CRAIC TECHNOLOGIES

UV-Visible-NIR Microspectroscopy of Nanocrystalline Cellulose

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Introduction

Cellulose is a natural polymer and the most common biological polymer on this planet. Materials formed with cellulose have many advantages including its ready availability, the fact that it is non-polluting and non-toxic. Cellulose is formed from a linear, repeating chain of D-glucose monomers. These linear biopolymers are major structural components of plant cellular walls and are found in many other types of life forms. Cellulose fibers are a common structural formation. Recently, nanomaterials have been formed using cellulose as a primary component. When treated by acid hydrolysis, cellulosic fibers form nanocrystalline cellulose.[1] In this form, cellulose has a number of additional structural features which are attractive for many applications. Features include crystalline structure, high strength, large surface area and unique optical properties. This is in addition to potentially lower cost when compared with such materials as carbon fibers.

UV-visible-NIR microspectrophotometers are built to acquire UV-visible-NIR absorbance and reflectance spectra of microscopic scale samples. They can also be equipped to acquire fluorescence and Raman spectra in addition to UV, color and NIR images. The purpose of this paper is to acquire UV-visible-NIR spectra of nanocrystalline cellulose.

Experimental Procedure

Sample preparation consisted of placing a drop of a 6% aqueous suspension of nanocrystalline cellulose on a quartz slide (CRAIC Technologies, San Dimas, CA). The drop was sealed under a quartz coverslip (CRAIC Technologies). No other sample preparation was required.
A 20/30 PV™ microspectrophotometer (CRAIC Technologies) was used to measure the absorbance spectrum of a small portion of the suspension mounted on the quartz slide. In this case, a 10x quartz objective with the variable aperture set yielded a sampling area of 51 by 51 microns. Absorbance spectra from 250 to 1650 nm were acquired from multiple locations to confirm results.

[1] Peng, B. L., Dhar, N., Liu, H. L. and Tam, K. C. (2011). "Chemistry and applications of nanocrystalline cellulose and its derivatives: A nanotechnology perspective.". *The Canadian Journal of Chemical Engineering* **89** (5): 1191–1206.

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Results

As stated in the experimental section, a single drop of a 6% aqueous suspension of nanocrystalline cellulose was placed on a quartz slide underneath a quartz coverslip. Figure 1 shows how the sample appeared on the 20/30 PV™ microspectrophotometer. The black square is the entrance aperture of the microspectrophotometer and spectra are acquired from anything situated underneath.

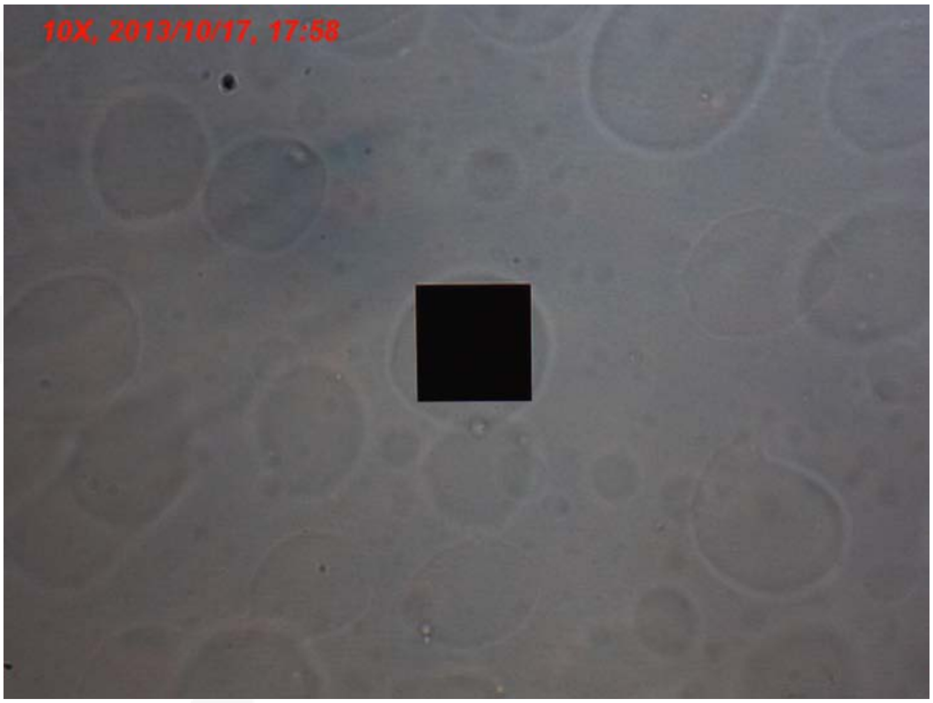

Figure 1 Image from drop of 6% aqueous suspension of nanocrystalline cellulose. The black square in the center is the entrance aperture of the spectrophotometer.

An absorbance spectrum was acquired from the material from 250 to 1650 nm spectral range. A large water peak was visible in the NIR region. However, the cellulose exhibited a weak absorbance in the UV that is due to the cellulose. See Figure 2.

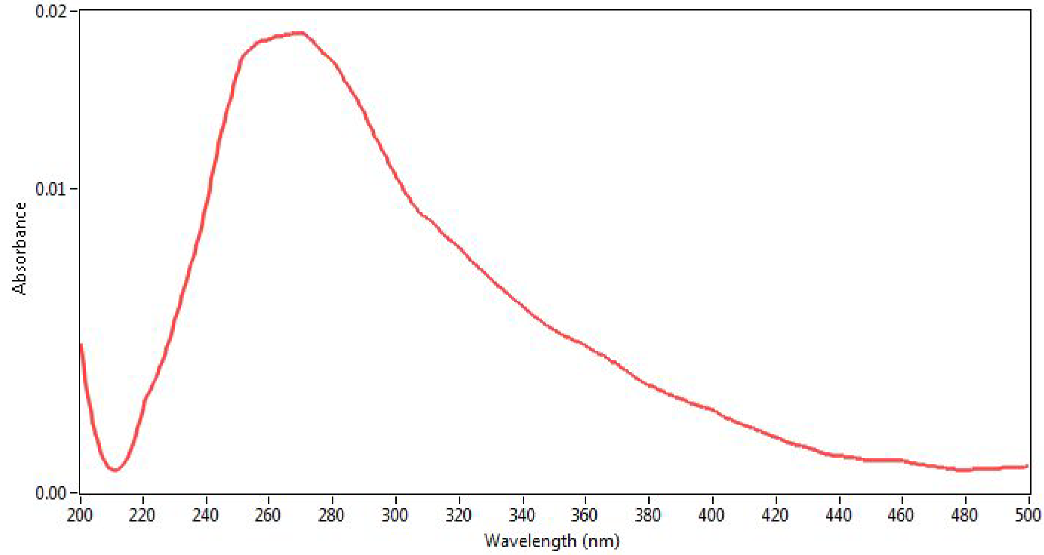

Figure 2 Absorbance spectrum of 6% aqueous suspension of nanocrystalline cellulose.

Conclusions

Nanocrystalline cellulose has the potential to become a very useful structural material with a large number of advantages including a "green" production process and relatively low cost. In this paper, we acquired the absorbance optical spectra from the ultraviolet to the near infrared regions but this biopolymer only showed a weak absorbance at 266 nm. There is also a stronger peak in the NIR region but it is due to the first overtone of the symmetric stretch of water.