

ABSTRACTS (MASTER THESIS)

Optically transparent materials from cellulose nanofiber (CNF)-stabilized resin-in-water Pickering emulsion**(Graduate School of Agriculture, Laboratory of Active Bio-based Materials, RISH, Kyoto University)****Subir Kumar Biswas****Introduction**

CNF-reinforced optically transparent composites of high-performance have been developed a decade ago.^[1] The composites were fabricated by impregnating acrylic resin monomer into the CNF-sheet. The CNF-sheet is very stiff due to the hydrogen (H) bonding among the nanofibers and hence, its resin impregnated composite is difficult to mold into a three-dimensionally (3D) curved material. To accomplish 3D-molding with optical transparency, CNF-suspension could be mixed with liquid resin, however, hydrophilic CNF-suspension and hydrophobic acrylic resin are typically immiscible. These drawbacks virtually hinder the fabrication of CNF-reinforced high-performance transparent materials that could be used in many exciting applications, such as contact lenses, substrate for curved displays, microlens arrays and so on.

Experimental

To overcome above two limitations, a Pickering emulsification process is developed. First, CNF-suspension was mixed with acrylic resin monomer (ABPE-10) at a concentration of 10% CNFs to the resin followed by

vigorous agitation in a high-speed blender (37,000 rpm). The obtained emulsion was vacuum-filtered to get a CNFs/resin mat. The mat was then hot-pressed by placing between respective substrates to fabricate planar, 3D-molded, or micro-patterned composites (Fig. 1). The thermal, mechanical and optical properties of the composites were evaluated.

Results and discussion

During emulsion formation, numerous resin droplets of 0.3-10 μm in diameter have been produced. The droplets are covered and stabilized by the suspended CNF-network in the emulsion. Interestingly, after vacuum-filtration a CNF/resin mat with self-assembled 'nacre-like' structure has been obtained (Fig. 1). The nacre-like alternating CNF-resin structure reduces the H-bonding between the CNFs and allows to fabricate a lens-shaped transparent material after hot-pressing (Fig. 2). The fabricated materials uniquely combines high optical transparency (regular transmittance 82% at 600 nm wavelength), high strength and toughness (15 and 24-times than neat acrylic resin, respectively), and a drastically low thermal expansion (1/24th of the neat acrylic resin) at a CNF content of 14-20%.

References

[1] Yano, H., Sugiyama, J., Nakagaito, A.N., Nogi, M. et al., *Adv. Mater.*, 17 (2), 153-155, 2005.

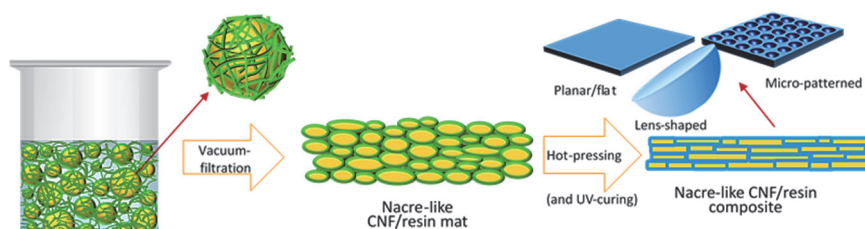


Figure 1. Schematic representation of diverse optical materials fabrication process.

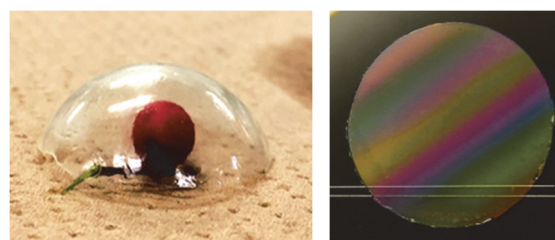


Figure 2. CNF-reinforced lens-like composite (left), and a micro-patterned composite showing beautiful colors (right).