

Size Effects of Nano-crystalline Cellulose

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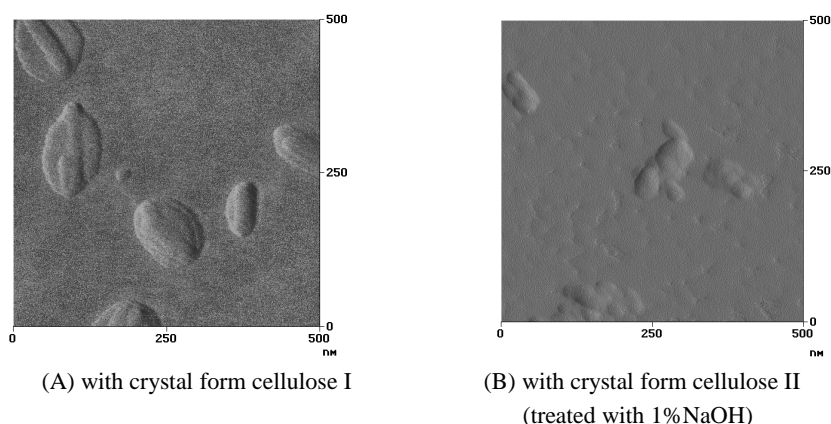
Abstract: Natural cellulose with the crystal form of cellulose I, when treated with condensed lye (*e.g.* 18%NaOH), can change into new crystal form of cellulose II. But the nano-crystalline cellulose (NCC) can do it when only treated with dilute lye (*e.g.* 1%NaOH) at room temperature and even can dissolve into slightly concentrated lye (*e.g.* 4%NaOH).

Keywords: Cellulose I, cellulose II, nano-crystalline cellulose.

It is well known that natural cellulose can change its crystal form from cellulose I to cellulose II after the treatment of condensed lye (*e.g.* 18%NaOH)¹. If the concentration of NaOH is between 12% and 18%, the treated cellulose has the mixed crystal forms of cellulose I and cellulose II. But if the concentration of NaOH is less than 12%, the finally obtained cellulose still has the crystal form of cellulose I².

Nano-crystalline cellulose (NCC) has been prepared from linters by the method of acid hydrolysis^{3,4}. The average value of the crystallite size of the NCC was within

Figure 1 AFM diagram of NCC with different crystal forms



100 nm (shown in **Figure 1**). The FTIR spectrum diagram of NCC shows its structure is totally the same as natural cellulose (NCC-I shown in **Figure 2**). From the X-ray

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diffraction diagram of NCC, it also can be known that the NCC has the crystal form of cellulose I (NCC-I shown in **Figure 3**).

Recent work in our laboratory reveals that the NCC with crystal form of cellulose I can totally change its crystal form to cellulose II when only treated with dilute lye (*e.g.* 1%NaOH) at room temperature within three seconds (NCC-II shown in **Figure 2** and **3**). This fact strongly suggests there are obvious size effects in NCC's transition process from cellulose I to cellulose II.

Another phenomenon related to the size effects is also very interesting. If the concentration of lye is up to 4%, NCC dissolves into the lye immediately. The ivory-white NCC suspension becomes clear liquid at the same time. A polarizing optical microscope was used to study this clear solution, it was testified that there was no any diffraction light observed, *i.e.* the NCC has totally dissolved. NCC can be regenerated from this solution through neutralization. The crystal form of the regenerated NCC is cellulose II.

It must be pointed out here that previous work reveals that lye only can expand but can not dissolve cellulose. The dissolution of cellulose in lye only acts in the situation that the size of cellulose is smaller than 100 nm.

Figure 2 IR curves of celluloses of celluloses

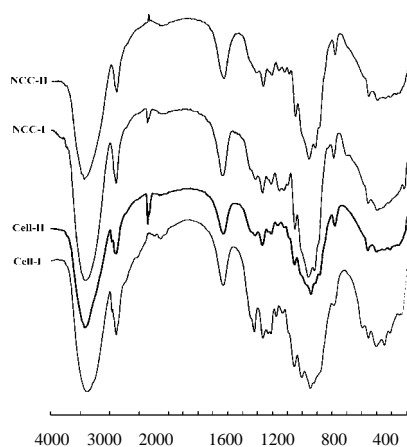
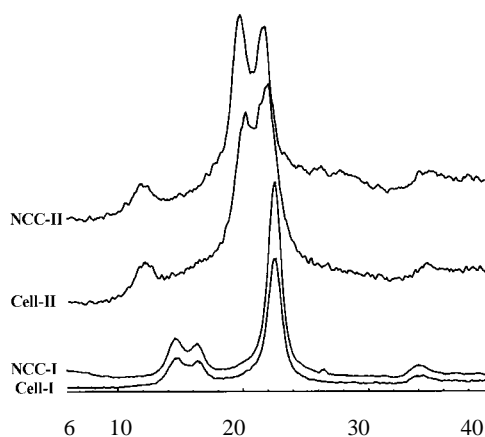


Figure 3 X-ray diffraction curves



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Received 27 September, 2002