Effect of TEMPO Oxidation on Texture of Ramie Fabrics
Graduate School of Humanities and Sciences, Tokyo Kasei University
Natsuki Shirai, Gyosuke Meseituka, and Hitomi Hamada

Ramie fabrics have many interesting characteristics. For example, a ramie fiber is a strong and hard natural fiber and feels cool on contact. Ramie fabrics are often used for apparel, especially summer clothing. However, they have a few drawbacks, such as poor resiliency and low wrinkle resistance.

It might be possible to develop new ramie fabrics with soft handling by chemical modification. In this study, we tried to modify ramie fabrics by TEMPO-oxidation and examined the effect of the oxidation on their texture. Ramie fabrics were soaked in a sodium carbonate buffer solution of pH 9.5, and prescribed amount of sodium bromide (NaBr) and 2,2,6,6-tetramethylpiperidine-1-oxyl radical (TEMPO) were added. Then, sodium hypochlorite (NaClO) of three different dose levels, namely 2, 3, 4 mmol/g (fabric) was added to the solution, and they were kept stirring for two hours at room temperature. By this treatment, the primary hydroxyl groups in cellulose molecules were oxidized to carboxyl groups. However, under this condition, it was assumed that some amount of aldehyde groups as the reaction intermediate might be remained in the fabrics and cause the damage by beta-alkoxy elimination mechanism. So the TEMPO-treated ramie fabrics were reduced in the buffer solution by adding sodium borohydride (NaBH₄). At last, two different finishing treatments by ethanol and a softening agent were conducted. The texture and physical properties of the treated ramie fabrics were evaluated by the Kawabata Evaluation System, drape tester, tensile strength tester, and scanning electron microscope. The number of carboxyl groups on TEMPO-treated ramie fabrics were determined by the potentiometric titration method.

The lower bending stiffness and hysteresis of TEMPO-treated ramie fabrics indicate that the fabrics became softer and more flexible. The drape property of TEMPO-treated fabrics also showed higher flexibility and the projected image obtained showed some deep nodes and a symmetrical shape. The air permeability of TEMPO-treated fabrics was lower than that of untreated ramie fabrics, but still obviously higher than untreated cotton fabrics. The good air permeability of ramie fabrics was maintained. The tensile strength of the ramie fabrics decreased by 30 percent after the TEMPO-treatment, and came closer to the value of untreated cotton fabrics. No apparent damage was observed on the surfaces of the treated ramie fabrics by a scanning electron microscope.

As the conclusion, we succeeded to give a softer texture and more flexibility to ramie fabrics by TEMPO-oxidation.