ABSTRACTS (MASTER THESIS)

Nanocomposite materials from acrylic resin latex and cellulose nanofibers

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

Tairi Miyake

Introduction

Cellulose nanofibers (CNFs) have outstanding characteristics such as high strength, high elasticity, and low thermal expansion. They have been widely investigated and used as reinforcing components in nanocomposites. A CNF water suspension was uniformly mixed with acrylic resin latex of different droplet sizes. A nanocomposite made of acrylic resin and CNFs was obtained by filtering and drying the mixture. In composites, CNFs form networks on the surfaces of individual resin droplets and bulk networks are formed in nanocomposites. The effect of droplet size on the CNF-reinforced nanocomposites was investigated.

Experimental

Hemicellulose and lignin were removed from cypress wood flour (*Chamaecyparis obtusa*) by the Wise method and alkaline treatment. The refined pulp was mechanically disintegrated with a grinder and diluted with distilled water to prepare a 0.1 wt% CNF water suspension. Three types of acrylic resin latex with different droplet sizes (55, 130, and 527 nm; solid content: 5 wt%) were mixed with the 0.1 wt% CNF water suspension at different ratios. Wet cakes were obtained by vacuum filtration and dried in a vacuum oven at 80 ℃ for 12 h. Acrylic resin/CNF films were obtained by hot-pressing the dried films at 120 ℃ and 3 MPa for 5 min (thickness: 200–300 µm). The mechanical properties of the nanocomposites were investigated.

Result and discussion

Optically transparent composites sheets consisting of fine acrylic particles and CNFs were obtained. SEM images of cross sections of the composites showed that the CNFs are homogeneously distributed on the surfaces of the acrylic resin particles and that particles combine to form networks (Fig. 1). The addition of CNFs to the acrylic resin significantly increased the elastic modulus and strength. The reinforcing efficiencies of the CNFs were higher for composites with larger acrylic particles, e.g., of size 527 nm (Fig. 2), than those for composites with smaller acrylic particles. It is considered that the larger particle have larger surface areas, and this restricts the distribution area of CNFs in the composites and enables efficient formation of strong CNF networks.

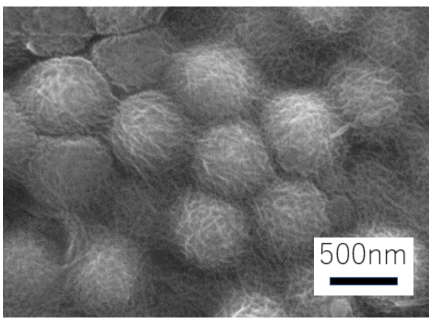

Figure 1. Cross-sectional SEM image of acrylic resin/CNF composite film (CNFs 10 wt%/527 nm acrylic resin particles).

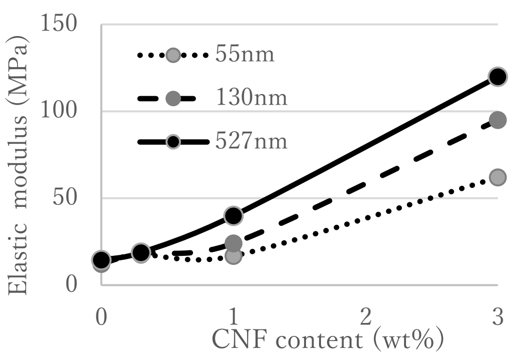

Figure 2. Relationship between Young's modulus of acrylic resin/CNF composites and CNF content.