Solution-dyed regenerated cellulose prepared using ionic liquids

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Abstract: In recent years, from the perspective of SDGs, regenerated cellulose fiber has been attracting renewed attention as a regenerated fiber made from plant-derived materials and as a biodegradable fiber. However, due to strong inter- and intramolecular hydrogen bonds, cellulose does not dissolve in common organic solvents, and toxic and environmentally hazardous solvents have been used.

Ionic liquids have attracted attention and many research reports since Swatloski et al. reported them as a new solvent for cellulose in 2002, because of their high chemical and thermal stability in addition to non-volatility, making environmentally friendly processes feasible [1]. Recently, the development of fibers with higher strength and better abrasion resistance than lyocell has also been reported [2,3].

On the other hand, scientific studies on dyeing of the produced regenerated cellulose fibers have not yet been started. It has been pointed out that the dyeing process generates a large amount of polluted wastewater and that 110 to 150 kt/year of chemical dyes in solid form are disposed of in the environment [4]. In order to use regenerated cellulose fiber as an environmentally friendly material, it is necessary to consider the dyeing process as well.

Therefore, the objective of this study was to develop "solution-dyed regenerated cellulose" in which natural dyes are dissolved in ionic liquids together with cellulose, and cellulose is regenerated and dyed at the same time during regeneration.

Pulp sheets made from bagasse, the lees of compressed sugarcane, were used as the cellulose raw material. The pulp sheet was placed in a 5% potassium hydroxide solution at 90°C for 2 hours, then washed with distilled water until the pH reached 7. Three cellulose solutions were prepared using [BMIM]Cl (CHEMFISH TOKYO, Japan), an ionic liquid: (a) an unstained cellulose solution, (b) a cellulose solution dyed with indigo, and (c) a cellulose solution dyed with Direct Blue 1. In (b) and (c), 2 wt% and 3 wt% of the dye was added to the ionic liquid with respect to the amount of cellulose, respectively. The solution was stirred at 10 rpm for 1 hour at 110°C under reduced pressure and drying. Finally, 4 wt% of cotton pulp was added, and the mixture was stirred at 20 rpm under reduced pressure drying at 110°C for 40 minutes. Each cellulose solution was poured into a petri dish, then placed in deionized water and allowed to coagulate. The coagulated gelatinous film was soaked in deionized water for 5 days, followed by dehydration pressing and heat pressing to produce the regenerated cellulose film.

The appearance of each cellulose solution and the regenerated cellulose film produced is shown in Figure 1. All dyes dissolved well in the ionic liquid. The solubility of cellulose in the ionic liquid in which the dye was dissolved was also good (Fig. 1b, 1c), and no insoluble matter was confirmed by polarized light microscopy of the solutions. In addition, uniformly colored regenerated cellulose film was obtained from the cellulose solution dissolved with the dye (Fig. 1e, 1f). The density of the films decreased with the inclusion of the dye.

In the presentation, we will report the results of colorimetric comparison between solution-dyed and post-dyed regenerated cellulose films.

Keywords: *solution-dyed, regenerated cellulose, ionic liquid.*

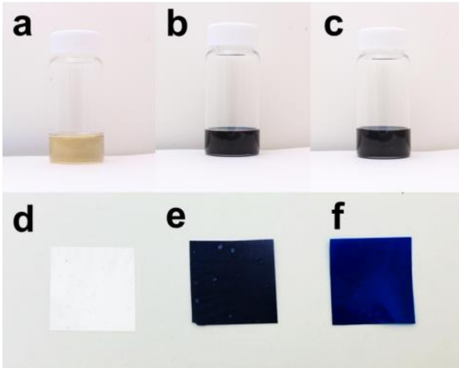

Figure 1 Cellulose solutions and regenerated cellulose film prepared using an ionic liquid: (a, d) without dye, (b,e) with indigo, (c,f) with Direct Blue 1.

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