Cellulose nanocrystals-based Pickering HIPE to prepare porous materials

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ABSTRACT

Cellulose nanocrystals (CNC) are bio-based renewable solid particles of rising interest for the stabilization of Pickering emulsions. Commonly extracted from cellulose substrates, these needle shaped nanoparticles can stabilize either oil-in-water (O/W) or water-in-oil (W/O) emulsions in the presence of salt or after chemical functionalization. Polymerization of one of the two phases enables to access different materials. While polymerization of the dispersed phase has been widely studied [1], very little literature reports the polymerization of the continuous phase of CNC-stabilized emulsions [2,3]. Yet, low density highly porous open-celled polymer foams are very attractive materials for a wide range of applications such as catalysis or purification. They can be easily obtained by emulsion templating, a modular technique to produce calibrated monoliths, through polymerization of high internal phase emulsion (HIPE). In the present work, CNC chemically modified by brominated functions were used to stabilize W/O HIPE. Free radical polymerization of the styrene/divinylbenzene continuous phase led to the production of self-standing monoliths (polyHIPE), Figure 1. The obtained materials were characterized regarding their cell size distribution, porosity and mechanical properties and then compared to other polyHIPE systems stabilized either with usual surfactants or solid particles. A study of the influence of the cell size or the internal phase fraction over the mechanical properties was conducted, showing quite good adequacy with the Gibson and Ashby model often used to describe porous solids.

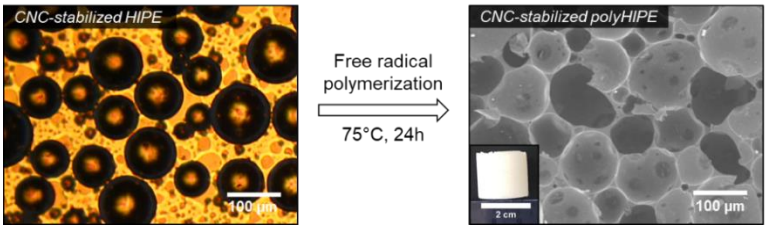

Figure 1: CNC-stabilized high internal phase emulsion before and after polymerization

[1] A. Werner et al., Polymer Chemistry, 9:5043, 2018.

[2] S. Liu et al. J. Mater. Chem. B, 5:2671-2678, 2017.

[3] A. Werner et al., Biomacromolecules, 20:490–501, 2019.