SUMMER RESEARCH 2024/25
PROJECT ABSTRACT

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

PROJECT # 74

SUPERVISOR/S: Dr. Mohammad Dalour Beg & Dr. Christian Gauss

PROJECT TITLE: Nanocellulsoe Aerogel Towards High-Performance Insulation Materials

FIELD: Materials Science

DIVISION/SCHOOL: HECS - Te Kura Mata Ao School of Engineering

PROJECT LOCATION: Hamilton

PROJECT ABSTRACT:

Thermal comfort is essential in any modern building. However, cooling and heating buildings contribute significantly to our carbon footprint, accounting for over 10% of total CO2 emissions. Therefore, efficient insulation is necessary to reduce energy consumption and greenhouse gas emissions throughout a building's operational life. Although several commercial insulation materials are available, they often have high embodied energy consumption, some are made of petrochemicals, and natural options generally have issues with durability and efficiency.

Aerogels are promising candidates for improving the thermal efficiency of buildings due to their ultralight nature and porous network, which result in very low thermal conductivity and high specific strength. An aerogel is a special type of solid material with nanometer-scale pores, with the most common being silica-based. Despite their unique and interesting properties, aerogels are brittle, difficult to scale up, and have sustainability issues. Cellulose is the most abundant naturally occurring biopolymer on Earth and is used in various areas, including paper production, electronics, green chemicals, and medicine. Nanocellulose, the building block of cellulose fibres, has unique properties, including high specific mechanical strength, ease of modification, abundance, and renewability. Nanocellulose can be obtained directly from bacteria-producing cellulose or from cellulose extracted from plants, seaweed, and algae. This bio-derived material can be used to produce sustainable aerogels with properties suitable for insulation purposes. However, manipulating nanocellulose and producing stable aerogels in an energy-efficient manner remains a challenge. In this project, the student will engage in an exciting initiative involving materials science, chemistry, and physics. First, different sources of nanocellulose (plant-derived and bacterial cellulose) will be modified to facilitate their dispersion in water. Various alternatives for cross-linking will be explored before producing cellulose-based aerogels through a freeze-drying process. We will assess and understand the material's properties using several mechanical, physical, and chemical characterisation methods.

STUDENT SKILLS:

- Good knowledge of materials chemistry
- Willingness to learn and work with laboratory equipment
- Teamwork
- Comfortable in writing technical reports
- Laboratory skills (in special chemistry)

PROJECT TASKS:

1. Literature review
2. Design of experiments – modification of nanocellulose
3. Production and characterisation (physical and mechanical) of cellulose-based aerogels
4. Data analysis
5. Writing the report

EXPECTED OUTCOMES:

- Student's Research Poster (as per clause 6 of the Scholarship regulations)
- Literature review on the use nanocellulose for aerogel applications
- Methodology to modify the surface of nanocellulose
- Produce mechanically and physically stable aerogels