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Application of surface-modified nanocellulose to improve the mechanical strength of Ultra-high molecular weight composites

Ju-Hong Lee, Si-Woo Kim, Won-Bin Lim, Ji-Hong Bae and PilHo Huh*

Department of Polymer Science and Engineering, Pusan National University, Busan 46241, Korea

*** pilho.huh@pusan.ac.kr**

Abstract

Ultra-high molecular weight polypropylene(UHMWPP) composites series with various compositions were manufactured using octadecyl isocyanate(ODI) and vinyl ester(VE). Modified-nanocellulose using ODI and VE showed high hydrophobicity when dispersibility was evaluated, and the presence or absence of change in -OH peak was analyzed using Fourier-transform infrared spectroscopy(FT-IR). The particle size of nanocellulose was evaluated by Dynamic light scattering(DLS) and Scanning electron microscope(SEM). The surface-modified nano-cellulose was divided by content and composited, and the composite material was used to prepare a specimen according to ASTM D638 and to analyze it using a universal testing machine(UTM). The processing conditions for making the specimen were conducted using an extruder having a twin screw and proceeded at a temperature between 180 to 230 ℃. In the case of the composite to which nanocellulose was added, it was confirmed that the increase in elongation was higher than that of the composite without the addition of nanocellulose.

Objective

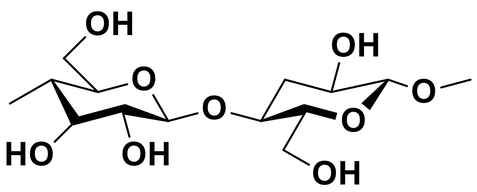
1. Surface modification of nanocellulose using modifiers followed by complexation with UHMWPP

2. Comparison of mechanical properties and spectroscopic properties of UHMWPP containing modified nanocellulose

3. Optimized process development by the difference of each section temperature of twin screw extruder

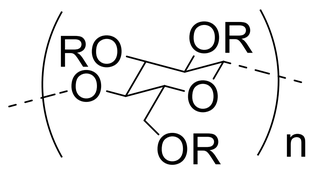
Experimental

Nanocellulose modification



Nanocellulose

Heat Catalyst



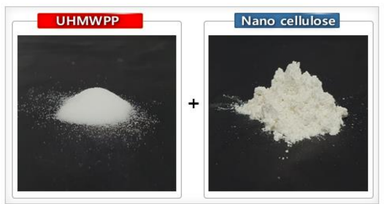
R = H or CH_3COCH_3 or $C_{19}H_{37}NO$

Step 1 Fabrication of surface-modified nanocellulose

Step 2 Compounding with UHMWPP using twin screw extruder

Step 3 Manufacture of dog bone specimens through the press and evaluation of physical properties

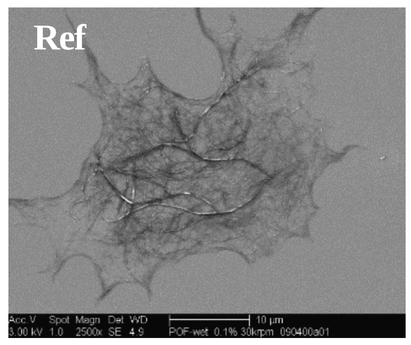
Twin Screw Extruder

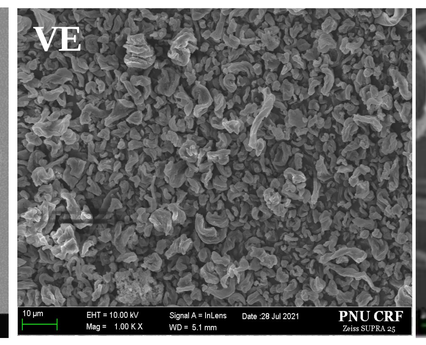


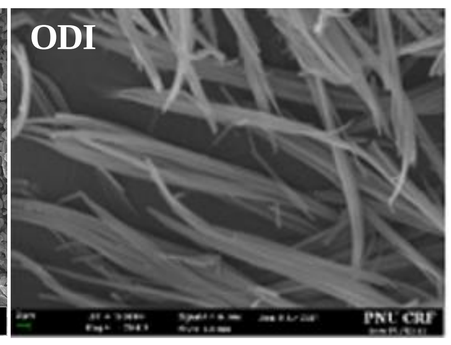
Hot Press + Mold

Results

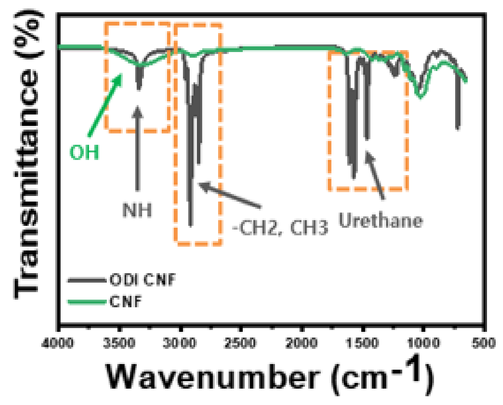
SEM

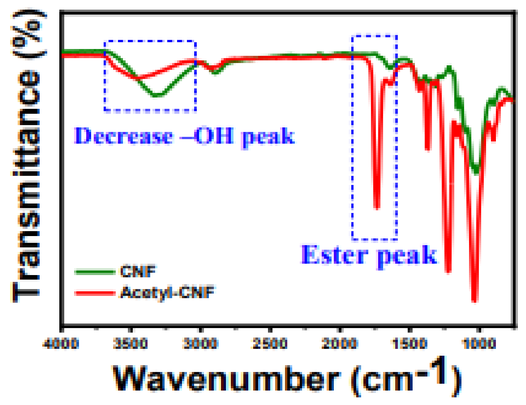




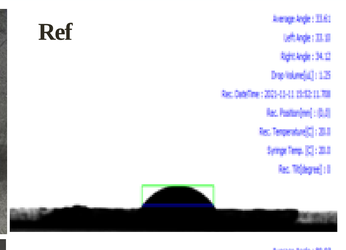


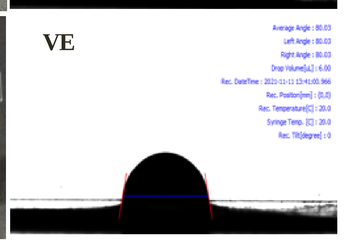
FT-IR

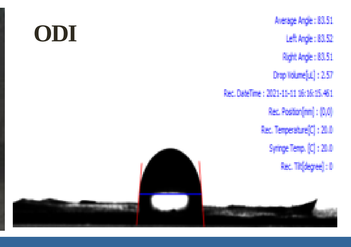




Solvent dispersion evaluation / Contact angle



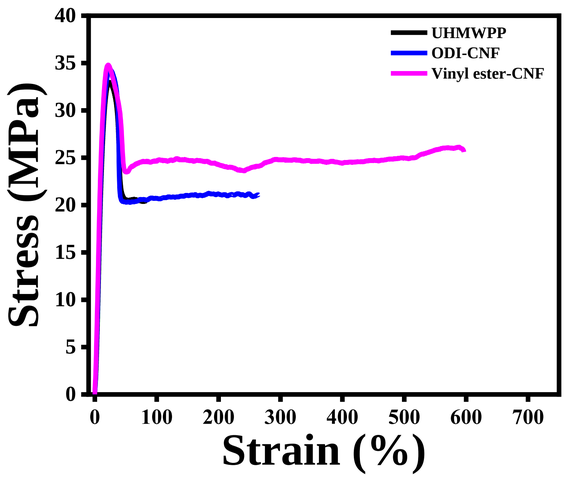




	UHMWPP	VE-CNF	ODI-CNF
Contact angle	33.61	71.26	83.51

In organic solvents, the surface of CNF is hydrophobized with VE, ODI showing high dispersibility compared to water.

UTM



	UHMWPP	VE-CNF	ODI-CNF
Stress (MPa)	32.97	34.29	34.80
Strain (%)	94.2	293.74	569.9

Tensile strength and elongation tests were carried out, and in the case of UHMWPP, which is a combination of ODI and VE-modified nanocellulose, both tensile strength and elongation were increased, and in particular, a dramatic increase in elongation was observed.

Conclusion

-. Successful CNF-vinyl ester / octadecyl isocyanate modification
-. pelleting and specimens preparation after compounding UHMWPP and CNF-Vinyl acetate
-. Improved mechanical properties (toughness and elongation) by using modified CNF

Acknowledgement

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