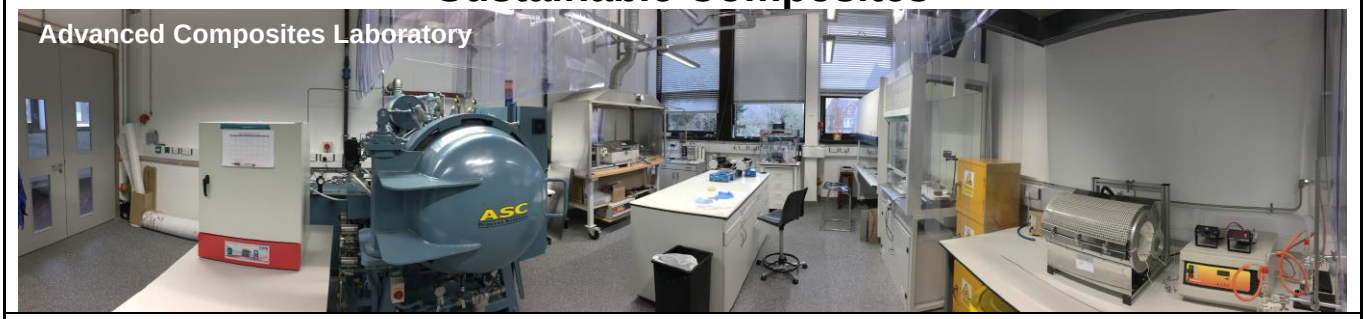
QUB- Mechanical and Aerospace Engineering

PhD Project 2021-22

Development of Cellulosic Structural and Semi-structural Sustainable Composites



Project Background:

Agricultural wastes represent an enormous reserve of unexploited resources that may provide avenues for economic growth, poverty reduction, and sustainable livelihoods while promoting improved waste management practices. One approach, in line with current UN sustainable development goals, is to utilise these abundant resources to produce value-added products.

In the proposed project, the successful PhD candidate will utilise pre-extracted cellulose and cellulose fibres attained from abundant agricultural waste streams and develop methodologies for their processing in conjunction with synthetic and emerging bio-polymers. Their use as polymer additives/precursors is a highly novel approach to sustainable manufacturing with the potential to 1) Extend the 'cradle-to- grave' value of initial raw materials (prior to waste creation) 2) Reduce the burden on petroleum feedstocks, a finite resource coming under increasing scrutiny and 3) Create novel materials with unique characteristics and functionality for an array of sectors including automotive, packaging, aerospace, biomedical etc.

Project Description:

The successful candidate will focus on:

Thermal Processing and Validation
The ability to utilise extracted cellulose as a functional additive will be investigated with optimum content determined to balance 1) functionality and 2) diversion of waste. Conversion of extracted cellulose to micro-crystalline cellulose (MCC) and nano-fibrillated cellulose (NFC) will be investigated. The aim will be to create structural/semi-structural sustainable composites through combinations of bio-polymer and bio-fibres. The potential to enhance interfacial bonding through the use of MCCs and NFCs will be investigated.

Pre and Post thermal processing characterisation will document the gambit of properties required to validate these materials for potential applications for commercial development in future projects. Commercial sectors targeted (packaging, aerospace, medical) will be dependent on the functional properties of the resultant materials.

The work will require expertise, ideas, and research methodology from different disciplines, and bring together researchers from different groups in engineering, natural sciences, and social sciences.

Alignment:

This research targets a number of priority areas within The National Research Priority Areas 2018 to 2023 supporting: 1) 'Energy, Climate Action and Sustainability' by furthering sustainable materials and helping

underpin waste management and 2) 'Advanced and Smart Manufacturing', helping drive the development and manufacturing of novel materials.

It is also aligned with broader policy objectives of improving the environmental footprint of the agri-food industry (DAERA, NI); the need for a 'climate smart and environmentally sustainable food system' (Food 2030); and exploring the opportunities and addressing the risks of introducing plastics with biodegradable properties (EU Action Plan for a Circular Economy 2015).

Key skills required for the post:
Applicants should hold or expect to hold a 2.1 Hons (or equivalent) degree in a relevant discipline such as Mechanical Engineering, Materials Science or in a related field. Students who have a 2.2 honours degree and a Master's degree may also be considered, but the School reserves the right to shortlist for interview only those applicants who have demonstrated high academic attainment to date.

It is essential that the candidate has an enthusiastic attitude towards undertaking research in the field of polymer alternatives and is willing to travel to both academic and industrial collaborators for placements, training courses and dissemination activities.

Key transferable skills that will be developed during the PhD:
These will include an ability to effectively communicate research outcomes to academic peers and industry, independent analytical thinking and problem solving, time management, and leadership.

Supervisory team:	Dr Eoin Cunningham, School of Mechanical & Aerospace Engineering, Queen's University Belfast, e.cunningham@qub.ac.uk, 028 9097 4206 Prof Brian G. Falzon School of Mechanical & Aerospace Engineering, Queen's University Belfast, b.falzon@qub.ac.uk, 028 9097 5640 Prof Biqiong Chen, School of Mechanical & Aerospace Engineering, Queen's University Belfast, 028 9097 4116 Dr Beatrice Smyth, School of Mechanical & Aerospace Engineering, Queen's University Belfast, 028 9097 4318
Funding mechanism:	UK nationals only.
Application closing date:	31st March 2021
Guaranteed stipend	£15,285 tax free. PhD students in the School may have the opportunity to apply to be demonstrators on undergraduate modules. Compensation for this can amount to in excess of £2,400 per year.

Queens University Belfast is a diverse and international institution which is strongly committed to equality and diversity, and to selection on merit. Currently women are under-represented in research positions in the School and accordingly applications from women are particularly welcome.