Mech. & Aero. Eng. INTERNATIONAL STUDENTSHIP 2019

Project Title: EU Agri Food Waste Streams as Biobased Polymer Precursors: Implications for Packaging Supply Chain Management and the Circular Economy

Industrial Collaborators: Moy Park Ltd, Fraunhofer Institute of Packaging, Waitrose, ABP Foodgroup, Aquascot

Supervisors: Dr Eoin Cunningham, Dr Beatrice Smyth

Fit with Priority Areas (EPSRC, Europe etc.):

The proposed research will target the 88 million tonnes of food waste being generated annually across the EU for the extraction of polymer precursors, specifically protein, starch and cellulose for their conversion into added value products including food packaging. The project will also determine the impact of integrating these materials into current production techniques, analysing supply chain logistics, 'whole-life cost' benefits and energy requirements.

Dependence on plastic has seen the quantity of polymers produced from fossil fuels in the first decade of the twenty-first century exceed that produced in the previous 100 years combined. Each year, 5.7 billion barrels of oil are consumed in the fabrication of 311 million tonnes of synthetic products. The unprecedented demand for fossil-based resources, coupled with diminishing reserves and the threat of climate change render the petrochemical industry unsustainable. Increasing awareness of this issue has led to renewed interest in the search for sustainable resources. While significant advances have been made recent years in the conversion of crops into both biofuels and biopolymers the sustainability and ethics are highly questionable when given preference as a material resource.

Reutilisation of agri-food waste for the development of new materials can mitigate the impending depletion of natural resources without diversion of land resource. These waste streams, often posing the industry a commercial and environmental challenge, in regard to their effective disposal, contain the building blocks for the development of natural polymers and represent a source of sustainable raw materials. At present they are simply underutilised.

The successful candidate will complement ongoing EPRSC and EIT funded projects involving Dr Cunningham and Dr Smyth, including Advancing Creative Circular Economies for Plastics via Technological-Social Transitions (ACCEPT) and Consumer Manufacturing Driven Alternative Packaging Solutions from Agri-Food Waste Streams.

Project Description:

The project will have two key strands of research;

1) **Polymer/Waste Composite Development:** Fundamental research and development will identify and rank potential polymer building block feedstocks from EU agri-food waste streams while developing processing techniques for their incorporation in polymer production. Their use as polymer building blocks 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 use of polymer precursor materials, a finite resource coming under increasing scrutiny and 3) Create new composites with unique characteristics and functionality for an array of applications. This strand of the project will utilise the expertise of Dr Cunningham and the Polymer Processing Research Centre (PPRC), who have experience in the development of novel polymer fillers and well established links with waste producers/suppliers and polymer processing plants across the EU.

2) **Supply Chain Logistics and Life-Cycle Analysis**: Integration and management of logistics is becoming a fundamental dimension of organisational strategy within manufacturing. Life cycle analysis of the production, transport and processing of raw materials, as well as of the subsequent distribution and use phases of the bio-based packaging will assess the 'key sustainable development indicators' in the supply chain. A cost benefit analysis of using waste streams from across the EU will be undertaken. Through repurposing wastes as by-products and displacing fossil resources, the embodied energy and environmental impacts of various product streams change, and the saving to industry must be fully quantified using cradle-to-grave life cycle analysis. Dr Smyth will provide expertise in this area.

Both strands of the project address escalating UK/EU/Global drives in legislation for improved resource efficiency and tie in with current funding from the varied UKRI branches.

Proposed Training & Development Areas for Researcher:

Supplementary courses such as; Journal report writing, industry case studies, post-doctoral career planning, guide to statistical analysis will be available. The student will also be linked with Sentinus as a STEM ambassador to attend local schools delivering talks and facilitating short projects with pupils aged 11-18.

Resources:

The project builds on existing work in Queen's on valorising waste streams, biopolymers and environmental lifecycle analysis. Resources can be supplemented from significant investment awarded through ongoing EPRSC and EU-funded projects involving Dr Cunningham and Dr Smyth. These include Advancing Creative Circular Economies for Plastics via Technological-Social Transitions (ACCEPT, £1M) and Consumer Manufacturing Driven Alternative Packaging Solutions from Agri-Food Waste Streams (£1M).
https://epsrc.ukri.org/newsevents/news/plasticsproductionanduse/
https://www.eitfood.eu/programmes/consumer-and-manufacturing-driven-alternative-packaging-solutions-from-agrifood-waste-streams.
The School's Polymer Processing Research Centre (PPRC) facilities will be utilised for the research providing access to state-of-the art equipment and expertise.