

Emulsion Templating Using Bacterial Cellulose Nanowhiskers as a Cross-Linkable Building Tool to Create Renewable Nanocomposite Polymer Foams

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Research efforts are being focused on the development of environmentally friendly bio-based nanocomposites in the desire to seek alternatives to petroleum-based composites. In this work, novel bio-nanocomposite foams made from acrylated epoxidized soybean oil (AESO) and functionalised cellulose nano-whiskers have been produced. Bacterial cellulose (BC) offers many attractive properties; its fibrils have diameters between 10 nm to 100 nm with a highly organised hierarchical structure, high crystallinity (~90%) and a Young's modulus of about 114 GPa. However, it has a highly hydrophilic character due to the many hydroxyl groups on the surface, which can be useful sites for modification.

Emulsion templating has emerged as an effective route to prepare porous polymer foams with a well-defined morphology since the latter is defined by the structure of the emulsion template at the gel-point of the polymerization. Pickering emulsions are emulsions that are solely stabilised by small particles. We produce water-in-oil Pickering emulsions and high internal phase emulsions (Pickering-MIPES/HIPES) of AESO having internal aqueous phase levels above 60% solely stabilised with hydrophobised bacterial nano-cellulose whiskers. We use these emulsions as templates for the synthesis of porous polymer foams. The nano-whiskers are grafted with organic acids (via esterification) to render them hydrophobic, including oleic acid, which contains a cross-linkable double bond. Polymerisation is then triggered by UV radiation; the nano whiskers are covalently bonded to the matrix giving an enhanced interface. We study the effect of the internal (aqueous) phase level, and amount of particles used to stabilise the emulsions on the droplet size, emulsion stability and when polymerised on the foam morphology, microstructure and mechanical properties. These novel bio-nanocomposite foams made using Pickering emulsion templating will expand the applications and processing options of such materials to use in large composite structures and sandwich cores and can be formed in situ.