**The Optical Response of Cellulose Nanocrystals**

David Frailey & David Cooper

Dr. Chiu Law, Electrical Engineering, UWM

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**INTRODUCTION**

**Cellulose Nanocrystals (CNCs)**

- Cellulose is the most abundant natural polymer (available from plants, fungi, bacteria, and many other sources) that plays a structural role in cell walls of plants and is a biodegradable-renewable resource.
- While cellulose nanocrystals (CNCs), are biomaterials derived from plants in the form of wood pulp, this substance will be the focused of our proposed research.

**OBJECTIVES**

- Optical devices, like filters and sensors are compact in size and immune from electromagnetic interference.
- Cellulose nanocrystals (CNCs) can self-assemble into liquid crystals, similar to those used in electronic displays and can function as a grating reflecting and transmitting circularly polarized light at certain wavelengths and viewing angles.
- Since gratings are building blocks of optical systems, like lasers and lidars, their fabrication at low costs will enable the further proliferation of optical technologies. Furthermore, if their fragility can be flipped into flexibility, their applications can be extended to wearable electronics.

**APPROACH**

CNCs can self-assemble into right-handed chiral twist structures similar to those of nematic liquid crystals. If the CNC concentration and aspect ratio are appropriately chosen, the resulting chiral nematic structures enable a remarkable optical activity that can be used to manipulate circularly polarized light.

Dimensions of CNCs can have diameters on the order to 10nm and lengths up to the order of 1000nm depending on what source and processes are used.

**METHODOLOGY**

The first step completed is the brittle formation of our CNC material. A thin layer of CNC lay ready for step two in a plastic container shown above.

**Swelling**

The next step done by Kose was to swell the film with dimethyl sulfoxide (DMSO) and 2,2’azobis(2-methylpropionitrile) (ABBN), which from the addition of glucose, swelling was also noticed to be uniform.

By swelling the films with DMSO, the elastomer precursor has a higher success rate to produce a homogeneous elastic film. The elastomer precursor was then chosen due to elastic properties along with transparency.

**Initiators**

Ethyl acrylate (EA) and 2-hydroxyethyl acrylate (2-HEA) were chosen along with ABBN as the initiator for polymerization. The resulting samples showed a changing reflection wavelength when stretched between two cross polarizers which is attributed to the birefringence changing when stretched [1].

**Soak 1 and Soak 2**

Additionally, the swelling time (Soak 1) and the monomer impregnation time (Soak 2) were altered to get this result [2].

Upon recreation of this work at UWM, along with assistance from Kose, a sample with the same optical effects was created as seen in Figure 6.

**RESULT**

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The key objectives of this study were met so far as different ranges of visible light were found to be present in our flexible CNC material as we stretched it. As good elastic properties can be observed from the flexible CNC material, we will be able to use the optical color changes in the CNCs stretch to detect changes in systems that we decide to incorporate this substance in the future.

Overall, through this research, I have learned that executing a plan and action takes time and patience when using equipment like a toaster oven to bake our CNC samples after Soak 1 and Soak 2 have been complete.

It is satisfying to know that we have made progress by tracking our work such as the recipes and techniques used to create certain color ranges on our flexible CNC material.

**BIBLIOGRAPHY**


