Kratek opis usposabljanja mladega raziskovalca (*Short description of the Young Researcher's training)*

1. Raziskovalna organizacija (*Research organisation)*:

Univerza v Ljubljani, Biotehniška fakulteta

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

Mirko Kariž, mirko.kariz@bf.uni-lj.si

3. Šifra in naziv raziskovalnega področja (*Research field*):

4.01 Gozdarstvo, lesarstvo in papirništvo

4. Kratek opis usposabljanja mladega raziskovalca (*Short description of the Young Researcher's training)*:

Navedite tudi morebitne druge zahteve, vezane na usposabljanje mladega raziskovalca (npr. znanje tujih jezikov, izkušnje z laboratorijskim delom, potrebne licence za usposabljanje…).

slo:

Dodajalne tehnologije, pogosto pogovorno poimenovane 3D tisk, so v zadnjih letih dosegle velik razvoj na področju same tehnike kot tudi materialov za tiskanje. Prvotno so se te tehnologije uporabljale predvsem za hitro izdelavo prototipov, danes pa omogočajo tudi že stroškovno konkurenčno izdelavo unikatnih izdelkov ali manjših serij enakih izdelkov, oziroma celo personaliziranih izdelkov prilagojenih vsakemu kupcu posebej. Razvite so še številne tehnike, ki se razlikujejo v načinu nanašanja, utrjevanja in vrsti materiala, skupno pa jim je grajenje izdelka po slojih, ki omogoča boljše izkoristke materiala in izdelavo kompleksnih oblik, vendar tudi vpliva na mehanske lastnosti izdelka (problem sprijemanja slojev, napetosti med sloji, temperaturni gradienti med gradnjo…). Velik poudarek v zadnjem času je na razvoju materialov, ki bi bili cenejši, iz naravnih virov, s čim manjšim izpustom škodljivih snovi med samim postopkom izdelave, z možnostjo uporabe odpadnih surovin ter možnostjo reciklaže po odsluženju. Les oziroma lesni ostanki, ki nastanejo pri primarni in sekundarni obdelavi lesa v precejšnji količini, so ena od možnih naravnih surovin, ki bi lahko bile v večji meri uporabljene za 3D tiskanje v kombinaciji z naravnimi in sintetičnimi polimeri. Les je naraven, higroskopen material, ki pri spremembi klime oddaja ali sprejema vodo iz okolice ter s tem tudi spreminja svoje dimenzije, poleg tega pa ima tudi omejeno trajnost. Ker les še vedno obdrži svoje lastnosti tudi pri vključitvi v lesno-plastične kompozite (sicer v manjšem obsegu, odvisno od deleža v kompozitu in dodatkov) in predstavlja vzrok za spreminjanje dimenzij in oblike lesno-plastičnih kompozitov, je potrebno njegovo delovanje zmanjšati (z dodatki, termično modifikacijo lesa itd). Odvisno od deleža, velikost in oblike delcev lahko lesni delci kompozit ojačajo (v primeru dodatka delcev ustrezne velikosti, razmerja dolžina/širina, oblike vlaken) ali pa služijo zgolj kot polnilo in s tem pocenijo kompozit, saj so precej cenejši kot polimer. S pravo kombinacijo polimera, deležev posameznih komponent, dodatki, vrsto in geometrijo lesnih delcev (dolžino) lahko izdelamo kompozite z zelo različnimi lastnostmi, ki natančno ustrezajo tehnološkim zahtevam uporabe.

Mladi raziskovalec bo delal na prioritetnih temah raziskovalnega programa P4-0015 »Les in lignocelulozni kompoziti« z osredotočenostjo na raziskovalne aktivnosti v delovni skupini WG3 »Novi materiali na osnovi lesa«. Cilj usposabljanja bo raziskati različne vidike 3D tiskanja z lesno-plastičnimi kompoziti. Izziv predstavlja področje izdelave lesno plastičnih kompozitov v obliki filamentov za 3D tiskanje, izbira ustreznega razmerja polimera, vrste polimera in lesnih delcev, dodatkov ter obdelave lesnih delcev ter vpliv teh dejavnikov na samo 3D tiskanje in lastnosti 3D tiskanih delov. Potrebno bo raziskati vpliv lesa na dimenzijsko stabilnost tiskanih delov ob spreminjajoči se klimi uporabe, oziroma raziskati možnosti uporabe (tudi dimenzijsko spreminjajočih se) izdelkov v različnih pogojih (izpostavljenost notranjim, zunanjim pogojem, biotskim, abiotskim faktorjem). Poleg raziskav materiala pa je potrebno upoštevati tudi končni izdelek in njegovo uporabo: možnosti lepljenja 3D tiskanih delov na les/lesne kompozite, problem adhezije, različne priprave površin lesa in tiskanih delov, površinska obdelava tiskanih delov kot tudi možnosti direktnega tiskanja na les.

Izobrazba in izkušnje
Izobrazba biotehniške, naravoslovne ali tehniške smeri.
Izkušnje pri delu v laboratoriju z analitsko opremo na področju delovanja skupine so dobrodošle.

eng:
Additive technologies, often referred to as 3D printing, have made great progress in recent years in the field of technology as well as printing materials. Originally, these technologies were used mainly for rapid prototyping, but today they also enable cost-competitive production of unique products or smaller series of identical products, or even personalized products tailored to each customer. Many techniques have been developed that differ in the method of application, hardening/curing and type of material, but they all have in common the construction of the product by layers, which allows better utilization of material and production of complex shapes, but also affects the mechanical properties of the product (problem of adhesion between layers, stresses between layers, temperature gradients during building…). Recently, great emphasis has been placed on the development of materials that would be cheaper, from natural sources, with the least possible release of harmful substances during the manufacturing process, with the possibility of using waste raw materials and the possibility of recycling after use. Wood or wood residues, which are formed during primary and secondary wood processing in significant quantities, are one of the possible natural raw materials that could be used to a greater extent for 3D printing in combination with natural and synthetic polymers. Wood is a natural, hygroscopic material that emits or absorbs water from the environment when the climate changes, and thus also changes its dimensions, and also has limited durability. As wood still retains its properties even when incorporated into wood-plastic composites (in a lesser extent, depending on the proportion in the composite and additives) and is a cause for changing the dimensions and shape of the wood-plastic composites, its dimensional stability should be increased (with additives, thermal modification of wood, etc.). Depending on the proportion, size and shape of the particles, wood particles can reinforce the composite (in the case of adding particles of appropriate size, length / width ratio, fiber shape) or serve only as filler and thus cheapen the composite, as they are much cheaper than polymer. With the right combination of polymer, proportions of components, additives, type and geometry of wood particles (length), we can produce composites with very different properties that precisely meet the technological requirements.

The young researcher will work on the priority topics of the research program P4-0015 "Wood and lignocellulose composites" with a focus on research activities in the working group WG3

"New wood-based materials". The aim of the training will be to explore different aspects of 3D printing with wood-plastic composites. The challenge is the production of wood-plastic composites in the form of filaments for 3D printing, the selection of the appropriate ratio of polymer, type of polymer and wood particles, additives and processing of wood particles and the impact of these factors on 3D printing and properties of 3D printed parts. It will be necessary to investigate the influence of wood on the dimensional stability of printed parts in the changing climates, or to investigate the possibility of using (also dimensionally changing) products under different conditions (exposure to internal, external conditions, biotic, abiotic factors). In addition to material research, it is necessary to consider the final product and its use: the possibility of gluing 3D printed parts on wood / wood composites, the problem of adhesion, various surface preparations of wood and printed parts, surface treatment of printed parts or even direct printing on wood.

Education and experiences:
Material science, Wood Science and Technology, Natural sciences, Technical sciences.
Experiences with analytical equipment used in respective laboratories are acknowledged.