ABSTRACTS (MASTER THESIS)

Optically transparent cotton composite and optical properties

**(Graduate School of Forest and Biomaterials science,
Laboratory of Active Bio-based Matesials, RISH, Kyoto University)**

Masahiro Morita

Introduction

In our previous studies, we investigated the preparation of optically transparent composites because CNFs don't cause light scattering in resin. It was found that a conventional purified pulp without aggregation of the cellulose microfibrils also become transparent by resin impregnation because cell walls of a plant primarily is composed with cellulose microfibrils[1)]. In this work, we focused on high cellulose content, crystallinity of the cotton fiber and its three-dimensional processability. The cotton fiber is also expected to become transparent but the cellulose microfibrils in the cotton fiber already aggregated. We tried to make the optically transparent cotton fiber composite with swelling between the cellulose microfibrils by tempo-oxidation treatment[2)] and surface acetylation of the cellulose microfibrils. Furthermore, we investigated that the acetylated cotton in toluene exhibited blue.

Experimental

Cotton powder was stirred in 16% NaOH for 24h(Mercerization). The mercerized cotton was tempo-oxidized at pH10 and then acetylated with acetic anhydride, perchloric acid, acetic and toluene after solvent exchange to acetic acid. Degree of substitution of the mercerized tempo-oxidized acetylated cotton(MTAC) was determined by titration. DS of carboxyl group and acetyl group were respectively adjusted to 0.55, 1.02. MTAC sample was dispersed in water and filtered by mesh. The mats of MTAC was hot-pressed at 105℃ and 0.17MPa. The dried sheet was impregnated with acrylic monomer in vacuum oven. The resin impregnated sheets were cured by UV. The MTAC composite sheets thus obtained were 119 μm thick, and its fiber content was about 40%.

Results and discussion

Compared with the untreated cotton, the mercerized tempo-oxidized cotton swelled in water and its slurry became transparent. It showed the swelling between cellulose microfibrils. The MTAC composite showed high transparency (Fig 1), because MTAC sheets was almost completely impregnated with acrylic resin. The MTAC reinforced composite showed low thermal expansion (Fig 2). In this case, the existence of cellulose crystals influenced the coefficient of thermal expansion. The cellulose crystals played an important role of reducing the thermal expansion of the acrylic resin. The acetylated cotton(DS:1.83) in toluene increased transparency and exhibited blue color. For the phenomenon, the regular light transmittance of the acetylated cotton toluene slurry decreased in the region of wavelength of blue color but it showed the constant light reflectance, regardless of the wavelength of the visible light. Therefore, the acetylated cotton in toluene selectively scattered the light of the wavelength of blue color. Moreover, the wavelength of the scattering light changed with depending on the refractive index of solvents. Consequently, the color of the acetylated cotton in the solvents changed. The acetylated cotton in the solvents behaved as the optical filters for the specific wavelength of the light.

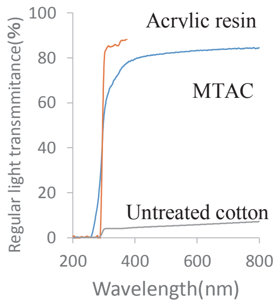

Figure 1. Transparency of composites

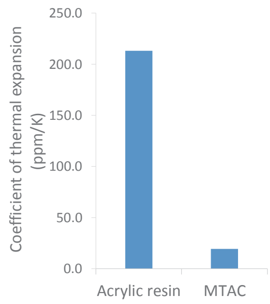

Figure 2. CTE of composite

References

1) H. Yano, et al., Adv. Optical Mater. **2**, 231-234, 2014.
2) M. Hirota, et al., Cellulose, **19**, 435-442, 2012.