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Integrated PHA Recovery from Biomass with Formulation and Production of Functional Films, Membranes, and/or Coatings

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Motivation

Membranes and films are well-established and known for ease of use and low energy consumption in applications. 95% of the market consists of polymeric materials, most of which are petrol-based[1]. Though membrane technologies provide tremendous benefits, improvements for more sustainable and environmentally friendly materials and production methods are of ongoing interest.
Polyhydroxyalkanoates (PHAs) are an alternative polymer family for petrol-based materials. Specifically, poly(3-hydroxybutyrate) (PHB) and poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) can be produced from wastewater and offer a wide range of possible blend compositions for versatility in applications (Figure 1). They are biobased, biodegradable, and can contribute to enhancing membrane and film environmental sustainability.

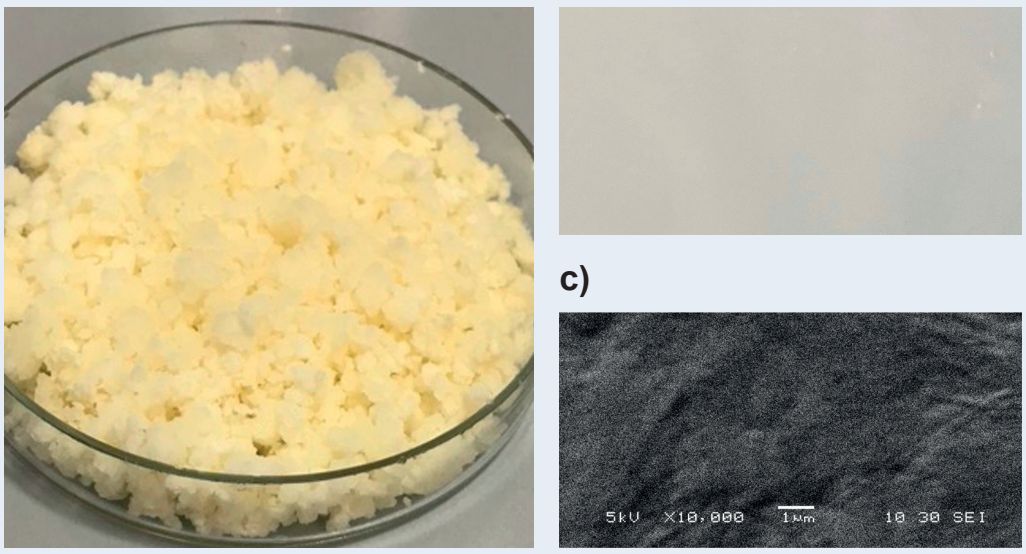

Fig 1. a) Solvent extracted PHA. b) PHA film casting with dimethyl carbonate (DMC). c) SEM image of the film.

Technological challenge

PHAs have been investigated for membrane, film, and coating applications[2]. However, developments are at an early stage. Systematic modulations of the properties coupled with polymer recovery and quality process control, with potential for impact on membrane properties and performance, are unexplored.
Traditionally, the recovery process of PHA from biomass and the application conversion process has been considered separately from one and the other. The polymer was to be recovered to its maximum possible purity. However, the properties of the polymer, such as molecular weight and purity, should be inextricably linked to the specific requirements for the intended application areas. Much effort has been spent on cost reduction and speculatively discussed rather than linking challenges to finding viable commercial outcomes coupled to the overall production process. Thus, synergy of the PHA production with recovery for membrane processes is a way to deliver desired quality for its utilization.

Research goals

This project aims to develop biobased PHA membranes. It not only investigates the membrane formation process and methods to tune membrane properties, but it also intends to merge the steps of polymer recovery and the membrane formation process (Figure 2). This investigation includes:
Development of principles to modulate and control PHA qualities during polymer processing towards specifications required for membrane formation for selected applications.
Generation and characterization of PHA membranes, films, and coatings using relevant technologies, e.g., electrospinning and phase separation, and exploring the operational windows.
Advancing the concept to integrate PHA recovery and subsequent membrane formation processes together.

[1] Hennessy, J. Nature Materials 16, 280–282 2017.
[2] Corre, Y., Bruzaud, S., Audic, J., Grohens, Y., Polymer Testing 31, 226-235 2012.

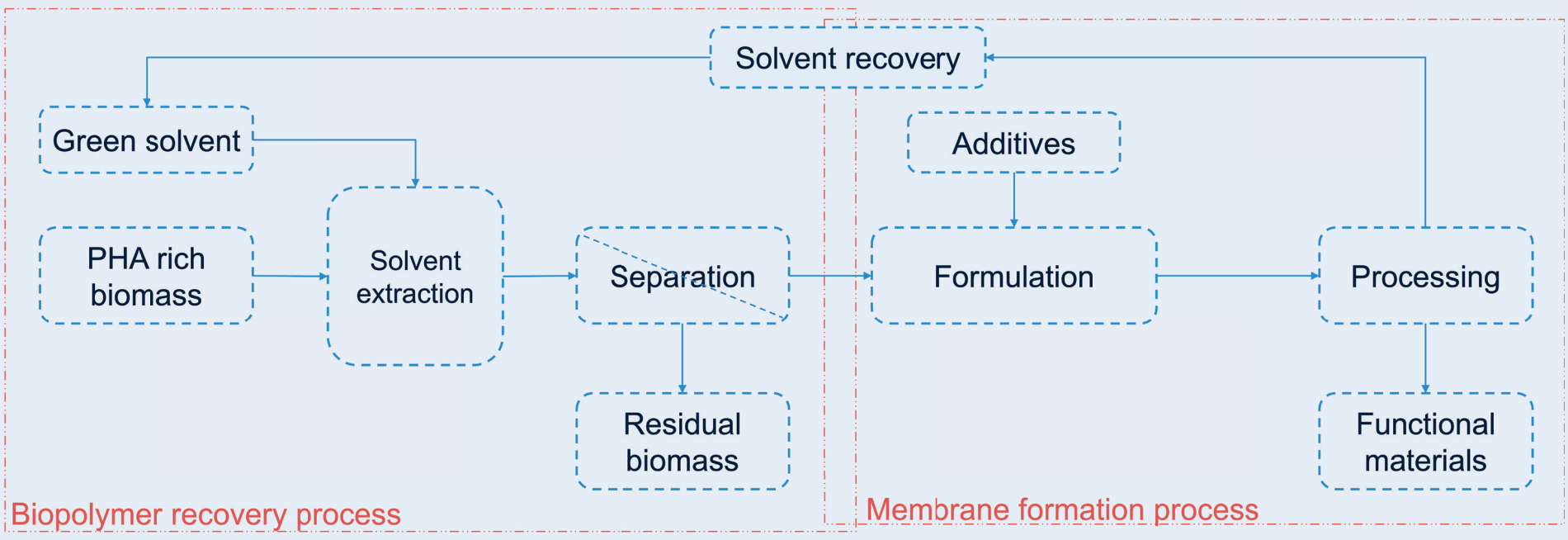

Fig 2. Schematics of the proposed synergy between the processes for PHA recovery and membrane formation.