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Project title:
Sustainable polymers via direct functionalization of lignocellulosic sugars

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Abstract (approx. 200 words)**:** Hemicellulose is easily extracted from non-edible biomass but is often underutilized due to limited pathways for its conversion into high-volume chemicals. Here, we developed a chemical platform of acetal-stabilized xyloses that offer aromatic performance in an array of different polymer chemistries, resulting in sustainable performance materials. This approach focuses on preserving the natural structure of sugars in biomass with minimal chemical modifications. Glyoxylic acid, a simple aldehyde that can be derived from CO2, is employed to attach carboxylic acid groups to hemicellulose-derived xylose on both sides, protecting it from degradation during extraction and enabling its polymerization. By maintaining the carbohydrate's structure within the plastic precursor (97 % atom efficiency), production becomes straightforward from non-edible biomass, and the cyclic, oxygenated structure of the sugar in the material backbone leads to performance-advantaged properties. We have utilized this monomer to create a class of well-rounded degradable polyesters, as well as a class of highly durable engineering polyamides. We have now also expanded this monomer platform to include other functionalities, such as a promising BPA replacement diol. This robust chemistry has the potential to enhance hemicellulose utilization in the forestry industry and provide society with sustainable, recyclable, and low-persistence materials.

Key words:
Plastics, hemicellulose, xylose, biomass, polyesters, polyamides, sustainable