Xylan Reinforcement on Poplar Cellulose Nanowhiskers films

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Abstract

The ever-increasing global demand for materials and international dependency on conventional petroleum resources plus the environmental concern call for alternative sustainable sources and greener technologies. In this study novel films were prepared by depositing xylan on poplar cellulose nanowhiskers via pH adjustment. The mechanical properties, water vapor transmission properties, surface morphology and chemical components of the films were evaluated and characterized using tensile testing, wet cup method, AFM, 3D Opto-digital Microscope and HPAEC-PAD under controlled temperature and humidity conditions. Addition of 8% xylan improved the film tensile strength to the largest extent, increasing the tensile strength by 90%. In addition, pH adjusted films were significantly better at improving physical properties than the controlled group without pH adjustment.

Results and Analysis

![Graph showing tensile strength analysis of films](image)

![Graph showing elongation at break of films](image)

![Graph showing specific water vapor transmission rate of films](image)

![Graph showing deposited amounts of xylan on CNW films](image)

![AFM images of CNW](image)

![3D Optical microscope images of CNW](image)

![3D Optical microscope images of films CNW+S](image)

![3D Optical microscope images of films pH adjusted X8%](image)

Conclusions

- Addition of 8% xylan improved the film tensile strength to the largest extent, increasing the tensile strength by 88.9%, and density by 16.4%, but decreased the strain by 15.6%.
- In addition, xylan addition increased the film water vapor transmission rate to different extents. pH adjusted sample X8% exhibited better surface uniformity than controlled sample. Moreover, there is a large reduction in the amount of light being transmitted through the pH adjusted X8% films compared to controlled sample.

Experimental

(1) Materials: Poplar cellulose nano-whiskers (CNW); Birchwood Xylan; Sorbitol;
(2) GPC measurement of Birch Xylan, Mw: 1.51 × 104 g/mol; Mn: 1.15 × 104 g/mol;
(3) Xylan dissolved in NaOH (pH 11.30) at room temp. for 30 min with stirring. Cellulose whiskers adding in with adjusting pH to 9, and heat to 70°C for 30 min, then cool to RM, H2SO4 adding in with adjusting pH to 4.5; Xylan deposited on CNW, solution is stirred at room temp. for 30 min and put into dialysis tubing, Dialysis undergoes for 3 days with DI water at room temp.; Adding sorbitol in and mix them thoroughly together at room temp. for 30 min. Film is prepared by Solution casting tech for further test.
(4) Density test, Mechanical Tensile strength—Strain test, Optical microscope and AFM analysis, Water vapor transmission rate (WVTR), film composition analysis to test the absorption amount of xylan–Film was Soxhlet extracted with DI water for 24 hour to ensure removal of un-cross-linked material. After extraction film was hydrolyzed by 72% H2SO4 and tested Dionex ICS-3000

![Flowchart](image)