Hydrophobic Coatings from Industrial Hemicellulosic Waste Streams

Background

- Plastic pollution is an increasingly urgent issue facing our world, and designing renewable, plant-based alternatives to conventional petroleum-based materials is one critical piece of the puzzle to further support the circular economy. Plant polysaccharides are the most abundant renewable polymers on earth, and valorization of the waste streams resulting from biomass processing has the added benefit of improving the economic feasibility of the respective process by offsetting upstream costs.

Approach

- We explored an industrial xylan waste stream, primarily composed of undecorated xylan with an average degree of polymerization of ~20. The xylan was dried, dissolved in DMSO at 80°C, and chemically functionalized with octyl isocyanate using carbamate chemistry. This functionalization gave the xylan special properties, making it fully soluble in organic solvents like chloroform.

Results

- The functionalization process made the xylan soluble and suitable for use as a hydrophobic coating on cellulose sheets. Without the coating, the cellulose absorbs water immediately, as shown in Figure 1a. However, after applying the functionalized xylan (Viscose-C8), the coated cellulose repels water completely (Figure 1b). Our combined analysis shows our material performs comparably to current commercially available hydrophobic coatings. Additionally, these materials were shown to be biodegradable in a composting study.

Significance

- This work shows that functionalized hemicelluloses have dramatic potential as drop-in replacements for conventional petroleum-based feedstocks that are currently used widely in industry. These valorization efforts can also serve to offset upstream biomass processing costs and reduce plastic pollution and environmental impact of hydrophobic coatings and similar materials. We are now applying this technology to bioprocessing residuals.

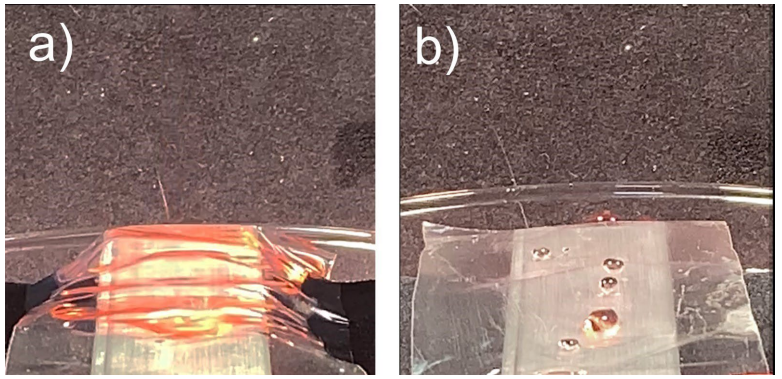

Figure 1. Hydrophobic Coating Performance. a) Uncoated Cellulose Sheet b) Hydrophobic Viscose-C8 Coating

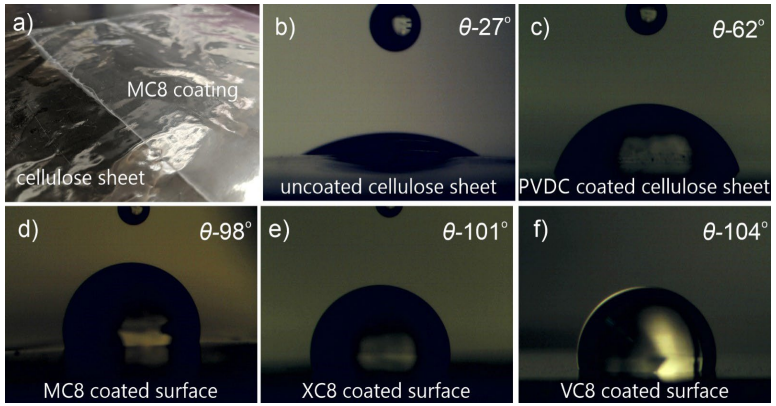

Figure 2. Contact Angle Measurement of b) Uncoated Cellulose Sheet, d) Mannose-C8, e) Xylose-C8, and f) Viscose-C8 Coated Cellulose Sheet

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