博　士　論　文　の　内　容　の　要　旨

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論文題目	Approaches to preparation of high strength and ultrafine regenerated cellulose fibers using ionic liquid solvents （イオン液体を溶媒とする再生セルロース繊維の高強度化ならびに極細化へのアプローチ）

（博士論文の内容の要旨）

Cellulose is the most abundant renewable polymeric resource on the earth, which has drawn much research interest under the global trend of sustainable development. The studies on regeneration of cellulose are of great meaning for preparing fibers with desired properties. Researches on high performance and highly functional fibers have been required. In particular, the pursuit of 'stronger' and 'thinner' fibers will not stop. Against that background, ionic liquids (ILs), as promising direct solvents for cellulose, have been numerously reported since 2002 because of their high solubility, thermal and chemical stability, and recyclability. This study aims to explore the potentials of regenerated cellulose fibers having high strength and ultrafine diameter by using ILs. This thesis consists of the general introduction and 5 chapters in two parts.

The general introduction gives details on the structure and properties of cellulose, the manufacturing technologies and mechanical properties of regenerated cellulose fibers, the ILs as cellulose solvents, and the methods of preparing ultrafine regenerated cellulose fibers. The aim of this thesis was then described briefly.

In the Part I, dry-jet wet spinning was conducted to prepare high strength regenerated cellulose fibers using an IL of 1-buthyl-3-methylimidazoliu chloride (BMIMCl). The effects of spinning conditions, kinds of solvent, molecular weight of cellulose and solution viscosity on the mechanical and structural properties were investigated. By optimization of various spinning conditions, a high performance regenerated cellulose fiber with a tensile strength of 1.15 GPa and a Young's modulus of 42.9 GPa were obtained from the cellulose/BMIMCl solution. To the best of our knowledge, these tensile properties are the highest values for IL-based regenerated cellulose fibers ever reported.

In the Part II, ultrafine regenerated cellulose fibers were fabricated from IL solutions by two different noble methods; the immiscible polymer blend method and the wet-type solution blow method. For the immiscible polymer blend method, cellulose/BMIMCl solutions blended with, polyacrylonitrile or cellulose acetate, as a minor polymer component were prepared, and spun into blend fibers. Cellulose and minor polymer components were phase-separated due to low affinity, and the lateral cohesion force of the spun fibers was weakened. This enabled the fibers to be fibrillated into ultrafine fibers with diameter of ca. 50 - 400 nm by mechanical milling and following removing a minor blended polymer. On the other hand, a wet type solution blow spinning method with a water-mist coagulation was newly proposed to regenerate ultrafine cellulose fibers. The IL of 1-ethyl-3-methylimidazolium diethyl phosphate was selected as the solvent in this method because of its excellent thermal stability and compatibility with spinnability. The coagulation effect by water mist, determination of air temperature and effects of the degree of polymerization of the cellulose and velocity of the hot air on fiber morphologies were investigated. As a result, ultrafine cellulose fibers with average diameters of ~1 μm were obtained at optimized conditions. In addition, the tensile strength and Young's modulus of prepared ultrafine cellulose fibers were improved markedly as the air velocity increased. Notably, this work is the first to generate high performance ultrafine cellulose fibers with a tensile strength of 941 MPa and a Young's modulus of 27.3 GPa, suggesting the great potential of this technique in the generation and utility of ultrafine cellulose fibers.

This thesis demonstrated great potentials of cellulose fibers through preparing high strength and ultrafine regenerated fibers using ILs. The results shown here is significantly expected to contribute building both sustainable and safe & secure societies.