

Poletna šola 2024 v Clausthalu

Summer school 2024 in Clausthal

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Izvilleček: Pet študentov in profesorja Oddelka za lesarstvo Biotehniške fakultete na Univerzi v Ljubljani so se konec septembra 2024 udeležili poletne šole v Nemčiji. To je bila že 5. poletna šola, ki jo Oddelek organizira v sodelovanju s Tehniško univerzo Clausthal v kraju Clausthal-Zellerfeld v Nemčiji. Tema poletne šole so vmesne faze na lignoceluloznih materialih. Slovenski in nemški študentje so izdelovali frizbije iz kompozitnih materialov po lastni zamisli (materiali, struktura). Nemški gostitelji so udeležencem teden popestrili z ekskurzijo v rudarski muzej in na jezero Oderteich. Teden v tujini je sklenil turnir v metu novo izdelanih frizbijev. Poletna šola se je ponovno izkazala za izvrstno priložnost za izmenjavo znanja in sklepanje novih prijateljstev.

Ključne besede: poletna šola, Nemčija, Clausthal-Zellerfeld, Oddelek za lesarstvo, TU Clausthal, lignocelulozni kompoziti, frizbi, ekskurzija

Abstract: Five students and two professors from the Department of Wood Science and Technology of the Biotechnical Faculty at University of Ljubljana attended a summer school in Germany at the end of September 2024. This was the 5th summer school organized by the Department in collaboration with the Technical University of Clausthal in Clausthal-Zellerfeld, Germany. The title of the summer school was "Interphases of Biobased-Lignocellulosic Materials". Slovenian and German students made frisbees using composite materials of their own design (materials, structure). The German hosts enriched the week for the participants with an excursion to the mining museum and the Oderteich pond. The week abroad was concluded with a competition throwing the newly made frisbees. The summer school again proved to be a great opportunity for the exchange of knowledge and making new friends.

Keywords: summer school, Germany, Clausthal-Zellerfeld, Department of Wood Science and Technology, TU Clausthal, lignocellulose composites, frisbee, excursion

1 UVOD

1 INTRODUCTION

Oddelek za lesarstvo Biotehniške fakultete Univerze v Ljubljani (kratko OL BF UL) in Technische Universität Clausthal iz Nemčije tradicionalno organizirata slovensko-nemško poletno šolo »Vmesne faze na lignoceluloznih materialih«. Šola poteka v mesecu septembru izmenoma, enkrat v Nemčiji, drugič na naši univerzi v Ljubljani. Vendar je bilo zaporedje lokacij v preteklosti zaradi covida in finančnih pogojev moteno. Eno od večjih težav pri organizaciji poletne šole vedno predstavljajo sredstva za pokritje stroškov. Letos smo za izvedbo šole uspeli pridobiti sredstva na internem razpisu Mednarodne poletne

šole UL 2024, ki se izvaja v okviru RSF (razvojni steber financiranja). Tako smo poletno šolo lahko uspešno izvedli tudi letos, v predzadnjem tednu septembra. Delavnico je vodil prof. dr. Leif Steuernagel s profesorjema dr. Markom Petričem in dr. Sergejem Medvedom (OL BF UL) ter petimi slovenskimi študenti 1. letnika magistrskega študija lesarstva (soavtorji tega prispevka) ter štirimi nemškimi študenti. Vsem je poletna šola zagotovila nepozaben teden inovativnega, praktičnega raziskovalnega dela. Zahvaliti se moramo tudi sodelavcem Inštituta v Clausthalu, ki so pomagali pri izvedbi delavnice: mag. Carrie Schulz, mag. Silvia Imrich, mag. Fabian

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Že 5. poletna šola zapovrstjo se je pričela v nedeljo, 15. 9. 2024, pred Oddelkom za lesarstvo v Ljubljani, od koder so se študentje in profesorja v zgodnjih jutranjih urah odpeljali proti Nemčiji. Po 12 urah vožnje so prispeli v Clausthal-Zellerfeld, kjer so jih sprejeli in pogostili predstavniki Tehniške univerze Clausthal.

The University of Ljubljana, Biotechnical Faculty (Department of Wood Science and Technology) and the Technical University Clausthal, Germany, traditionally organize a Slovenian-German Summer School – “Interphases on Biobased-Lignocellulosic Materials”. The school takes place alternately in September, once in Germany, and the other time in Slovenia. However, this sequence of venues has been interrupted in the past due to COVID and financial conditions. One of the biggest difficulties in organizing a summer school is always financing the costs. This year, we were able to obtain funding for the summer school through the internal call for proposals “International Summer Schools UL 2024”, which is organized under the RSF (the pillar of development funding). As a result, we were able to successfully hold the summer school again this year in the penultimate week of September. The workshop was led by Prof. Dr. Leif Steuernagel, and together with Prof. Dr. Marko Petrič and Prof. Dr. Sergej Medved (UL BF) he offered five Slovenian students (we are co-authors of this paper together with M. Petrič and S. Medved) of the first year MSc in Wood Science and Technology and four German students an unforgettable week of innovative, hands-on research. We would also like to thank the colleagues at the Institute who helped organize the workshop. Carrie Schulz, MSc. Silvia Imrich, MSc. Fabian Hartkopf, MSc. Cedric Tschentscher, Markus Lenk, Petra Dröttboom and Dipl.-Ing. Martin Novotny.

The 5th Summer School began on Sunday, September 15, 2024, in front of the Department of Wood Science and Technology in Ljubljana, where the students and professors left for Germany in the early hours of the morning. After a 12-hour drive, they arrived in Clausthal-Zellerfeld, where they were welcomed and hosted by representatives of the Technical University Clausthal.

2 CLAUSTHAL-ZELLERFELD IN TAMKAJŠNJA UNIVERZA

2 CLAUSTHAL-ZELLERFELD AND THEIR UNIVERSITY

Clausthal-Zellerfeld (slika 1) se nahaja v severni Nemčiji v zvezni državi Spodnja Saška. Leži v jugozahodnem delu hribovja Harz, na 560 m nadmorske višine. Najbližje veliko mesto je okoli 100 kilometrov oddaljeni Hannover na severu. Mesto je nastalo s postopnim zblizanjem in zlitjem dveh naselij, katerih začetki segajo v 16. stoletje. Razvijalo se je hkrati z uspešno rudarsko dejavnostjo v okolici, ki je leta 1775 sprožila tudi ustanovitev Tehniške univerze v Clausthalu. Danes ima mesto 15000 prebivalcev, velik del živosti pa kot središče inovativnosti in razvoja zagotavlja prav univerza (Harz Tourism Association, 2024).

Slednja bo prihodnje leto praznovala 250-letnico ustanovitve. Sestavljajo jo 3 fakultete s kar 33 oddelki – učijo vse od znanosti o materialih, ekonomike, do računalništva in strojništva. Univerzo obiskuje prek 3000 študentov (kar 40 % mednarodnih), katerim se posveča okoli 1100 zaposlenih. Poudarek dajejo krožnemu gospodarstvu, trajnosti in učinkoviti rabi virov. Glavna področja raziskav zajemajo sisteme trajnostne energije, oskrbo s surovinami in trajnostnimi materiali ter digitalizacijo za razvoj zelene družbe. Svoj doseg povečujejo s tesnim sodelovanjem z mnogimi podjetji (TU Clausthal, 2024).



Slika 1. Študentje so se dobro seznanili s središčem mesta Clausthal (foto: M. Jančar).

Figure 1. The students explored Clausthal city centre (photo: M. Jančar).

Clausthal-Zellerfeld (Figure 1) is located in northern Germany in the federal state of Lower Saxony. It lies in the south-western part of the Harz Mountains at 560 m above sea level. The nearest major city is Hannover, about 100 kilometres to the north. The town was formed by the gradual merging of two settlements whose origins date back to the 16th century. It developed in parallel with the flourishing mining industry in the area, which also led to the founding of the Technical University of Clausthal in 1775. Today, the town has a population of some 15,000 and the university is an important part of its vibrant life as a centre for innovation and development (Harz Tourism Association, 2024).

The university celebrates its 250th anniversary next year. It consists of three faculties with 33 departments teaching everything from materials science and economics to computer science and mechanical engineering. The university has over 3,000 students (40% of whom come from abroad) and around 1,100 employees. The focus is on the circular economy, sustainability and resource efficiency. The main research areas include sustainable energy systems, the supply of raw materials and sustainable materials as well as digitalization for the development of a green society. Close cooperation with many companies increases its reach (TU Clausthal, 2024).

3 PROJEKT KOMPOZITNI FRIZBI

3 THE COMPOSITE FISBEE PROJECT

Cilj tokratne šole sta bila snovanje in izdelava kompozitnega frizbija. Ta naj bi bil sestavljen iz dveh različnih naravno-polimernih kompozitnih materialov, kar je spodbujalo interdisciplinarno razmišljanje in povezovanje.

Prvi dan po prihodu v Clausthal sta poletno šolo s predavanji na temo polimernih in lignoceluloznih materialov otvorila profesorja Steuernagel in Medved. Na daljavo je prek videoklica študentom delil znanje tudi prof. dr. Milan Šernek, ki je govoril o tehnologiji lepljenja. Za tem so se študentje razdelili v tri skupine in brez odlašanja pričeli z razvojem svojih frizbijev.

Skupina A, ki so jo sestavljali Matic Jančar, Nicolas Uzunhan in Shaoqin Ruan, si je zamislila frizbi



Slika 2. Prvi frizbi se je oprijel kalupa (foto: P. Zore).
Figure 2. The first frisbee got stuck to the mould (photo: P. Zore).

iz mešanice smrekovega žaganja in polipropilena ter lanenih vlaken in polibutilena. Skupina B, ki so jo sestavljali Primož Zore, Enej Lipovec Zupanc in Valentin Heinmüller, se je odločila za komercialna kompozitna materiala Lifocork UV in JELU WPC. V zadnji skupini C pa so Anže Zajc, Matevž Vrhovec in Jafaar Naciri preizkušali kombinacijo smrekovine in polipropilena v različnih razmerjih v spodnji in zgornji plasti.

Po idejni zasnovi so se študentje takoj lotili praktičnega dela. V izjemno dobro opremljeni in urejeni delavnici Inštituta so najprej pripravili poskusne vzorce izbranih materialov. Na teh so preverili mehanske lastnosti zamišljenih kombinacij in po potrebi prilagodili deleže različnih komponent. Preverjali so upogibno in udarno trdnost svojih kompozitov.

Ko so bili zadovoljni z rezultati, so se lotili izdelave frizbijev. Prvi dve skupini sta se odločili za takojšnje vroče stiskanje v kalupu, tretja pa za dvostopenjski pristop – najprej ekstruzijo posamezne plasti in šele nato oblikovanje v kalupu.

Tretji dan je skupina B kot prva pogumno stisnila svoj frizbi in naletela na težave pri odstranjevanju iz kalupa (slika 2). Čeprav je prvi frizbi pri tem razpadel, jih to ni ustavilo. Prilagodili so kalup in predlagali uporabo povoščenega papirja za lažje odstranjevanje. Spodrsrlaje in odkritja so skupine odprto delile med seboj in se tako podpirale in spodbujale.

The aim of this year's school was to design and create a composite frisbee. This was to be com-

posed of two different natural-polymer composite materials, which encouraged interdisciplinary thinking and networking.

On the first day after their arrival in Clausthal, Professors Steuernagel and Medved opened the summer school with lectures on polymer and lignocellulosic materials. Prof. Dr. Milan Šernek also shared his knowledge with the students via video call and spoke about bonding technology. The students then split into three groups and immediately began developing their frisbees.

Group A, consisting of Matic Jančar, Nicolas Uzunhan and Shaoqin Ruan, developed a frisbee made from a mixture of spruce sawdust and polypropylene on one side and flax fibres and polybutylene on the other. Group B, consisting of Primož Zore, Enej Lipovec Zupanc and Valentin Heinmüller, opted for commercially available composite materials, Lifocork UV and JELU WPC. In the last group, C, Anže Zajc, Matevž Vrhovec and Jafaar Naciri tested a combination of pine wood and polypropylene in different proportions in the bottom and top layers.

After the conceptual design, the students got straight down to practical work. First, they produced test samples of the selected materials in the institute's well-equipped and well-organized workshop. Using these, they were able to check the mechanical properties of the combinations they had designed and, if necessary, adjust the proportions of the various components. They tested the bending and impact strength of their composite materials.

Once they were satisfied with the results, they started to make the frisbees themselves. The first two groups opted for immediate hot pressing in a mould, while the third group chose a two-step approach – first extruding each layer and then forming it in a mould.

On the third day, Group B was the first to boldly press their frisbee, and had difficulty releasing it from the mould (Figure 2). Although the first frisbee fell apart, this did not stop them. They adjusted the mould and suggested using wax paper to make it easier to remove. Accidents and discoveries were openly shared between the groups to support and encourage each other.

4 EKSURZIJA V RUDNIK SAMSON IN JEZERO ODERTICH

4 THE EXCURSION TO THE SAMSON MINE AND ODERTICH POND

Gostitelji so Slovencem popestrili bivanje v Nemčiji z ekskurzijo v rudniški muzej v kraju Sankt Andreasberg, ki leži 15 kilometrov jugovzhodno od Clausthal-Zellerfelda. Muzej je postavljen na rudniku Samson, enem od mnogih v hribovju Harz.

Rov Samson so pričeli kopati v 16. stoletju. Obratoval je vse do leta 1910, dosegel pa je globino kar 840 metrov. Glavna ruda, ki so jo pridobivali, je bilo srebro. Rudnik je še posebej zanimiv, ker je v njem ohranjena in delujoča pomična lestev iz leta 1837. Gre za zgodnjo alternativo dvigalu, kar je rudarjem omogočalo mnogo hitrejšo potovanje v globine in nazaj na površje kot po klasičnih lestvah (slika 3). Celoten sistem je bil gnan z vodo, ki je prihajala iz akumulacijskih jezer na višjih legah. V muzeju je danes postavljena delujoča replika enega največjih vodnih koles, premera kar 12 metrov. Kolo je izdelano iz smrekovine in hrastovine. Kljub temu da rudnik ne obratuje več, pa se še danes izkorišča moč vode, ki priteka vanj. V glavnem jašku je namreč na globini 190 m postavljena hidroelektrarna.

Po ogledu jaška, pomične lestve in vodnega kolesa je skupina rudnik zapustila po krajšem rovu. Za tem so si ogledali še razstavo v sosednji stavbi, ki je prikazala življenje rudarjev in njihovih družin skozi čas.

Po končanem obisku muzeja so se odpeljali do bližnjega akumulacijskega jezera Oderteich (slika 4), okoli katerega je speljana lepa pohodna pot. Skupina se je sprehodila ob jezeru in se čudila nekaterim pohodnikom, ki so se opogumili in celo zaplavali v njem.

Med potjo na ekskurzijo in nazaj je bilo presemetljivo videti obseg škode, ki jo je na tamkajšnjih pretežno smrekovih gozdovih povzročil lubadar. Ker celotno območje spada pod narodni park Harz, napadenih dreves ne odstranjujejo. Posledica je na tisoče posušenih dreves, do koder seže oko.

Po vrnitvi v Clausthal je dan sklenila proslava rojstnega dne profesorja Petriča, ki je vse udeležence povabil na večerno druženje ob pšeničnih in ječmenovih napitkih.



Slika 3. Model pomične lestve, star toliko kot sama naprava. Na njem so se novi rudarji učili uporabe tega nenavadnega dvigala (foto: M. Jančar).

Figure 3. A model of the man engine, as old as the machine itself. It was used to teach new miners how to use this unusual lift (photo: M. Jančar).

On Wednesday afternoon, the hosts invited the Slovenians on an excursion to the mining museum in Sankt Andreasberg, 15 kilometres southeast of Clausthal-Zellerfeld. The museum is located in the Samson mine, one of many in the Harz Mountains.

The Samson mine was first utilized in the 16th century. It was in operation until 1910 and reached a depth of 840 metres. It was mainly silver that was mined. The mine is particularly interesting because it houses a preserved and functioning sliding ladder from 1837. This was an early alternative to the elevator, allowing miners to reach the depths and back to the surface much faster than the conventional ladder (Figure 3). The entire system was powered by water from the higher reservoirs. A working replica of one of the largest water wheels with a diameter of 12 metres is on display in the museum today. The wheel is made of pine and oak wood. Although the mine is no longer in operation, the power of the water flowing into the mine is still being harnessed. There is a hydroelectric power station in the main shaft at a depth of 190 metres.

After visiting the shaft, the moving ladder and the water wheel, the group left the mine through a short tunnel. They then visited the exhibition in the adjacent building, which showed the life of the miners and their families over the course of time.

After the museum visit, the group drove to the nearby Oderteich pond (Figure 4), around which



Slika 4. Favna jezera Oderteich (foto: M. Jančar).

Figure 4. The fauna of lake Oderteich (photo: M. Jančar).

there is a beautiful hiking trail. The group walked along the lake and were amazed at some of the hikers who dared to swim in it.

On the way there and back it was surprising to see the extent of the damage caused by the bark beetle in the local, predominantly spruce forests. As the entire area is part of the Harz National Park, the infested trees are not removed. The result is thousands of dead trees as far as the eye can see.

After returning to Clausthal, the day was rounded off with a birthday party for Professor Petrič, who hosted an evening of wheat and barley drinks.

5 ZAKLJUČNI TURNIR IN VRNITEV DOMOV

5 THE FINAL TOURNAMENT AND THE RETURN HOME

V četrtek so študentje nadaljevali z izdelavo frizbijev. Z novim pristopom so vsem trem skupinam izdelki dobro uspeli. Za tem so pripravili predstavitev svojih projektov, ki so jih naslednje jutro predstavili ostalim prisotnim. Proti večeru so si udeleženci ogledali tradicionalni sejem, ki se v Clausthalu poleti odvija vsak teden.

V petek je nastopil pomemben zaključek – praktično testiranje frizbijev. Le-to je potekalo na bližnjem travniku, kjer so se skupine pomerile v dolžini meta svojih mojstrov. Vsak član je metal

enkrat, pri čemer je nekaterim rahlo ponagajal veter. V vlogo sodnika se je postavil profesor Steuernagel, ki je skupne razdalje izmeril z nitjo. Uvrstitev skupin se je nato določila glede na mase pridobljenih klopov. Najdlje so metali v skupini B, za tem v C in naposled v A. Ali je na rezultat bolj vplivala masa posameznega rekvizita, ali sposobnost metalca, je težko opredeliti, vsekakor pa so se vsi frizbiji dobro odrezali z vidika trdnosti in obstojnosti.

Po končanem turnirju so profesorji uradno sklenili poletno šolo z izmenjavo simboličnih daril in podelitvijo priznanj o udeležbi študentom. Zvečer je sledil še poslovilni piknik, ki ga je za vse organiziral profesor Steuernagel. Po slovesu od nemških gostiteljev so se študentje še zadnjič sprehodili po mestu in prijetno preživeli preostali del dneva.

V soboto, 21. 9. 2024, je slovenska delegacija rano odrinila proti domu. Zahvaljujoč vztrajnemu šoferju so že popoldne prispeli nazaj v Ljubljano. Teden je minil, kot bi trenil in tako študentje kot profesorja so bili s poletno šolo zelo zadovoljni. Odprava v Nemčijo je poleg novih znanj in izkušenj s področja polimernih in lignoceluloznih kompozitov udeležencem razširila obzorja in omogočila nova poznanstva.

On Thursday, we continued with making the frisbees. All three groups did well with a new approach. The students then presented their projects, which they then showed to the rest of the audience the next morning. Towards the evening, the participants visited the traditional fair that takes place every week in Clausthal during the summer.

On Friday, an important final event took place – a practical test of the frisbees. This took place in a nearby meadow, where the groups competed in the throwing distance of their masterpieces. Each member threw once, with some of them being slightly hindered by the wind. Professor Steuernagel acted as referee, measuring the total distance with a rope. The ranking of the groups was then determined based on the results of this. The longest throws were made in group B, followed by C and finally A. Whether the weight of the individual frisbee or the skill of the thrower had more influence on the result is difficult to determine, but in any case all frisbees performed well in terms of strength and durability.

After the tournament, the professors officially closed the summer school by exchanging symbolic

gifts and presenting the students with certificates of participation. In the evening, a farewell picnic was organized by Prof. Steuernagel. After saying goodbye to their German hosts, the students took a final walk through the city and made the most of the rest of the day.

On Saturday, September 21, 2024, the Slovenian delegation left for home early in the morning. Thanks to a determined driver, they arrived back in Ljubljana in the afternoon. The week flew by and both the students and the professors were very satisfied with the summer school. In addition to the new knowledge and experience that was gained in the field of polymer and lignocellulose composites, the trip to Germany broadened the participants' horizons in general and enabled them to make new friends and acquaintances.

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