Sustainability: Cellulose from Weeds

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Abstract

- Sustainability is a goal of many scientists as well as society
- Not only can wood be used sustainably for manufacturing products, but common weeds (containing large amounts of cellulose) can be used as well
- Biomass can be grown sustainably and can be made into novel materials
- Cellulose fibers can be broken down chemically at the molecular level and processed into strong, light fibers
- These fibers can then be used to make novel materials

Curriculum elements

- My engineering classes study about the engineering design process, and design their own products in the second semester
- We study the material properties of common materials (wood, metal, plastic, composites)
- Students will learn to characterize a variety of materials and learn how each one is best suited for manufacturing in particular circumstances
- After students learn about basic materials, they will learn about new approaches, such as densification of wood and the use of cellulose described here

Lessons learned

This was an excellent opportunity for me to witness the engineering design and research processes up close for myself. I have had few chances to be part of a research group and this gave me an opportunity to be part of it. I was also able to learn about the sustainability work in Dr. Hu's group and how it can benefit the environment while developing new approaches in engineering.

Background and methods

- Sustainability
  - Renewable and sustainable materials, (such as wood and cellulose) can be used in manufacturing
  - For example, weeds (such as pepperwood, Fig 1) are usually considered to be a nuisance, and not wanted, but can actually be useful due to cellulose content
- Preparation of samples
  - Wood products can be modified to be as strong as steel but with ⅛ the weight (MettleWood)
  - The densification process involves the removal of some lignin from the plant, and further treatment to change the properties
  - These materials can be light, strong and made in a sustainable manner with minimal damage to the environment
- Characterization of samples
  - Wide and small angle x ray scattering, (WAXS and SAXS) (Fig 2) can characterize cellulose on both the Angstrom and nano levels, showing what type of cellulose chains are contained within the chosen plant (long, thin fibers are preferred)
  - WAXS (Fig 3 and 4) and SAXS (Fig 5 and 6) can correlate the structure of materials with materials that have high mechanical strength

Fig. 1

Fig 2

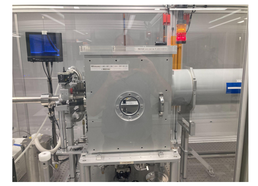


Fig. 3

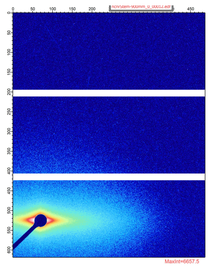


Fig. 4

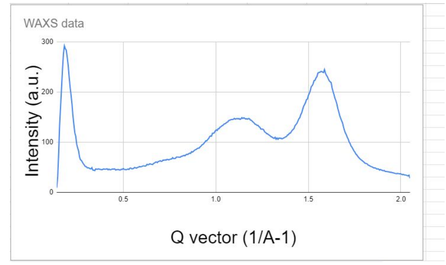


Fig. 5

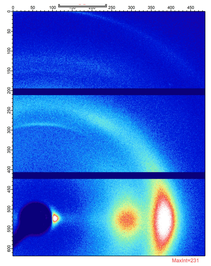
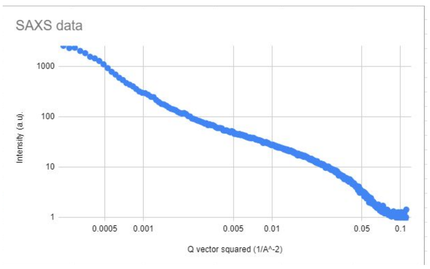


Fig. 6



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