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Development of Ultra-high Molecular Weight Polypropylene Reinforced with Modified Nanocellulose for Mechanical Strength and Low Specific Gravity

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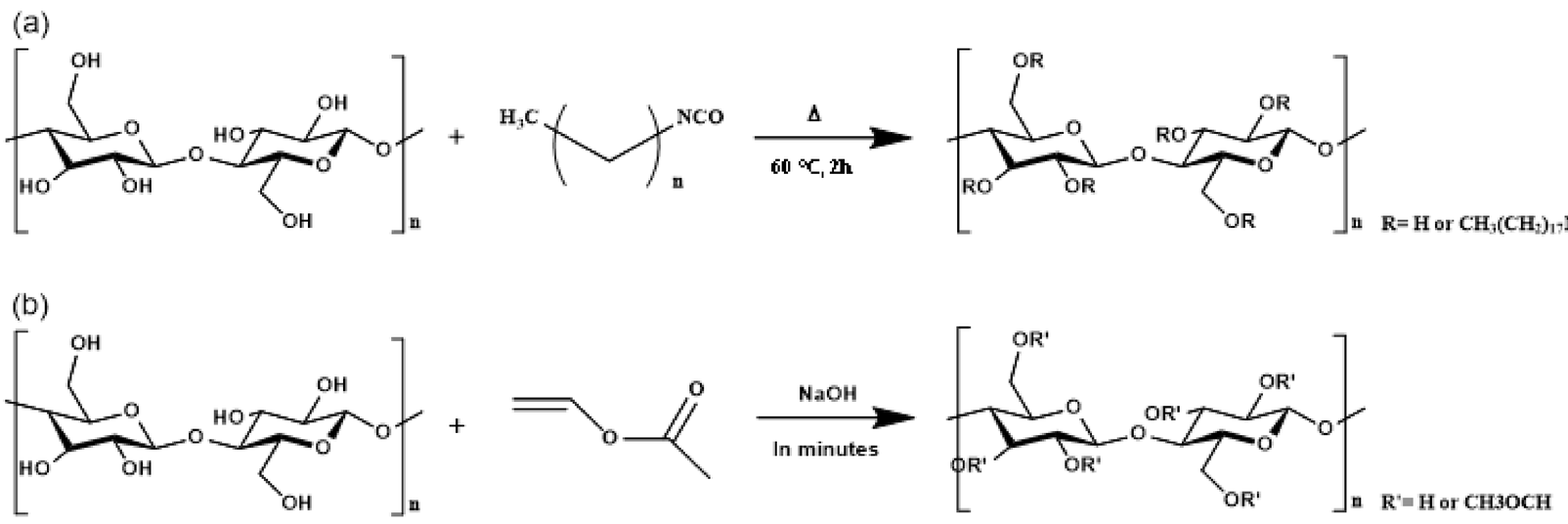
Abstract

Nanocellulose have a poor property to compound with polymer resins having a hydrophobic group on the surface. The surface of nanocellulose is modified as hydrophobic groups using octadecyl isocyanate (ODI) and vinyl ester (VE) as modifiers, to overcome this problem. In the case of ODI, NCO group combined with the OH group of nanocellulose to form a urethane bond, and VE, an esterification reaction is performed step by step, and these processes are confirmed through Fourier transform infrared spectroscopy. The modified nanocellulose could ensure a particle size in units of several micrometers through spray drying, and it could be confirmed that nanocellulose was hydrophobized through contact angle and solvent dispersion. For measurement of mechanical properties, the tensile strength was measured after physical dispersion of ultra-high molecular weight polypropylene (UHMWPP) and modified nanocellulose using a twin-screw extruder. Compared to UHMWPP, samples containing 1 wt% of nanocellulose modified using ODI and VE increased by up to 67% and 83% in strain. In addition, the distribution of nanocellulose on the surface of the complex was confirmed through scanning electron microscope analysis. As a result, it was found that the mechanical properties of the composite were improved when the modified nanocellulose was applied.

Experimental



-. (a) Urethane bonding of ODI with CNF and (b) esterification and hydrolysis reaction of vinyl esters in DMSO

Step 1 Fabrication of surface-modified nanocellulose

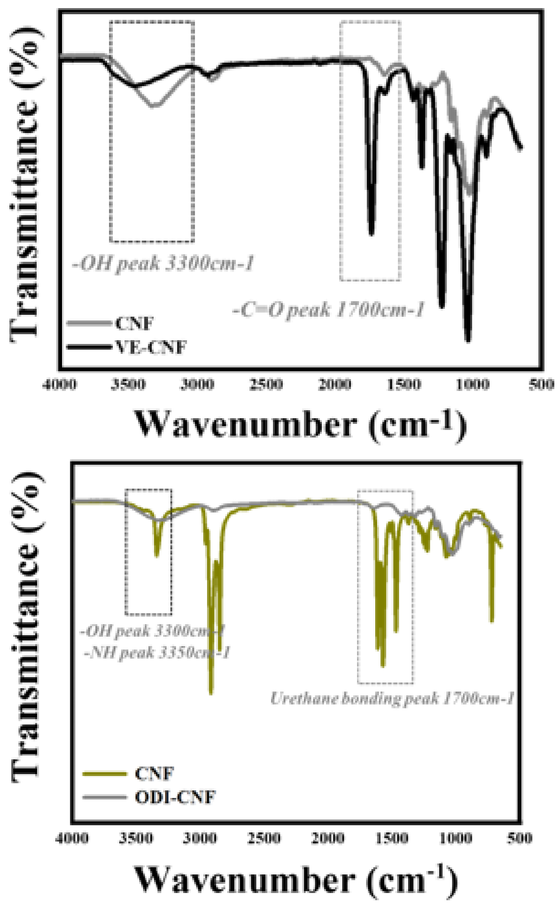
Step 2 Compounding with UHMWPP using twin screw extruder

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

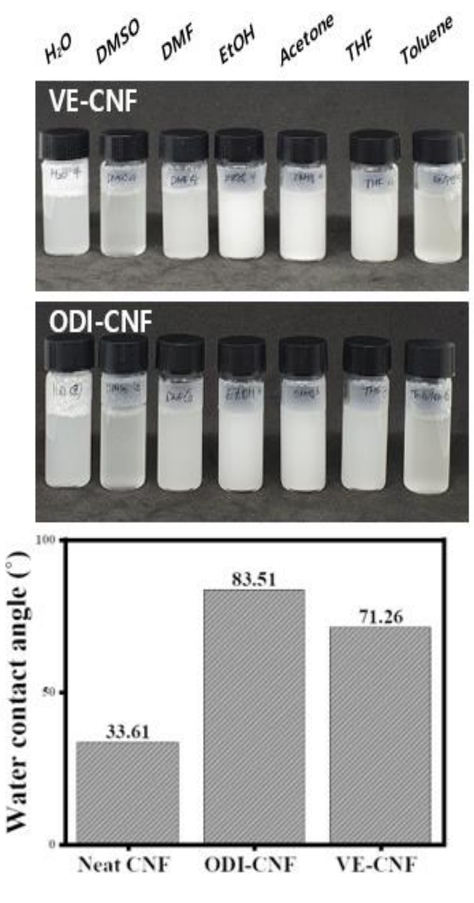
1. Surface modification of nanocellulose using modifiers followed by complexation with UHMWPP
2. Comparison of mechanical properties and spectroscopic properties of UHMWPP containing modified nanocellulose

Results

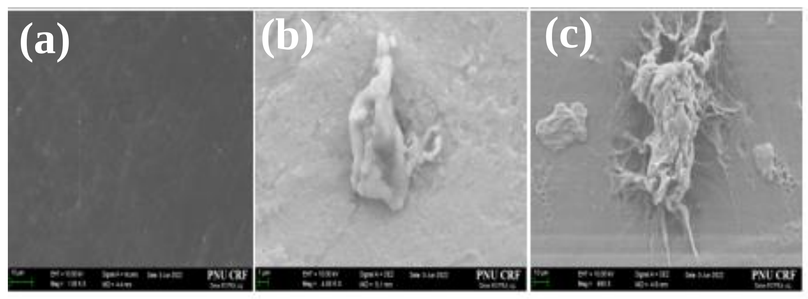
FT-IR



Solvent dispersion & Water CA

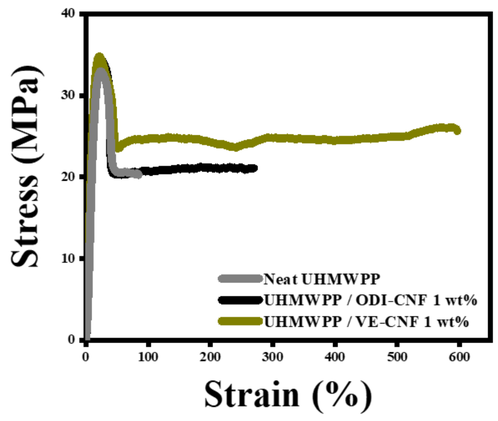


SEM



-. To confirm the composite properties of UHMWPP and modified CNF, the surface of the specimen was observed with SEM, and the images are shown in (a) neat UHMWPP, (b) UHMWPP/VE-CNF 1wt%, and (c) UHMWPP/ODI-CNF 1wt%

UTM



	Stress (Mpa)	Strain (%)
Neat UHMWPP	32.97	94.2
UHMWPP/VE-CNF 1 wt%	34.80	569.9
UHMWPP/ODI-CNF 1 wt%	34.29	293.74

-. Successfully synthesized through spectroscopic and mechanical properties analysis.
-. The prepared composite was homogeneously mixed at 1% content to improve mechanical properties compared to pure UHMWPP

Acknowledgement

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