

## Sustainable packaging from agricultural waste

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We live in a throw-away society in which we make, use, and dispose with detrimental effects to our environment and health, such as plastic contaminants in oceans and food chains. This has come about because of the industrialisation of many commercial processes, dramatically reducing the cost of products for consumers. These lower prices do not reflect the real cost to the environment of either their manufacture or their disposal. Over 40% of plastic packaging is discarded in landfills with almost one third being dumped illegally. A new paradigm is needed, a bio-circular economy with waste reuse to generate products and energy. This project will turn materials obtained from agricultural waste with no current usage, into compostable plastic packaging and so has the real potential for significant impact.

The first part of the PhD is to quantify and understand the properties of the films produced from tomato waste leaf by Futamura, and the effect of adding a coating (formed from orange peel) to these films. For each film the following will be measured: tensile modulus; strain to failure; tensile strength; peel tests (heat sealability); dynamical mechanical thermal analysis (molecular mobility); thermogravimetric analysis; barrier properties (CO<sub>2</sub>, O<sub>2</sub>, N<sub>2</sub>, H<sub>2</sub>O); transparency (film quality); X-ray (crystallinity); Fourier transform infrared/Raman spectroscopy (orientation/composition); fast field cycling nuclear magnetic resonance (molecular mobility); and scanning electron microscopy/optical microscopy (surface properties/uniformity of coatings). In addition to studying the coated cellulose films, the coatings on their own will be studied. This will be achieved by casting the coatings on to glass plates, to create films made from the coatings alone, which can then be subsequently tested. The aim is to determine relationships between microscopic properties and mechanical/optical/barrier properties of the films. The interactions between plant polymers are interesting in and of themselves, and through this work we can learn both from nature and about nature.

This project will work with the Japanese company Futamura, the biggest world-wide producer of cellulosic films. You will have the opportunity to visit one of their production sites in the UK and work alongside their team of scientists.

<https://www.futamuragroup.com/en/divisions/cellulose-films/>