

ABSTRACTS (MASTER THESIS)

Mechanical properties of poly (vinyl alcohol)-cellulose nanofiber hydrogels prepared by repeated freeze-thaw treatment

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

Yuki Tomobe

Introduction

Cellulose nanofiber (CNF) is a nanostructured material composed of cellulose fibrils featuring a high length-to-width ratio. It has novel structural properties and has been used as a reinforcing fiber in resin-based materials. CNF can be prepared from various cellulose sources, although plant biomass is often favored as a renewable resource. It is considered that the mechanical properties of CNF-resin composites depend on the dispersibility of CNF, the interfacial adhesion between CNF and the resin, and the nature of the CNF network. However, the actual mechanism of how CNF reinforces a resin is poorly understood. Therefore, in this study, poly(vinyl alcohol)-CNF hydrogels were prepared by repeated freeze-thaw treatment, and used to study the reinforcement mechanism. Poly(vinyl alcohol) (PVA) has good compatibility with CNF, and the gelation of PVA solution can be easily achieved. In particular, a freeze-thaw method has the advantages of being experimentally straightforward and does not require the use of potentially undesirable chemical crosslinking agents.¹ Gelation of PVA by the cyclic freeze-thaw treatment is driven by the phase separation that occurs as the solution freezes and the polymer is rejected from the growing ice crystallites.¹

Experiment

Pulp was prepared from the wood flour of Cypress (*Chamaecyparis obtusa*). CNF was isolated by grinding. PVA was added to a CNF suspension and the mixture was poured onto a plate. By repeated freeze-thaw treatment (liquid nitrogen atmosphere, 15 min/23°C, 60 min), gelation of the mixture was achieved. The tensile properties of the gels were measured.

Results and discussion

The Young's modulus of PVA gels increased with increasing PVA content. By adding 1.3 vol% CNF, the Young's modulus increased significantly. This shows that a CNF network formed when CNF content was between 0.65 and 1.3 vol%. The Young's modulus of the PVA-CNF gels also increased as the PVA content increased. This trend of increasing Young's modulus with increased PVA content was more marked in the PVA-CNF gels than in the PVA gels. In other words, the modulus of the PVA-CNF gels increased more than expected as the PVA content increased. This suggests that the PVA network can reinforce the CNF network.

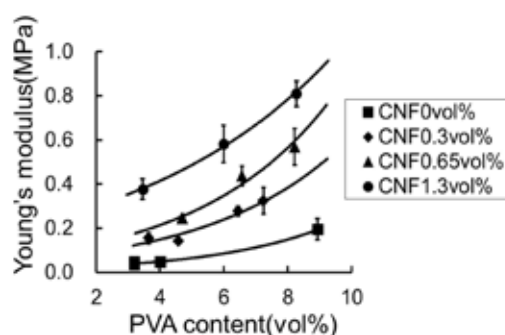


Figure 1. Relationship between Young's modulus of PVA/CNF hydrogels and PVA content.

References

- [1] Tiffany Abitbol, Timothy Johnstone, Thomas M. Quinnb and Derek G. Gray, "Reinforcement with cellulose nanocrystals of poly(vinyl alcohol) hydrogels prepared by cyclic freezing and thawing", *Soft Matter*, vol. 2011, no. 7, pp. 2373-2379.