Use of photoacoustic AFM to spatially resolve nanomechanics of plant cell wall delignification

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Background

- Lignin prevents the efficient extraction of sugars from the cell walls that is required for large scale biofuel production. Because lignin removal is crucial in overcoming this challenge, the question of how the nanoscale properties of the plant cell ultrastructure correlate with delignification processes is important.

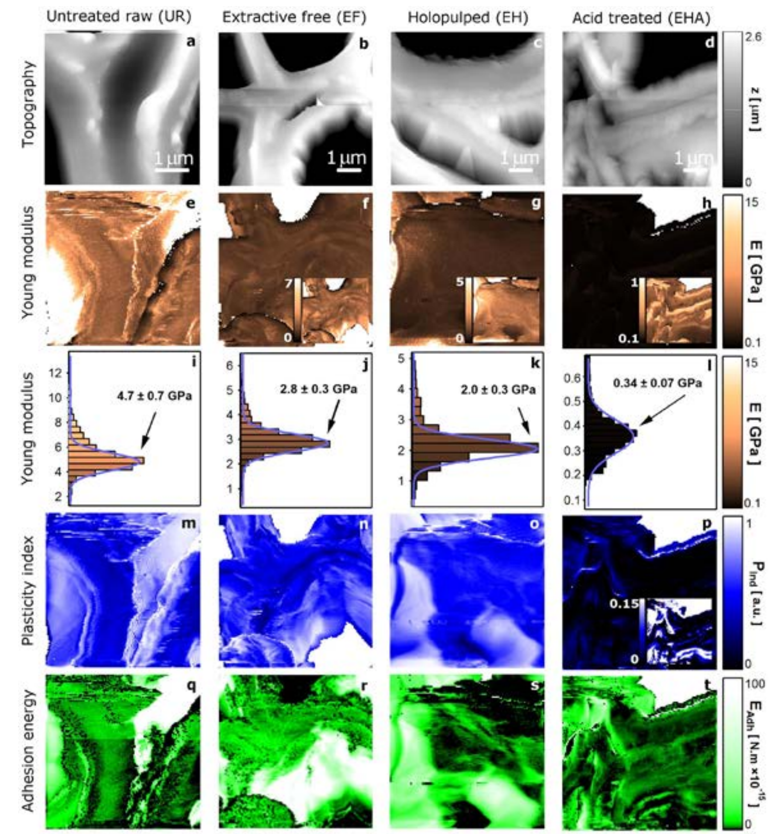
Approach

- By chemically processing biomass and employing emerging nanometrology techniques, the various stages of lignin removal may be distinguished through the observation of morphochemical and nanomechanical variations. Such spatially resolved correlations between chemistry and nanomechanics during deconstruction provide a better understanding of the cell wall architecture and may be vital for devising optimum chemical treatments.

Outcome

- The cell walls' nanomechanical properties undergo quantifiable reductions in plasticity, adhesion energy, and elasticity. These quantitative observations can be used to characterize delignification. The observed reduction in plasticity seems counterintuitive considering that lignin adds to cell wall rigidity.

Increasing delignification shows changes in morphology, elasticity, plasticity and adhesion



Significance

- Nanomechanical mapping may quantify the extent of dissolution of the lignin. Spatially resolving the changes of the cell wall structure may establish a correlation between morphochemistry and nanomechanics. These would shed light on the role of *in situ* lignin in structures which provide a functional capacity within the plant.

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Farahi et al., "Plasticity, elasticity, and adhesion energy of plant cell walls: nanometrology of lignin loss using atomic force microscopy," *Scientific Rep.* 7:152 (2017). DOI:10.1038/s41598-017-00234-4.