:

Fakulteta za strojništvo (Faculty of Mechanical Engineering)

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

Martin Česnik, martin.cesnik@fs.uni-lj.si

3. Raziskovalno področje (*Research field*):

Vibracijsko utrujanje 3D tiskanih struktur iz naprednih polimernih materialov (*Vibration Fatigue of 3D-Printed Structures Using Advanced Materials*)

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 je preučiti obnašanje vibracijskega utrujanja 3D-natisnjenih struktur, izdelanih iz naprednih polimernih materialov in kompozitov. Ti materiali se zaradi svojih izjemnih mehanskih lastnosti pogosto uporabljajo v letalski, avtomobilski in medicinski industriji. Študija bo analizirala vpliv parametrov tiskanja (npr. usmerjenost plasti, gostota polnila) na zmogljivost pri dinamični obremenitvi. Poleg tega bo ocenjen tudi vpliv okoljskih dejavnikov, kot sta temperatura in vlaga, na življenjsko dobo zaradi utrujanja in mehanizme odpovedi. S kombinacijo eksperimentalnih preizkusov in numeričnih simulacij bo raziskava razvila napovedne modele za utrujanje zaradi vibracij. Rezultati bodo prispevali k optimizaciji oblikovanja, izbire materialov in proizvodnih procesov, kar bo izboljšalo strukturno zanesljivost 3D-natisnjenih komponent v kritičnih aplikacijah.

Eng.: The aim of the research work is to investigate the vibration fatigue behavior of 3D-printed structures fabricated from advanced polymer materials. These materials are widely used in aerospace, automotive, and biomedical industries due to their superior mechanical properties. The study will analyze the influence of printing parameters (e.g., layer orientation, infill density) on fatigue performance under dynamic loading. Additionally, it will assess the impact of environmental factors such as temperature and humidity on fatigue life and failure mechanisms. Using a combination of experimental testing and numerical simulations, the research will develop predictive models for vibration-induced fatigue failure. The outcomes will contribute to the optimization of design, material selection, and manufacturing processes, enhancing the structural reliability of 3D-printed components for critical applications.

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

☒ **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)*
☒ **bibliografija** *(bibliography)*
☒ **življenjepis** *(CV)*
☒ **motivacijsko pismo** *(motivation letter)*

Opis raziskovalnega dela *(Research work description*)

1. Članica UL (*UL member)*:

Fakulteta za strojništvo (Faculty of Mechanical Engineering)

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

Andrej Kitanovski, andrej.kitanovski@fs.uni-lj.si

3. Raziskovalno področje (*Research field*):

Strojništvo (Mechanical Engineering)

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.: Skoraj polovico svetovne končne rabe energije predstavlja ogrevanje in hlajenje, pri čemer velika večina te energije še vedno temelji na fosilnih gorivih. Poleg tega se približno polovica letne svetovne rabe energije nanaša na odpadno toploto, ki ostaja neizkoriščena. Za razogljičenje in tudi defosilizacijo ogrevanja in hlajenja je potrebno implementirati izboljšave energetske učinkovitosti naprav in sistemov, izrabiti razpoložljivo odpadno toploto ter povečati rabo obnovljivih virov energije. Najučinkovitejši način za dosego teh ciljev je mogoč z uporabo tehnologij toplotnih črpalk. Za uporabo v bivalnem okolju so še posebej zanimive tiste vrste tehnologij toplotnih črpalk, ki omogočajo obratovanje brez gibljivih delov, vibracij ali prekomerne ravni hrupa in uporabo takih hladilnih sredstev, ki ne predstavljajo nevarnosti izpusta v okolje. Eno takih tehnologij predstavljajo termoelektrične toplotne črpalke, ki pa imajo dokaj nizek izkoristek pretvorbe energije. Zato so potrebne rešitve, ki bi omogočale izboljšanje njihove učinkovitosti. Raziskovalno delo bo obsegalo konceptualno zasnovo, simulacije in eksperimentalno delo na medsebojno povezanih področjih prenosa toplote, Peltier učinka ter toplotnih črpalk. Skladno z nalogo bo potrebno zasnovati posebne topografije prenosnikov toplote, izdelanih s pomočjo aditivnih tehnologij in le te (optimizirano) kombinirati s specifično prilagoditvijo Peltier modulov. Integrirano toplotno črpalko bo potrebno implementirati v izbranem realističnem primeru ter demonstrirati njeno delovanje pri različnih pogojih.

Prednost bodo imele kandidatke ali kandidati z znanjem fizike, strojništva ali elektrotehnike. Močno je zaželeno celovito razumevanje principov prenosa toplote in sposobnost izvajanja numeričnih simulacij in eksperimentalnega dela. Praktične izkušnje na teh področjih so izjemnega pomena, saj bodo pomembno prispevale k raziskovalnim ciljem. Sposobnost kritičnega razmišljanja, reševanja kompleksnih problemov in prilagajanja izzivom na področju energetsko učinkovitih ogrevalnih in hladilnih sistemov bo ključna za uspeh raziskovalne naloge. Prav tako mora kandidatka ali kandidat izkazovati izrazito natančnost, zanesljivost, dobre komunikacijske veščine in sposobnost dela v timu.

Eng.: Nearly half of the world's final energy consumption is devoted to heating and cooling, with the vast majority still reliant on fossil fuels. Furthermore, approximately half of the world's annual energy use is dissipated as waste heat, remaining largely untapped. To decarbonize and transition heating and cooling away from fossil fuels, it is imperative to implement improvements in the energy efficiency of devices and systems, recover or harness available waste heat, and increase the utilization of renewable energy sources.

Heat pump technologies offer the most efficient pathway to achieving these objectives. For residential applications, there is particular interest in heat pump technologies that operate without moving parts, vibrations, or excessive noise levels, while using refrigerants that pose no environmental risk if released. Thermoelectric heat pumps represent one such technology; however, their relatively low energy conversion efficiency presents a significant challenge. Consequently, innovative solutions are needed to enhance their performance.

The proposed research work will encompass conceptual design, simulations, and experimental investigations in the interconnected fields of heat transfer, the Peltier effect, the additive manufacturing, and heat pump technology. A key aspect of the project will involve designing specialized heat exchanger topographies using additive manufacturing techniques and optimally integrating them with the specific adaptation of Peltier modules. The resulting integrated heat pump will be implemented in a selected real-world scenario to demonstrate its operational capabilities under various conditions.

Candidates with a strong background in physics, mechanical engineering, or electrical engineering will be given priority consideration for this position. The ideal applicant should possess a comprehensive understanding of heat transfer principles and demonstrate proficiency in conducting numerical simulations and experimental work. Practical experience in these areas will be highly valued, as it will contribute significantly to the research objectives. The ability to think critically, solve complex problems, and adapt to emerging challenges in the field of energy-efficient heating and cooling systems will be essential for success in this research endeavor. *The candidate must also demonstrate exceptional precision, reliability, strong communication skills, and the ability to work in a team.*

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)*

☒ **druge priloge** *(other attachments)*

Opis raziskovalnega dela *(Research work description*)

1. Članica UL (*UL member)*:

Fakulteta za strojništvo (Faculty of Mechanical Engineering)

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

Andrej Kitanovski, andrej.kitanovski@fs.uni-lj.si

3. Raziskovalno področje (*Research field*):

Strojništvo (Mechanical Engineering)

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.: Skoraj polovico svetovne končne rabe energije predstavlja ogrevanje in hlajenje, pri čemer industrijski procesi doprinašajo polovico tega deleža. Od celotne rabe energije v industriji predstavlja procesna toplota kar tri četrtine, preostanek pa predstavljata mehansko delo in elektrika. Velika večina te energije še vedno temelji na fosilnih gorivih. Poleg tega se približno polovica letne svetovne rabe energije nanaša na odpadno toploto. Za razogljičenje in tudi defosilizacijo ogrevanja industrijskih procesov je potrebno implementirati izboljšave energetske učinkovitosti naprav in sistemov, izrabiti razpoložljivo odpadno toploto ter povečati rabo obnovljivih virov energije. Najučinkovitejši način za dosego teh ciljev je mogoč z uporabo tehnologij visoko-temperaturnih toplotnih črpalk. Od teh predstavlja parno-kompresijska tehnologija najbolj razširjen in energetsko najučinkovitejši način črpanja toplote do 200 °C. Slabost tehnologije predstavlja resna omejitev okoljskih, varnostnih zahtev in karakteristik hladiv. Naslednji problem predstavlja miniaturizacija naprav, saj danes najmanjše enote visoko-temperaturnih toplotnih črpalk dosegajo moči nad 20 kW. Hkrati je znano dejstvo, da nižanje moči in hkrati dimenzij vodi v dodatno znižanje energetske učinkovitosti naprav. Alternativno rešitev predstavljajo t.i. kalorične tehnologije, ki uporabljajo trdninska hladiva in teoretično dosegajo zelo visok eksergijski izkoristek. Ta je posledica reverzibilnosti procesov kaloričnih učinkov, ti pa so analogni procesom kompresije in ekspanzije. Med kaloričnimi tehnologijami predstavljajo tehnologije, ki temeljijo na elektrokaloričnem učinku, možnost izvedbe najbolj kompaktnih naprav in delovanje brez gibljivih delov. Posebno prednost pa predstavljajo razpoložljivi elektrokalorični materiali s faznimi prehodi pri visokih temperaturah, kar omogoča njihovo rabo v visoko-temperaturnih toplotnih črpalkah.
Cilj doktorskega dela je raziskati različne konceptualne rešitve visokotemperaturnih elektrokaloričnih toplotnih črpalk ter na podlagi analiz realizirati demonstracijsko napravo, s katero je moč eksperimentalno potrditi koncept in ovrednotiti delovanje pri različnih delovnih pogojih.

Prednost bodo imele kandidatke ali kandidati z znanjem fizike, strojništva ali elektrotehnike ter znanjem in izkušnjami s področja vsebine doktorskega dela.

Eng.: Nearly half of the world's final energy consumption is dedicated to heating and cooling, with industrial processes accounting for half of this share. Within industry, process heat constitutes approximately three-quarters of total energy use, while the remainder is divided between mechanical work and electricity. A significant portion of this energy still relies on fossil fuels. Moreover, about half of the world's annual energy use is wasted as heat.

To decarbonize and transition industrial process heating away from fossil fuels, several measures are essential: improving the energy efficiency of devices and systems, harnessing available waste heat, and increasing the adoption of renewable energy sources. High-temperature heat pump technologies offer one of the most effective solutions to achieve these goals. Among these technologies, vapor-compression systems are the most widely used and energy-efficient method for pumping heat up to 200 °C. However, this technology faces challenges such as strict environmental and safety requirements, as well as limitations related to refrigerant properties. Another issue is miniaturization—current high-temperature heat pump units typically operate at powers exceeding 20 kW. Reducing power and size often results in a further decline in energy efficiency.

An alternative approach lies in caloric technologies, which utilize solid refrigerants and theoretically achieve exceptionally high exergy efficiency due to the reversibility of caloric effect processes). Among these, electrocaloric technologies stand out for their potential to create highly compact devices that operate without

moving parts. A notable advantage is the availability of electrocaloric materials with phase transitions at high temperatures, enabling their application in high-temperature heat pumps.

The objective of this doctoral thesis is to explore various conceptual designs for high-temperature electrocaloric heat pumps. Based on these analyses, the goal is to develop a demonstration device capable of experimentally validating the concept and assessing its performance under diverse operating conditions.

Preference will be given to candidates with knowledge of physics, mechanical engineering or electrical engineering and knowledge and experience in the research field of the doctoral thesis.

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)*

☒ **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 existing research work, relevant to the research domain)*

☒ **druge priloge** *(other attachments)*

Opis raziskovalnega dela *(Research work description*)

1. Članica UL (*UL member)*:

Fakulteta za strojništvo (Faculty of Mechanical Engineering)

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

Jernej Klemenc, jernej.klemenc@fs.uni-lj.si

3. Raziskovalno področje (*Research field*):

2.11 Konstruiranje – 2.11.03 Specialna razvojna znanja

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.:

Tema usposabljanja mladega raziskovalca bo vezana na razvoj metodologij za napovedovanje dobe trajanja sendvič kompozitnih struktur, v katere so dodana granulirana polnila za dušenje vibracij. Sendvič strukture bodo sestavljene iz spodnje in zgornje plasti večplastnega kompozita ogljikovih vlaken in umetne smole. Med zgornjo in spodnjo plastjo kompozita bo vstavljeno aluminijasto satovje, katerega celice bodo zapolnjene z različnimi granuliranimi materiali s ciljem boljšega dušenja vibracij. Usposabljanje bo kombinacija laboratorijskega dela in numeričnih simulacij. Potrebna znanja bo mladi raziskovalec pridobil med samim usposabljanjem.

Usposabljanje bo potekalo tako, da se bo mladi raziskovalec najprej seznanil s širšim področjem problematike in se nato omejil na ožje področje obratovalne trdnosti kompozitnih sendvič struktur z granuliranimi materiali. Ta del usposabljanja bo potekal preko opravljanja izpitov in seminarjev na doktorskem študiju UL-FS. Nato bo s pridobljenimi znanji izbral najperspektivnejše kombinacije materialov, ki omogočajo najboljšo kombinacijo med lahko gradnjo in dušilnimi sposobnostmi. Razdelal bo načrt eksperimentalnega dela, katerega cilj bo pridobitev čim več uporabnih rezultatov v dani časovni omejitvi. S pomočjo statistično obdelanih eksperimentalnih rezultatov bo nato postavil model za numerično napovedovanje dobe trajanja, ki bo uporaben tudi za zgodnje faze razvoja izdelkov, ko ustrezni prototipi še niso na voljo.

Med svojim usposabljanjem bo mladi raziskovalec napisal in objavil dva izvirna znanstvena članka in se udeležil vsaj ene mednarodne konference iz širše tematike njegovega usposabljanja.

Eng.:

The topic of the young researcher's training will be related to the development of methodologies for predicting the service life of sandwich composite structures, to which granular fillers for vibration damping are added. The sandwich structures will consist of the lower and upper layers of a multilayer composite of carbon fibres and epoxy matrix. An aluminium honeycomb will be inserted between the upper and lower layers of the composite. The honeycomb cells will be filled with various granular materials to improve damping properties of the sandwich structure. The training will be a combination of laboratory work and numerical simulations. The young researcher will acquire the necessary knowledge during the training itself.

The training will be carried out in such a way that the young researcher will first study the broader field of the research domain and then limit himself to the narrower field of operational strength of composite sandwich structures with granular materials. This part of the training will be carried out through exams and seminars at the doctoral study program at UL-FS. With a help of the acquired knowledge, the young researcher will select the most promising combinations of materials that enable the best trade-off between the lightweight design and damping capabilities. He/she will develop an experimental work plan in order to obtain as many useful experimental results as possible within a given time limit. After the statistical processing of the experimental data, he/she will set up a model for numerical prediction of the service life that will also be useful for the early phases of product development, when the prototypes are not yet available.

During his/her training, the young researcher will write and publish two original scientific articles and attend at least one international conference on the broader topic of his training.

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)*

☒ **življenjepis** *(CV)*

Opis raziskovalnega dela *(Research work description*)

1. Članica UL (*UL member)*:

Fakulteta za strojništvo (Faculty of Mechanical Engineering)

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

Leon Kos, leon.kos@fs.uni-lj.si

3. Raziskovalno področje (*Research field*):

Fuzijske tehnologije (Fusion Technologies)

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.: Reakcija zlivanja lahkih jeder predstavlja potencialno rešitev človeške potrebe po velikih količinah čiste energije. Na poti do njenega koristnega izkoriščanja je še precej fizikalnih in inženirskih izzivov, ki se jih loteva tudi programska skupina Fuzijske tehnologije. Programska skupina je močno vpeta v dva glavna raziskovalna okvirja na področju fuzijske energetike in sicer Konzorcija EUROfusion, ki združuje evropske raziskave na tem področju, in organizacije ITER, katere cilj je izgradnja največjega fuzijskega eksperimentalnega reaktorja na svetu. Mladi raziskovalec se bo pri svojem delu ukvarjal predvsem s problematiko plazemske obremenitve prve stene fuzijskih naprav, ki predstavlja ključno omejitev pri načrtovanju reaktorjev in operativnih scenarijev. Pri svojem delu se bo spoznal z modeliranjem plazme in njene interakcije s steno, kjer se mešata naravoslovni in inženirski pristop. Tema doktorata bo povezana z razvojem in uporabo računalniških simulacijskih orodij potrebnih za izračun delčnih in toplotnih obremenitev komponent reaktorja, ki so v stiku s plazmo ter povezava z eksperimentom. Delo je izrazito mednarodno, saj je tematika pomembna za celotno svetovno fuzijsko srenjo. Poleg motivacije za raziskovalno delo je zaželeno tudi znanje programiranja in želja po nadaljnjem razvoju programerskega znanja, tudi v povezavi s superračunalništvom.

Eng.:The reaction of fusing of light nuclei represents a potential solution for human needs for large quantities of clean energy. There are still several physics and engineering related challenges on the path to nuclear power plants and some of them are addresses by the Fusion Technologies Programme. The Programme Group is strongly involved in the two main research frameworks in the field of fusion energy research, namely the EUROfusion Consortium, which brings together European research institutions in this field, and ITER, which aims to build the world's largest experimental fusion reactor. The junior researcher's work will focus on the issue of plasma loads of the first wall of fusion devices, which is a key constraint in reactor design and design of operational scenarios. His work will introduce him to modelling of plasma and its interaction with the wall, mixing the natural science and engineering approach. The topic of the PhD will be related to the development and use of computer simulation tools necessary to calculate the particle and thermal loads of reactor components in contact with plasma and the validation by the experiments. In addition to high motivation for research, programming skills are desired, as well as willingness to further develop programming skills, especially in relation to supercomputing.

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

☒ **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)* ☒ **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)*:

Fakulteta za strojništvo (Faculty of Mechanical Engineering)

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

Boštjan Mavrič, bostjan.mavric@fs.uni-lj.si

3. Raziskovalno področje (*Research field*):

2.13.01 Procesno strojništvo, Večfazni sistemi

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.:
Raziskovalno delo se bo osredotočalo na inovativne brezmrežne metode in rešitvene postopke za modeliranje večfaznih procesov v kompleksnih geometrijah. Posebej se bomo osredotočili na prevzorčene metode ter iterativne večnivojske metode. V ospredju bo razvoj metod za reševanje enačb mehanike kontinuuma v povezavi z opisom faznih prehodov ter sledenja gibanju medfaznih robov.

Raziskovalno delo bo vključevalo razvoj novih algoritmov, njihovo karakterizacijo in analizo ter implementacijo s ciljem izrabe sodobnih superračunalniških okolij.

Ciljna raba razvitih metod je na področju modeliranja strjevanja in drugih naprednih proizvodnih procesov, ki zahtevajo simulacijsko podprto poznavanje obnašanja proizvodne naprave in širšega proizvodnega okolja.

Poleg entuziazma za področje numeričnih metod pričakujemo tudi višjo raven znanja angleškega jezika, znanje programiranja ter izobrazbo s področja strojništva, fizike ali uporabne matematike.

Eng.:
The research will focus on innovative meshless methods and solution procedures for modelling multiphase processes in complex geometries. Special attention will be given to oversampled methods and iterative multilevel methods. We will tackle methods for solving continuum mechanics coupled with describing phase change and interphase boundary tracking.

The research work will span from the development of new algorithms, their analysis and characterization to the implementation focusing on the exploitation of modern supercomputing environments.

The developed methods are targeted for use in solidification modelling and other advanced material processing techniques that require a simulation-supported understanding of the processing equipment both on its own and in interaction with the wider processing environment.

Besides enthusiasm for numerical methods, we expect proficiency in English, experience with programming, and a background in mechanical engineering, physics, or applied mathematics.

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)*

☒ **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)*

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

Opis raziskovalnega dela *(Research work description*)

1. Članica UL (*UL member)*:

Fakulteta za strojništvo (Faculty of Mechanical Engineering)

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

Mitja Mori, mitja.mori@fs.uni-lj.si

3. Raziskovalno področje (*Research field*):

ARIS: 2.03.01 Smotrna raba energije, CERIF T140 Energijske raziskave

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.: Ocena okoljskih vplivov izdelkov in procesov v energetiki postaja vse pomembnejša tako za industrijo kot tudi za raziskovalno skupnost. Uvajanje novih obnovljivih virov energije, naprednih tehnologij za shranjevanje, kot so vodikove rešitve in baterijski sistemi, sektorsko povezovanje ter optimizacija rabe energije v različnih družbenih sektorjih predstavljajo odmik od tradicionalnih praks z namenom zmanjšanja okoljskega odtisa. Ključni cilj sodobne družbe je vzpostavitev krožnega gospodarstva kot osnove trajnostnega razvoja, pri čemer je nujno celovito upoštevanje okoljskih, ekonomskih in družbenih vidikov. Mladi raziskovalec bo raziskoval napredne energetske koncepte in infrastrukturo ter uporabljal orodja za ocenjevanje okoljskih in ekonomskih vplivov procesov. Ključne metodologije bodo študija življenjskega cikla (Life Cycle Assessment – LCA) za celostno oceno okoljskih vplivov, analiza ogljičnega odtisa na ravni posameznih komponent in celotnih energetskih sistemov ter vrednotenje učinkov mehanizma za ogljično prilagoditev na mejah EU (CBAM). Od kandidata pričakujemo odlično razumevanje termodinamskih procesov, kompleksnih energetskih sistemov ter osnov programiranja. Prav tako so zaželena osnovna znanja s področja določanja ogljičnega odtisa izdelkov, modeliranja LCA ter ocenjevanja okoljskih vplivov tehnologij, procesov in izdelkov. Prednost bodo imeli kandidati, ki razumejo metodologije za vrednotenje ekonomskih vplivov procesov in izdelkov.

Eng.: Assessing the environmental impact of products and processes in the energy sector is becoming increasingly important for both industry and research. The integration of new renewable energy sources, advanced energy storage technologies such as hydrogen solutions and battery systems, sector coupling and the optimization of energy use in various areas of society mean a shift from traditional practices with the aim of reducing the environmental footprint. An important goal of modern society is the creation of a circular economy as the basis for sustainable development, which requires comprehensive consideration of environmental, economic and social aspects. The young researcher will focus on advanced energy concepts and infrastructures, using tools to assess the environmental and economic impact of processes. Key methodologies include life cycle analysis (LCA) for a holistic assessment of environmental impacts, carbon footprint analysis at both component and energy system level, and assessment of the impact of the carbon border adjustment mechanism (CBAM) at EU borders. The ideal candidate should have a strong understanding of thermodynamic processes, complex energy systems and basic programming skills. In addition, basic knowledge of carbon footprint assessment, LCA modeling and environmental impact assessment of technologies, processes and products is expected. Applicants with experience in economic impact assessment methods are preferred.

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)*

☒ **bibliografija** *(bibliography)*

Opis raziskovalnega dela *(Research work description*)

1. Članica UL (*UL member)*:

Fakulteta za strojništvo (Faculty of Mechanical Engineering)

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

Doc. dr. Marko Polajnar, marko.polajnar@fs.uni-lj.si

3. Raziskovalno področje (*Research field*):

2.11 Konstruiranje

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.:
25 % svetovne proizvodnje energije se porabi za premagovanje trenja, kar je ogromno. Še več, trenje vodi do obrabe, kar pomeni obrabljene komponente, ki jih je treba zamenjati, kar nato povzroči še večjo dodatno porabo energije in s tem večje onesnaževanje okolja. Za zmanjšanje tega trenja in obrabe uporabljamo maziva. Pravilno mazivo medsebojno deluje in reagira z materiali v kontaktih in morebitnimi nanesenimi površinskimi prevlekami, da se tvorijo mejne tribokemijske plasti, ki ščitijo pred obrabo in imajo nizko trenje. Vendar pa večina učinkovitih maziv, ki so danes v uporabi, vsebuje žveplo, fosfor, cink in druge elemente, ki onesnažujejo okolje, kar pomeni, da bo zakonodaja, ki že prihaja v veljavo, povzročila številne spremembe v formulacijah maziv za zmanjšanje onesnaževanja. Idelano bi se taka maziva nadomestila, za kar pa je potrebno razumevanje njihovega delovanja. Na žalost je tak primer tudi daleč najbolj uspešen aditiv proti obrabi, t.j. cink dialkil ditiofosfat (ZDDP). Raziskovalci že več kot 20 let poskušajo razumeti njegovo vedenje in mehanizme takšne učinkovitosti, napredek pa je počasen. Medtem ko njegov nastanek na kvalitativni način precej dobro razumemo, so kvantitativni in tudi obrabni mehanizmi ZDDP aditiva skoraj povsem neznani. Ko k temu dodamo še možnost poškodb z električnim tokom, npr. v elektromobilnosti, je ta problem še toliko bolj aktualen in kompleksen. Kandidat tega doktorskega študija se bo tako osredotočil na mehanizem obrabe tribofilmov ZDDP, da bi jih kvalitativno razkril in po možnosti razvil tudi kvantitativni model.

Eng.:
A massive 25% of the world’s energy production is used to overcome friction. What’s more, friction leads to wear, which means worn out components that need replacing, which then leads to more energy being consumed and so more environmental pollution. To reduce this friction and wear we use lubricants. The right lubricant interact with the materials in the contact and any applied surface coatings to develop wear-protective and low-friction interface layers. However, most of the effective lubricants in use today contain sulphur, phosphorus, zinc and other elements that pollute the environment, which means legislation that is already coming into force will see many changes in the formulations to influence use of environmentally adapted lubricants. Ideally, such lubricants would be replacet with greener ones, however, to do this, the current mechanisms need to be understood. Unfortunately, this is the case with the far the best known anti-wear additive, zinc dialkyl dithiophosphate (ZDDP). Researchers are trying to understand its behaviour and mechanisms of such efficacy for more than 20 years and the progress is slow. While we understand its formation in a qualitative way quite well, the quantitatively, as well as the wear mechanisms of ZDDP are almost entirely

unknown. When new electric current options, for example in electromobility, are coming to play more important role, the situation is even more contemporary and complicated. The candidate of this PhD study will thus focus on wear mechanism of ZDDP tribofilms to reveal them qualitatively and possibly develop and quantitative model as well.

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

☒ **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 raziskovalnega dela *(Research work description*)

1. Članica UL (*UL member)*:

Fakulteta za strojništvo (Faculty of Mechanical Engineering)

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

Primož Poredoš, primoz.poredos@fs.uni-lj.si

3. Raziskovalno področje (*Research field*):

Energetika, obnovljivi viri energije

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.:

Raziskovalno delo mladega raziskovalca (kandidata) se bo osredotočalo na povezavo energija-voda-zrak na področju pridobivanja vode iz atmosfere (AWH) s higroskopskimi sorpcijskimi sredstvi. Kandidat bo raziskoval nove pristope k integraciji obnovljivih virov energije za intenziviranje procesov desorpcije in adsorpcije, kar predstavlja obetavno rešitev za globalne izzive pomanjkanja vode.

Globalni problem
Pomanjkanje vode trenutno prizadeva 2/3 svetovne populacije. Številne raziskave na področju pridobivanja vode iz atmosfere se osredotočajo na produkcijo materialov s hidrofilnimi lastnostmi, ki adsorbirajo vodo iz atmosfere v zelo sušnih pogojih, saj je to ključno za zagotavljanje vode tam, kjer je dostop omejen.

Predstavitev rešitve
Raziskave se bodo osredotočale na učinkovito koriščenje energije sonca in potencial hladnega vesolja za pospešitev procesov desorpcije in adsorpcije vode iz poroznega higroskopskega kompozitnega sredstva na osnovi higroskopskih soli, kot je LiCl. Osnova za te raziskave bo raziskava možnosti 3D tiskanja monolitnih naprednih energetskih materialov z opisanimi lastnostmi ter integracije tovrstnih materialov v celovite sisteme za pridobivanje vode iz atmosfere, ki omogočajo naslednjih pet korakov: 1. adsorpcija vode iz zraka pri povišani relativni vlažnosti, 2. desorpcija vode iz zraka pri vnosu toplote v tovrstne materiale, 3. senzibilno hlajenje pare do točke rosišča, 4. kondenzacija pare, 5. zbiranje tekoče vode.

Raziskovalni izzivi
Trenutni raziskovalni izzivi na tovrstnem področju so uporaba različnih načinov pospeševanja procesov adsorpcije in desorpcije, kar lahko izvedemo na ravni monolitnega materiala. Bolj specifično, raziskave se trenutno osredotočajo na energetsko učinkovito integracijo optičnih lastnosti in specifične morfologije tovrstnih materialov v smislu dizajniranja tovrstnih materialov, pri čemer se bo kandidat osredotočal na osnovne mehanizme interakcije svetloba, toplotno sevanje – material – voda.

Cilji raziskav
Glavni raziskovalni cilj doktorskega dela je predstaviti koncept energijsko učinkovite manipulacija vnosa in iznosa vode iz higroskopskih materialov z obnovljivimi viri energije. Sočasno bo ta cilj tudi nadgrajen z izvedbo skalabilnega multicikličnega sistema, ki bo zasnovan za kontinuirano pridobivanje vode kjerkoli in kadarkoli, 24 ur na dan. Sekundarni cilj doktorskega dela je raziskovanje možnosti skalabilnosti tovrstnih materialov, ki jih bo mogoče uporabiti v večjih AWH sistemih v sušnih predelih.

Metodologija
Kandidat bo pri tem uporabljal metode numeričnega modeliranja v COMSOL Multiphysics simulacijskem orodju, različne tehnike 3D printa s podpornimi tehnikami nanosa premazov z dnevno-sevalnimi materiali, kot je elektropredenje, pršilni nanos, potopni nanos, vrtilni nanos, ipd. Zaželjeno je, da kandidat poseduje osnovno znanje s področja mehatronike za izvedbo krmilnega sistema AWH naprave, ki bo omogočala sočasno adsorpcijo in desorpcijo vodne pare v/iz materiala na osnovi kontinuirno in šaržno delujočih AWH sistemov.

Pomen za razvoj znanosti in družbe

Rezultati tega doktorskega raziskovalnega dela bodo pripomogli k implementaciji sistemov AWH v sušnih področjih, kjer je na voljo veliko ur sončnega obsevanja pri večjih intenzitetah. Prav tako sušna območja omogočajo koriščenje dnevno sevalnega hlajenja, saj transparentna atmosfera omogoča izkoristek potenciala za visoke gostote hladilnih tokov tovrstnih materialov, kar sinergistično omogoča intenzivirane procesa adsorpcije vodne pare v higroskopski kompozitni material.

Eng.:

The candidate's research will focus on the energy-water-air nexus in the field of atmospheric water harvesting (AWH) using hygroscopic sorption materials. The candidate will explore new approaches to integrating renewable energy sources to enhance desorption and adsorption processes, providing a promising solution to global water scarcity challenges.

Global Problem
Two-thirds of the global population currently faces water scarcity. Many studies on atmospheric water harvesting focus on the production of materials with hydrophilic properties that adsorb water from the atmosphere under extremely arid conditions, as this is crucial for ensuring water supply in areas where access is limited.

Proposed Solution
The research will focus on the efficient utilization of solar energy and the potential of cold space to accelerate the desorption and adsorption of water from/to a porous hygroscopic composite material based on hygroscopic salts, such as LiCl. The foundation of this research will be the exploration of 3D printing possibilities for monolithic advanced energy materials with these properties and the integration of such materials into comprehensive atmospheric water harvesting systems, enabling the following five steps: 1. adsorption of water from the air at elevated relative humidity, 2. desorption of water from the material upon heat input, 3. sensible cooling of vapor to the dew point, 4. vapor condensation, 5. collection of liquid water.

Research Challenges
Current research challenges in this field involve the use of different methods to accelerate adsorption and desorption processes, which can be implemented at the monolithic material level. More specifically, ongoing studies focus on the energy-efficient integration of optical properties and specific morphology of such materials in terms of designing these materials, with the candidate focusing on the fundamental mechanisms of interaction between light, thermal radiation, material, and water.

Research Objectives
The primary research objective of the doctoral work is to present the concept of energy-efficient manipulation of water uptake and release to/from hygroscopic materials using renewable energy sources. Simultaneously, this goal will be upgraded by developing a scalable multi-cycle system designed for continuous water harvesting anytime and anywhere, 24 hours a day. The secondary objective of the doctoral work is to explore the scalability potential of such materials, making them applicable in larger AWH systems in arid regions.

Methodology
The candidate will use numerical modeling methods in the COMSOL Multiphysics simulation tool, various 3D printing techniques, and additional coating deposition techniques with daytime-radiative materials such as electrospinning, spray coating, dip coating, spin coating, etc. It is desirable that the candidate has basic knowledge in mechatronics to develop a control system for the AWH device, enabling simultaneous adsorption and desorption of water vapor into/from the material with continuous or batch-operated AWH systems.

Importance for the Development of Science and Society
The results of this doctoral research will contribute to the implementation of AWH systems in arid regions, where high-intensity solar irradiation is available for many hours. Additionally, arid areas enable the utilization of daytime radiative cooling, as the transparent atmosphere allows for the exploitation of the potential for high cooling flux densities in such materials, which synergistically enhances the adsorption process of water vapor into the hygroscopic composite material.

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)*

☒ **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)*

Opis raziskovalnega dela *(Research work description*)

1. Članica UL (*UL member)*:

Fakulteta za strojništvo (Faculty of Mechanical Engineering)

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

Primož Potočnik, primoz.potocnik@fs.uni-lj.si

3. Raziskovalno področje (*Research field*):

Področje: Tehnološko usmerjena fizika (Tehnology driven physics) Tematika: Uporaba strojnega učenja v aditivnih tehnologijah (Application of machine learning in additive technologies)

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.:

Raziskovalno delo bo potekalo na Fakulteti za strojništvo v Ljubljani v okviru Laboratorija za sinergetiko (LASIN). Osrednje raziskovalno področje bo uporaba metod strojnega učenja in nevronskih mrež za optimizacijo laserskih dodajnih procesov (LDP). Cilj raziskovalnega dela mladega raziskovalca je razvoj inovativnih metod za izboljšanje stabilnosti procesov in s tem povezane kakovosti izdelkov in povečane dimenzijske točnosti, ter napovedovanje lastnosti materialov in procesno vodenje z uporabo naprednih analitičnih pristopov. Raziskave bodo obsegale tako teoretično modeliranje, kot tudi eksperimentalno delo na laboratorijski opremi za direktno lasersko depozicijo (DLD) in selektivno lasersko taljenje (SLM) kovinskih materialov.

Glavne naloge kandidata:

- Raziskave in modeliranje procesov direktne laserske depozicije in selektivnega laserskega taljenja.
- Identifikacija ključnih senzorjev in merljivih spremenljivk za spremljanje in diagnostiko LDP procesov.
- Optimizacija procesnih parametrov za izboljšanje kakovosti in ponovljivosti aditivnih tehnologij.
- Načrtovanje optimalnih poti nanašanja materialov glede na obliko izdelka.
- Razvoj metod za prediktivno vodenje LDP procesov.
- Razvoj algoritmov strojnega učenja za analizo in optimizacijo LDP procesov.
- Eksperimentalno validiranje razvitega modela na laboratorijski opremi (industrijski 3D tiskalnik LASERTEC 30 SLM in lastno razviti DLD sistem s 6-osnim robotskim sistemom ABB).
- Priprava in objava znanstvenih člankov v mednarodnih revijah ter predstavitve na strokovnih konferencah.

Zahtevane kvalifikacije:

- Zaključen magistrski študij na področju strojništva, materialov, računalništva ali sorodnih disciplin.
- Osnovno poznavanje aditivnih tehnologij in metod strojnega učenja.
- Izkušnje s programskimi orodji, kot so Python, MATLAB in ANSYS.
- Aktivno znanje angleškega jezika (pisno in ustno).
- Sposobnost samostojnega raziskovalnega dela in analitičnega razmišljanja.
- Zmožnost znanstvenega pisanja in priprave publikacij.

Eng.:

The research work will be carried out at the Faculty of Mechanical Engineering in Ljubljana within the Laboratory for Synergetics (LASIN). The main research area will be the application of machine learning methods and neural networks for the optimisation of laser additive manufacturing (LAM) processes. The aim of the young researcher's research work is to develop innovative methods for improving process stability and related product quality, and dimensional accuracy, as well as predicting material properties and process control using advanced analytical approaches. The research will include both theoretical modelling and experimental work on the laboratory equipment for direct laser deposition (DLD) and selective laser melting (SLM) of metallic materials.

Main tasks of the candidate:

- Research and modelling of direct laser deposition and selective laser melting processes.
- Identification of key sensors and measurable variables for monitoring and diagnostics of LAM processes.
- Optimisation of process parameters to improve the quality and reproducibility of additive technologies.
- Optimisation and design of optimal material deposition paths with respect to the part geometry.
- Development of methods for predictive control of LAM processes.
- Development of machine learning algorithms for the analysis and optimisation of LAM processes.
- Experimental validation of the developed model on the laboratory equipment (industrial 3D printer LASERTEC 30 SLM and developed DLD system with 6-axis ABB robotic system).
- Preparation and publication of scientific papers in international journals and conference presentations.

Qualifications required:

- Completion of a Master's degree in Mechanical Engineering, Materials Science, Computer Science or related discipline.
- Basic knowledge of additive technologies and machine learning methods.
- Experience with programming tools such as Python, MATLAB and ANSYS.
- Active knowledge of English (written and oral).
- Ability to work independently in research and analytical thinking.
- Ability to write scientific papers and prepare publications.

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)*

☒ **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)*

Opis raziskovalnega dela *(Research work description*)

1. Članica UL (*UL member)*:

Fakulteta za strojništvo (Faculty of Mechanical Engineering)

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

Prof.dr. Franci Pušavec

3. Raziskovalno področje (*Research field*):

Moderne proizvodne in izdelovalne tehnologije s poudarkom na pametnih procesih in okolijskih odtisih / Advanced manufacturing and production technologies with a focus on smart processes and environmental footprints

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.: Mladi raziskovalec, bo po potrditvi vključen v raziskovalno skupino Katedre za menedžment obdelovalnih tehnologij (Laboratorij za odrezavanje in Laboratorij za zagotavljanje kakovosti). Poleg študijskih obveznosti, bo sodeloval na industrijskih, domačih, ter evropskih raziskovalnih projektih, na katerih sodeluje oz. jih koordinira raziskovalna skupina. Tu bo možnost aktivne sodelave/izmenjave z drugimi mednarodnimi univerzami (Švedska, Francija, Španija, Avstrija, Nemčija, ZDA), s katerimi raziskovalna skupina tesno sodeluje.

Trajnostni razvoj, digitalizacija in umetna inteligenca se oblikujejo kot ključna raziskovalna področja, saj bo od razvoja visoko-zmogljivih obdelovalnih/izdelovalnih tehnologij in njihove praktične uporabe, odvisna bodoča konkurenčna prednost slovenskih proizvodnih podjetij pri zelenem prehodu in digitalizaciji. Raziskovalne vsebine in cilji skupine so tako usmerjeni v sprejemanje, prenos in raziskovalno podporo visoko-zmogljivih obdelovalnih tehnologij, med katere štejemo: inoviranje visoko-produktivnih izdelovalnih procesov, vpeljava orodij umetne inteligence za doseganje pametnih procesov, razvoj visoko preciznih mikro obdelav in doseganje sodobnih čistih načinov obdelave, uporaba tehnologij »big data«, itd. za katere je namenjen velik delež aktivnosti raziskovalne skupine. Program mladega raziskovalca bo tako usmerjen v tri potencialna področja:

- Razvoj inovativne metodologije karakterizacije obdelovalnosti z moderno senzoriko (Kistler, Dewesoft).
- Zajemanje »Big data« in uporaba umetne inteligence za karakterizacijo obdelovalnih procesov/strojev/izdelkov.
- LCA odrezovalnih procesov (čistost procesov, delovnega prostora, super maziva na vodni osnovi, itd.)

Področja so široka in primerna tudi za študente, ki so zaključili magistrski študij strojništva, elektrotehnike, kemije, itd.

Za delo je v laboratoriju zagotovljen širok nabor raziskovalne opreme:

- moderni obdelovalni stroji (struženje, frezanje, mikofrezanje, precizni EDM, Abrasive Flow Machining, antropomorfni robot, itd.),

- precizni merilniki vibracij/pospeškov in sil (dinamometri),
- moderna visokohitrostna termo kamera/pirometri/termoelemneti,
- sinhronizirana merilna oprema Dewesoft (zajem signalov: napetostni, tokovni, merilni lističi, dinamometri, pospeškometri, termočleni, kamera za strojni vid, itd.),
- merilniki/analizatorji čistosti površin,
- merilniki kakovosti zraka v delovnih prostorih (trdi delci, itd.),
- Beckhoff PLC računalnik za povezavo s krmilniki obdelovalnih strojev,
- itd.

Na podlagi teh smernic in individualnih želj/zanimanj kandidata, bo v začetni fazi kandidatu določena tema/smer raziskovanja, ustrezni podiplomski izpiti, seminarji in komisije za zagovore le teh. Mlad raziskovalec bo uvrščeni v izhodiščni 22 plačilni razred z možnostjo napredovanja. Poleg tega ima plačano šolnino na doktorskem študiju. Glede na dogovor pa so mogoče tudi nagrade za delovno uspešnost oz. omogočanja gostovanja na tujih mednarodnih raziskovalnih inštitucijah.

Eng.: The young researcher will be included in the research group of the Department for Management of Machining Technologies (Cutting Laboratory and Quality Assurance Laboratory). In addition to his/her studies, the young researcher will participate in industrial, national and European research projects, which are co-ordinated by the research group. There will be the possibility of active collaboration/exchange with other international universities (Sweden, France, Spain, Austria, Germany, USA) with which the research group is working closely.

Sustainable development, digitalization and artificial intelligence are emerging as key research areas, as the future competitive advantage of Slovenian manufacturing companies in the green transition and digitalization will depend on the development of high-performance machining/manufacturing technologies and their practical application. The research content and objectives of the group are thus focused on the adoption, transfer and research support of high-performance machining technologies, including: innovations of high-productivity manufacturing processes, introduction of artificial intelligence tools to achieve smart processes, development of high-precision micro-machining processes, achievement of modern clean machining methods, application of "big data" technologies, etc., for which a large share of the research group's activities is devoted. The Young Researcher Program will thus focus on three potential areas:

- Development of an innovative methodology for characterizing machinability using modern sensors (Kistler, Dewesoft).
- Capturing "Big Data" and using Artificial Intelligence to characterize machining processes/machines/products.
- LCA of machining processes (cleanliness of processes, workspace, water-based super lubricants, etc.).

The fields are broad and suitable for students who have completed a master's degree in mechanical engineering, electrical engineering, chemistry, etc.

The laboratory has a wide range of modern research equipment that is available for activities of candidates:

- modern machine tools (turning, milling, micro-milling, precision EDM, Abrasive Flow Machining, anthropomorphic robot, etc.),
- precision vibration/acceleration and force sensors (dynamometers),
- modern high-speed thermal camera/pyrometers/thermocouples,

- Dewesoft synchronized measuring equipment (signal acquisition: voltage, current, measuring slips, dynamometers, accelerometers, thermocouples, machine vision camera, etc.),
- surface cleanliness sensors/analyzers,
- workplace air quality monitors (particulate matter, etc.),
- Beckhoff PLC computer for connection to machine controllers,
- etc.

Based on these guidelines and the candidate's individual wishes/concerns, the candidate will be initially assigned a topic/direction of research, the relevant postgraduate examinations, seminars and their defense committees. The young researcher will be placed in 34 Slovenian public salary grade with possibility for advancement. In addition, he/she will have his/her PhD tuition fees paid. Depending on the agreement, there may also be merit awards or opportunities to be hosted by international research institutions abroad.

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)*

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

Opis raziskovalnega dela *(Research work description*)

1. Članica UL (*UL member)*:

Fakulteta za strojništvo (Faculty of Mechanical Engineering)

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

Janko Slavič, janko.slavic@fs.uni-lj.si

3. Raziskovalno področje (*Research field*):

Pametne in aktivne 3D tiskane strukture in naprave (Smart and active 3D printed structures and devices)

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.:
Doktorski študent se bo izobraževal na področju pametnih 3D (metoda FFF ciljnega nalaganja) natisnjenih dinamskih struktur. Pametne in aktivne dinamske strukture so tiste, ki zaznavajo dinamske spremembe in se prilagajajo dinamskim spremembam. 3D tehnologija tiskanja prevodnih materialov je v zadnjih treh letih naredila velik napredek; tako je danes mogoče v celoti natisniti dinamični senzor (npr. deformacij ali pospeškomer).

Doslej objavljeni 3D natisnjeni dinamični senzorji temeljijo na principu piezoupornosti (ob deformaciji zaznamo spremembo upornosti) ali piezoelektričnosti (ob deformaciji se generira naboj). Raziskovalni fokus bo torej izraba fenomena piezoupornosti in piezoelektričnosti za zaznavalno funkcijo ter Joulovega segrevanja materiala za doseganje strukturnih sprememb strukture ali naprave. Raziskovalno delo bo osredotočeno na materiale z relativno visoko temperaturo steklastega prehoda.

Raziskovalno delo bo med drugim vključevalo: eksperimentalno delo, teoretično in numerično modeliranje.

Eng.:
The doctoral student will be educated in the field of smart 3D (FFF targeted deposition method) printed dynamic structures. Smart and active dynamic structures are those that sense dynamic changes and adapt to dynamic changes. 3D printing technology for conductive materials has made significant progress in the last three years; thus, it is now possible to fully print a dynamic sensor (e.g., strain or accelerometer).

Previously published 3D printed dynamic sensors are based on the principle of piezoresistivity (a change in resistance is detected upon deformation) or piezoelectricity (charge is generated upon deformation). The research focus will therefore be on utilizing the phenomena of piezoresistivity and piezoelectricity for sensing functions and Joule heating of the material to achieve structural changes in the structure or device. The research work will be focused on materials with a relatively high glass transition temperature.

The research work will include, among other things: experimental work, theoretical, and numerical modeling.

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

☒ **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)*

☒ **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)*:

Fakulteta za strojništvo (Faculty of Mechanical Engineering)

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

Roman Šturm roman.sturm@fs.uni-lj.si

3. Raziskovalno področje (*Research field*):

2.10 – proizvodne tehnologije in sistemi

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.: Materiali iz skupine sivih litin so tradicionalni materiali, ki se skozi stoletja nenehno spreminjajo, vedno znova prihaja do sinteze novih in/ali izboljšanih materialov, ki dosegajo vedno boljše mehanske, korozijske in druge fizikalne lastnosti. Danes materiali iz skupine sivih litin v izotermno poboljšanem stanju dosegajo trdnosti že do 1600 MPa. V naravi inženirskega sveta je posebej zanimiv edinstveni učinek kompenzacije krčenja taline s širjenjem materiala zaradi kristalizacije grafita iz grafitnega evtektika. Tako je mogoče izvesti litje in kristalizacijo določenih zlitin in določenih geometrij brez uporabe napajalnikov. Material je na ta način najbolj celostno trajnosten in z najnižjim ogljičnim odtisom, primeren za različne aplikacije v transportni industriji (tovorna vozila, avtomobili, železniški vagoni), kot tudi za delovne stroje, ohišja vetrnih elektrarn… V okviru doktorske naloge bo mladi raziskovalec poglobljeno študiral vpliv različnih procesnih parametrov na razvoj mikrostrukture sive litine z načrtovanimi lastnostmi, s poudarkom na optimizaciji procesov, kot so načrtovana kemijska sestava, stopnja cepljenja in/ali izvedba globulacije grafita, izvedba litja in »in situ« merjenje značilnih referenčnih temperatur ter parametrov s področja strjevanja, izločanja iz prenasičene trdne raztopine, ter transformacije v trdnem stanju. Nadalje bodo v okviru naloge najprej razvite tako imenovane geometrije, ki bodo zagotovile usmerjeno strjevanje preiskovanih litin, pri čemer bo mikrostruktura zvezno zasledovana v odvisnosti od ohlajevalne hitrosti. Dodatno bo potekal študij še drugih fizikalnih in tehnoloških lastnosti, kot so nagnjenost litine k belemu strjevanju, livnost, itd. Za posamezne materiale iz skupine sivih litin bo celovito izvedena karakterizacija mikro in makro strukture s pomočjo sodobnih analiznih metod. Uporabljena bo optična in elektronska mikroskopija s sistemom za analizo slike. Za kvantitativno in kvalitativno vrednotenje bo uporabljen ustrezen standard EN ISO 945. Na ta način bo mogoča kakovostna primerjava elementov mikrostrukture novih materialov iz skupine sivih litin z obstoječimi, ki jih opredeljuje standard. Poseben poudarek bo namenjen razvoju kontrolnih metod za načrtovanje mikrostrukture, faznih sprememb in drugih zahtevanih lastnosti. Predvidevamo, da bomo eksperimentalno opredelili vse značilne parametre in veličine na relaciji kemijska sestava - nukleacijski potencial - mikro in makrostruktura - mehanske, korozijske in tehnološke lastnosti. Na osnovi slednjega bodo postavljeni ustrezni fizikalni modeli, ki bodo predstavljali pomemben znanstveni doprinos, in ki bo pomemben tudi za industrijsko tehnološko prakso. Na tej osnovi bo mogoče že iz staljenega stanja litine po izvedenem testiranju napovedovati različne lastnost. Usposabljanje bo tako usmerjeno v poglobitev znanj pri karakterizaciji elementarnih procesov cepljenja sive litine, ki vplivajo na razvoj mikrostrukture na različnih prostorskih in časovnih skalah. Od kandidata se pričakuje znanje slovenskega jezika.

Eng.: Materials from the gray cast iron group are traditional materials that have been constantly changing over the centuries, with new and/or improved materials being synthesized with time achieving increasingly better mechanical, corrosion and other physical properties. Today, materials from the gray cast iron group in an isothermally hardened state reach strengths of up to 1600 MPa. Of particular interest in the nature of the engineering world is the unique effect of compensating for melt shrinkage by expanding the material due to the crystallization of graphite from the graphite eutectic. This makes it possible to cast and crystallize certain alloys

and certain geometries without the use of melt feeders. In this way, the material is the most comprehensively sustainable and with the lowest carbon footprint, suitable for various applications in the transport industry (trucks, cars, railway wagons), as well as for working machines, wind turbine housings, etc.
As part of the doctoral thesis, the young researcher will study in depth the influence of various process parameters on the development of the microstructure of gray cast iron with designed properties. He will emphasize the process of optimization of the planned chemical composition, the degree of inoculation and/or implementation of graphite globulization, the implementation of casting and "in situ" measurement of typical reference temperatures and parameters in the areas of solidification, precipitation from supersaturated solid solution, and transformation in the solid state.
Furthermore, within the scope of the task, first so-called geometries will be developed, which will ensure directional solidification of the investigated castings, whereby the microstructure will be continuously monitored as a function of the cooling rate. In addition, other physical and technological properties will be studied, such as the chilling tendency of the cast iron, castability, etc.
For individual materials from the gray cast iron group, a comprehensive characterization of the micro and macro structure will be carried out using modern analysis methods. Optical and electron microscopy with an image analysis system will be used. The relevant EN ISO 945 standard will be used for quantitative and qualitative evaluation. In this way, a qualitative comparison of the microstructure elements of new materials from the gray cast iron group with existing ones defined by the standard will be possible.
Special emphasis will be placed on the development of control methods for designing microstructure, phase changes and other required properties. We anticipate that we will experimentally define all characteristic parameters and quantities in the relation chemical composition - nucleation potential - micro and macrostructure - mechanical, corrosion and technological properties. Based on the latter, appropriate physical models will be established, which will represent an important scientific contribution, and which will also be important for industrial technological practice. On this basis, it will be possible to predict various properties from the molten state of the cast iron after testing.
The training will thus be aimed at deepening knowledge in the characterization of elementary processes of gray cast iron inoculation, which affect the development of the microstructure on different spatial and time scales. The candidate is expected to have knowledge of the Slovenian language.

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

☒ **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 raziskovalnega dela *(Research work description*)

1. Članica UL (*UL member)*:

Fakulteta za strojništvo (Faculty of Mechanical Engineering)

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

Daniele Vella, daniele.vella@fs.uni-lj.si

3. Raziskovalno področje (*Research field*):

Laserske tehnologije / Laser technologies

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 raziskave je razviti fotoakustična orodja za biomedicinske aplikacije, ki omogočajo učinkovito pretvorbo laserske svetlobe v zvok. Prvi del bo posvečen razvoju fotoakustičnih naprav z uporabo teoretičnega pristopa za napovedovanje fotoakustičnega obnašanja. Zaporedoma, v skupnem projektu, bo naprava realizirana in eksperimentalno raziskana z uporabo naših fotoakustičnih zmogljivosti, vključno z bliskovnim laserskim virom, visokofrekvenčnim detektorjem in slikovnim sistemom. Biomedicinski aplikativni del bo izveden v sodelovanju z drugimi raziskovalnimi institucijami, katerih cilj je implementacija fotoakustičnih orodij. To vključuje: i) sodelovanje pri realizaciji in implementaciji slikovnega sistema, ki temelji na impulznem odmevu z velikim vidnim poljem, ki uporablja fotoakustični vir in zgodaj razvit fotoakustični pretvornik.

Eng.: The research proposal within the frame of laser light to sound conversion aims to develop photoacoustic tools for biomedical applications. The first part of the work will be dedicated to the engineering of photoacoustic devices by using a rigorous theoretical approach to predict the photoacoustic behaviour. Successively, in a collaborative project, the device will be realized and experimentally investigated at the FS by using our photoacoustic facilities, including a pulsed laser source, high frequency detector and imaging system. The biomedical application part will be carried out in collaboration with other research institutions aiming at the implementation of the photoacoustic tools. This includes: i) participation in the realization and implementation of an imaging system based on pulse-echo with a large field of view employing the photoacoustic source and the early developed photoacoustic transducer.

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)*

☒ **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)*

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

Opis raziskovalnega dela *(Research work description*)

1. Članica UL (*UL member)*:

Fakulteta za strojništvo (Faculty of Mechanical Engineering)

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

Mojca Zupanc, mojca.zupanc@fs.uni-lj.si

3. Raziskovalno področje (*Research field*):

2.03.00 Energetika

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/ke bo potekalo na področju bazičnih raziskav dinamike tekočin. Delo bo usmerjeno v raziskave kavitacijskih struktur z namenom intenzifikacije procesov. Osredotočili se bomo prevsem na področje priprave emulzij pod posebnimi pogoji. Poleg mehanskih učinkov mehurčkov na medfazno mejo, nameravamo raziskati tudi kemijske vplive, ki bi lahko procese še pospešili. Nedavno smo namreč opazili, da lahko ob določenih pogojih, kolaps mehurčka vodi do nepričakovanega fokusiranja energije, kar bi jo lahko uporabili za lokalno vzpodbujanje kemijskih reakcij. Raziskave bodo zato zajemale predvsem v razumevanje dinamike mehurčka ali množice mehurčkov ter meritve nastajanja reaktivnih spojin. Usposabljanje zahteva izobrazbo iz naravoslovne ali tehniške smeri in znanje angleškega jezika. Od kandidata/ke se pričakuje samostojnost, organiziranost, ambicioznost in seveda želja po raziskovanju.

Eng.: The training of the Young Researcher will be carried out in the field of basic research in fluid dynamics. The work will be directed towards research into cavitation structures with the aim of intensification of processes. We will focus mainly on the field of preparation of emulsions under special conditions. In addition to the mechanical effects of bubbles on the interphase boundary, we also intend to investigate chemical influences that could further accelerate the processes. We have recently observed that under certain conditions, the collapse of a bubble can lead to an unexpected energy focusing, which could be used to locally stimulate chemical reactions. The research will therefore primarily involve understanding the dynamics of a songle bubble or a bubble cluster and measurements of the formation of reactive species. The training requires an education in natural sciences or engineering field and knowledge of the English language. The candidate is expected to be independent, organized, ambitious and, of course, have a desire for research.

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

Opis raziskovalnega dela *(Research work description*)

1. Članica UL (*UL member)*:

Fakulteta za strojništvo (Faculty of Mechanical Engineering)

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

Andrej Žerovnik, andrej.zerovnik@fs.uni-lj.si

3. Raziskovalno področje (*Research field*):

2.11.02 Specialna konstrukcijska znanja, 3.08 Javno zdravstvo (varstvo pri delu)

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.: Raziskovalna skupina Laboratorija za modeliranje elementov in konstrukcij je mednarodno vpeta v napredne inovativne raziskave na področju specialnih konstrukcijskih znanj in medicine. Mladi raziskovalec bo član dinamične in multidisciplinarne ekipe, z delom na področju eksperimentalne analiza, numeričnega modeliranja in razvoja inovativnih rešitev na področju specialnih konstrukcijskih znanj ter medicinskih aplikacijah. V stimulativnem okolju bo v sodelovanju s člani raziskovalne skupine Modeliranje v tehniki in medicini aktivno deloval na enem od sledečih področji (področje se določi na podlagi razgovora):

- *Utrujanje večosno obremenjenih materialov z oblikovnim spominom (SMA): Raziskovanje vpliva večosnih obremenitev in njihovih faznih zamikov na strukturno in funkcijsko utrujanje SMA zlitin, ki se uporabljajo v različnih inženirskih aplikacijah kot so elastokalorična tehnologija, aktuatorji, vzmeti itd.*
- *Več-nivojsko modeliranje kompozitnih materialov z oblikovnim spominom: Eksperimentalno opazovanje ter razvoj in validacija numeričnih modelov za napovedovanje mehanskih lastnosti in odzivov kompozitnih materialov pri različnih obratovalnih pogojih.*
- *3D tiskani kompozitni materiali kot medicinski implantati: Raziskave na področju razvoja, izdelave in uporabe naprednih kompozitnih materialov za razvoj in izboljšanje medicinskih implantatov z namenom prilagojene izdelave ter izboljšanja bio-kompatibilnosti in funkcionalnosti.*

Zaželeno je:

- *Predhodno znanje in veščine kandidatov s področja strojništva, fizike in materialov (najmanj enega področja).*
- *Znanje angleškega jezika, tako pisno kot ustno, za komunikacijo z mednarodnimi raziskovalnimi skupinami in objavo znanstvenih prispevkov.*
- *Močna motivacija za raziskovalno delo in želja po doseganju odličnosti.*
- *Samostojnost, dobre organizacijske sposobnosti in sposobnost dela v ekipi.*
- *Pripravljenost na sodelovanje z mednarodnimi partnerji in udeležbo na mednarodnih znanstvenih konferencah.*

Eng.: The research group from the Laboratory for the Modelling of Elements and Structures is internationally engaged in advanced innovative research in the field of specialized construction knowledge and medicine. The young researcher will be a member of a dynamic and multidisciplinary team, working in the areas of experimental analysis, numerical modelling, and the development of innovative solutions in the field of specialized construction knowledge and medical applications. In a stimulating environment, in collaboration with members of the research group of Modelling in Engineering and Medicine, they will actively work in one of the following areas (the area is determined based on an interview):

- *Fatigue of multi-axially loaded shape memory alloys (SMA): Investigating the influence of multi-axial loads and their phase shifts on the structural and functional fatigue of SMA alloys used in various engineering applications such as elastocaloric technology, actuators, springs, etc.*
- *Multi-scale modelling of shape memory composite materials: Experimental observation and the development and validation of numerical models for predicting the mechanical properties and responses of composite materials under different operating conditions.*
- *3D printed composite materials as medical implants: Research in the development, manufacturing, and use of advanced composite materials for the development and improvement of medical implants aimed at customized fabrication and enhancing bio-compatibility and functionality.*

Expected candidate skills:

- *Prior knowledge and skills in the fields of mechanical engineering, physics, and materials (at least one of fields).*
- *Proficiency in English, both written and spoken, for communication with international research groups and the publication of scientific contributions.*
- *Strong motivation for research work and a desire to achieve excellence.*
- *Independence, good organizational skills, and the ability to work in a team.*

Willingness to collaborate with international partners and participate in international scientific 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)*

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☒ **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)*