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****Please read accompanying guidance notes****

Department	School of Engineering and the Built Environment
Supervisors	Professor Hexin(Johnson) Zhang; Prof Peter Andras
Funding Status	Funded PhD Project (Worldwide)
Application Deadline	14/04/2022
Project Title	Developing engineered living materials with bamboo and timber based composites for construction

PROJECT DESCRIPTION

Engineering living materials (ELMs) have many advantages including self-regeneration, self-healing, self-regulation, environmental responsiveness and self-sustainability that are supporting them to be the future materials for many applications such as textile, packaging, constructions, etc [1-3]. Mycelium as one of the popular ELMs, the filamentous fungi have been considered as the candidates to replace petroleum-based adhesives and plastics in novel composite material production [4]. In this proposal, one of the most important applications of the mycelium bonding is to replace the gluing process in the engineered bamboo, bamboo-timber composite production in which the unstainable and health-detrimental petroleum-based adhesives are heavily used. This proposed low energy bio-fabrication process provides alternatives to this most energy intensive synthetic process in production. Moreover, the geometry and microorganism of the mycelium networks can be reprogrammed by stimulating the fungi's electrical activities with electrical stimulations to generate different microorganism patterns that can be regulated by the machine learning algorithm [5, 6]. The mycelium composite has customisable material properties based on their composition and manufacturing process and can replace foams and plastics for applications, such as insulation, door cores, panelling, flooring, cabinetry and other building elements. Draw on the current success of the research in bamboo-timber composite materials [10] , the project aims to to develop a programmable biosynthetic and biomineralization technology to produce mycelium bonded bamboo-timber shell materials for construction.

The main aims of this project are to:

1) develop a programmable biosynthetic and biomineralization technology to produce the graphene enhanced mycelium bonded bamboo-timber shell structures
2) understand and optimise the functionality of mycelium interface and graphene additives in bamboo and wood bonding.
3) verify the graphene enhanced mycelium bio-programming mechanism with electrical stimulation powered by the machine learning algorithm.

References

1. Elsacker, E., et al., A comprehensive framework for the production of mycelium-based lignocellulosic composites. Science of The Total Environment, 2020. 725: p. 138431.
2. Girometta, C., et al., Physico-Mechanical and Thermodynamic Properties of Mycelium-Based Biocomposites: A Review. Sustainability, 2019. 11(1).
3. Sydor, M., et al., Mycelium-Based Composites in Art, Architecture, and Interior Design: A Review. Polymers, 2022. 14(1).
4. Sun, W., et al., Functionality of Surface Mycelium Interfaces in Wood Bonding. ACS Applied Materials & Interfaces, 2020. 12(51): p. 57431-57440.
5. Adamatzky, A., On spiking behaviour of oyster fungi Pleurotus djamor. Scientific Reports, 2018. 8(1): p. 7873.
6. Adamatzky, A., et al., Fungal electronics. Biosystems, 2022. 212: p. 104588.
7. Zhang, H., et al., Effect of concentrated Butt-Joints on flexural properties of laminated Bamboo-Timber flitch beams. Journal of Sandwich Structures & Materials, 2021: p. 10996362211040103.

Johnson's research on bamboo-timber composite materials is showcased in Royal Academy of Engineering website: https://www.raeng.org.uk/grants-prizes/grants/support-for-research/case-studies/industrial-fellowship/dr-hexin-(johnson)-zhang

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Academic qualifications
A first degree (at least a 2.1) ideally in civil engineering/mechanical engineering or material science or a cognate discipline with a good fundamental knowledge of mechanics of materials, material science and experimental skills.

English language requirement
IELTS score must be at least 6.5 (with not less than 6.0 in each of the four components). Other, equivalent qualifications will be accepted. Full details of the University's policy are available online.

Essential attributes:

- Experience of fundamental Click here to enter text.
- Competent in conducting experimental research in material science, structural analysis and modelling, and/or coding
- Knowledge of mechanics of materials
- Good written and oral communication skills
- Strong motivation, with evidence of independent research skills relevant to the project
- Good time management

Desirable attributes:

- Lab skills in material science
- Knowledge of structural analysis, design and finite element analsysis
- Knowledge of bio-based construction materials

Indicative Bibliography	https://www.researchgate.net/profile/Hexin-Zhang https://scholar.google.co.uk/citations?user=_vgmtOUAAAAJ&hl=en https://www.researchgate.net/profile/Peter-Andras https://scholar.google.com/citations?user=PUGnd_gAAAAJ&hl=en
Funding notes	This project may be funded by a scholarship of the School of Engineering and Built and Environment. Please see School-funded PhD scholarships - RESEARCH AND INNOVATION (napier.ac.uk) for information on the scholarships and how to apply for them.
Enquiries	For informal enquiries about this PhD project, please contact Prof Hexin(Johnson) Zhang, j.zhang@napier.ac.uk
Web page	https://www.napier.ac.uk/research-and-innovation/research-degrees/application-process

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