Understanding why cellulose resists degradation could lead to cost-effective biofuels

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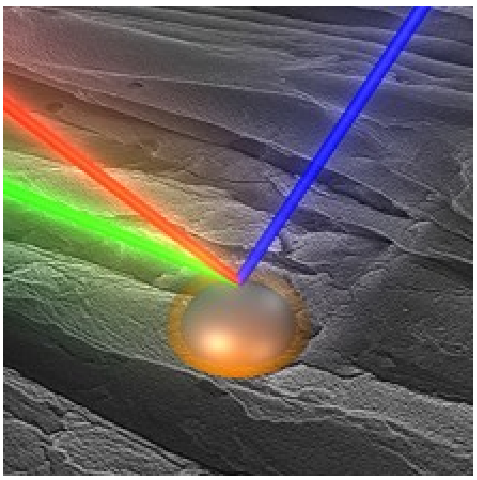

Researchers increased understanding of cellulosic biomass recalcitrance, which not only challenges traditional understanding, but provides further insight into the molecular structure of cellulose that will advance bioproducts. Credit: Environmental Molecular Sciences Laboratory

A major bottleneck hindering cost-effective production of biofuels and many valuable chemicals is the difficulty of breaking down cellulose—an important structural component of plant cell walls. A recent study addressed this problem by characterizing molecular features that make cellulose resistant to degradation.

The findings reveal for the first time structural differences between surface layers and the crystalline core of the two types of cellulose found in plant cell walls. These insights could help researchers develop efficient, cost-effective strategies for breaking down cellulose for renewable energy production and other industrial applications.

A molecular-level understanding of the resistance of cellulose to degradation is a key step toward overcoming the fundamental barrier to making biofuels cost-competitive. However, significant questions remain with respect to cellulose's structure, particularly its surface layers and crystalline core.

To address this knowledge gap, researchers from Washington State University; EMSL, the Environmental Molecular Sciences Laboratory; and Pacific Northwest National Laboratory developed a novel high-resolution technique called Total Internal Reflection Sum Frequency Generation Vibrational Spectroscopy (TIR-SFG-VS) and combined it with conventional non-TIR SFG-VS to characterize molecular structures of cellulose's surface layers and crystalline bulk, respectively. The researchers used Sum Frequency Generation for Surface Vibrational Spectroscopy at EMSL, a DOE Office of Science user facility.

The findings revealed for the first time the structural differences between the surface layers and the crystalline core of cellulose.

By revealing cellulose's conformation and non-uniformity, the results challenge the traditional understanding of cellulose materials and showcase the strong value of powerful spectroscopic tools in advancing knowledge about the structure of cellulose.

More information: Libing Zhang et al. Discovery of Cellulose Surface Layer Conformation by Nonlinear Vibrational Spectroscopy, *Scientific Reports* (2017). DOI: 10.1038/srep44319