ABSTRACTS (MASTER THESIS)

The new technical development of wet-spinning with cellulose nanofiber

**(Graduate School of Agriculture,
Laboratory of Active Bio-based Materials, RISH, Kyoto University)**

Momoyo Utsumi, Kentaro Abe, and Hiroyuki Yano

When obtaining a molded product from cellulose, it is necessary to dissolve cellulose once and regenerate it. In that case, special solvents such as carbon disulfide are used, and the crystallinity of cellulose decreases and crystal transformation occurs. However, cellulose, which occupies about 50% of the plant cell wall, originally exists as a crystalline nanofiber having a width of about 3 nm. By using this cellulose nanofiber(CNF), it is considered that a high strength molded body can be produced without dissolving cellulose. Our laboratory already establishes a method for gelling CNF by simple alkaline treatment. Since it can be molded into an arbitrary shape while maintaining the crystal structure of I type, it is not necessary to use special solvents. Therefore, in this research, we aimed to develop new cellulose fiber by spinning CNF under alkaline conditions. On the other hand, it is reported that CNF is uniaxially oriented by utilizing shearing action. [1] As the material with higher degree of orientation is considered to exhibit superior physical properties, the second objective of this research was to arbitrarily set the spinning speed in order to uniaxially orient CNF under alkaline conditions.

Non-cellulose components were removed from Japanese cypress wood meal, and CNF was prepared from the obtained refined pulp using a grinder. CNF was treated with 8% sodium hydroxide aqueous solution and then spun into 2% sulfuric acid using a syringe. At this time, the spinning speed was controlled to 1-100 m / min.

The surface cellulose molecular chain of CNF swelled by alkali treatment, and the cellulose molecular chains entangled with each other by spinning (neutralization step) into the coagulation bath and then a fibrous gel could be obtained. (Figure 1) From the X-ray diffraction results, it was revealed that this spun fiber was a cellulose type I crystal, and succeeded in the production of spun fiber of cellulose I by simple alkali treatment. From the results of the tensile test (Table 1), an increase in elastic modulus and tensile strength was revealed as the spinning speed increased. The X - ray diffraction results revealed that the degree of orientation of CNF increased with increasing spinning speed. Therefore, the orientation of CNF can be controlled by increasing the spinning speed, which contributes to the increase of elastic modulus.

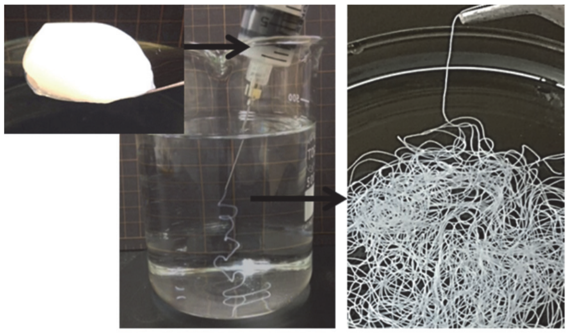

Figure 1. Wet-spinning of CNF

Table 1. Tensile properties of wet spun fibers

Spinning rate (m/min)	Young's modulus (GPa)	Tensile strength (MPa)	Strain at break (%)
1	11.9 ± 2.7	77 ± 6	1.1 ± 0.2
10	12.2 ± 2.8	98 ± 8	2.4 ± 0.7
100	12.7 ± 1.9	112 ± 18	2.8 ± 0.8

Reference

[1] Iwamoto. S, "Structure and mechanical properties of wet-spun fibers made from natural cellulose nanofibers," *Biomacromolecules*, vol. 12, pp. 831-836, 2011.