Cellulose Dissolution

An estimated $1.5 \times 10^{12}$ tons of cellulose is generated every year making it the most abundant biopolymer on the planet. However, the wide scale sustainable use of this almost inexhaustible raw material is hindered by its low solubility by virtue of an extensive hydrogen bonding network (Figure 1, A).

Ionic liquids (ILs) can dissolve cellulose opening up a potential processing avenue especially when used with a co-solvent, such as DMSO, due to reduced viscosity, faster dissolution and less ionic liquid. Here we demonstrate the controlled formation of cellulose beads by membrane emulsification of solutions of cellulose dissolved in EMIMOAc-DMSO (Figure 1, B) followed by phase inversion with ethanol. Beads may be further functionalized and used in water purification, chromatography as well as solid supports.

Membrane Emulsification

Emulsions, a mixture of two immiscible liquids, are usually formed via high shear force processes. There is, however, a drive towards lower energy and less harsh membrane emulsification techniques which also provide greater control over dispersity and droplet size (Figure 2).

Water in Oil emulsions (W/O), stabilised with a surfactant, were used as a precursor to cellulose bead products. Specifically, cellulose solutions were dispersed in a continuous sunflower oil phase then subject to an anti-solvent producing solid cellulose beads (Figure 3).

Control of polydispersity and particle size is important and influenced by a range of factors including: temperature, flow rate, surfactant concentration, cellulose concentration, membrane pore size etc. These factors influence the beads via changes in the viscosity and interfacial tension.

References