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題目(和文)	セルロースとリグニン由来2-ピロン-4,6-ジカルボン酸の非共有結合により形成される導電性有機ゲルおよびハイドロゲル
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Thesis Outline

Conductive Organogels and Hydrogels Formed by the Non-covalent Interactions of Cellulose and Lignin-Derived 2-Pyrone-4,6-Dicarboxylic Acid

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In Chapter 1, the definition of conductive gels was introduced. Additionally, the commonly used fabrication methods for producing conductive gels and the applications of conductive gels in flexible sensors, energy storage devices, triboelectric nanogenerators, and actuators were comprehensively introduced.

In Chapter 2, ionic conductive organogels prepared by dissolving 2-pyrone-4,6-dicarboxylic acid (PDC) in cellulose LiCl/DMAc solution were introduced. The gelation mechanism was investigated by structural characterization including FTIR, ^{1}H-NMR, ^{13}C-NMR, SANS, and DLS. The addition of PDC interfered with the electrostatic balance in cellulose LiCl/DMAc solution, which further resulted in the formation of a polymer network connected by cellulose-PDC colloids. Attributed to free Li^{+} and Cl^{-} dispersed in DMAc, the resultant organogels showed high ionic conductivities. Additionally, the formation of strong hydrogen bonds between cellulose-PDC colloids endowed the organogels with repairability. The organogels were further applied to the GPEs for supercapacitors and electrical responsive actuators in LiCl/DMAc-based electrolyte. Due to its high ionic conductivity and facile fabrication method, the cellulose-PDC organogels showed a significant potential for applications in the fabrication of environmentally-friendly supercapacitors and actuators.

In Chapter 3, a series of PVA/PEDOT:PSS/PDC organogels were fabricated. Due to the strong acidity of carboxyl groups, PDC could induce the crosslinking of PEDOT:PSS, which eventually forms a conductive polymer network of the organogel. The characterization of ESR and UV-vis-NIR spectra suggested the secondary doping of PEDOT:PSS by PDC, which could significantly improve the charge transfer efficiency and conductivity of PEDOT:PSS. By forming a PVA polymer network in the

PEDOT:PSS/PDC polymer network via solvent exchange with ethylene glycol, the resultant PVA/PEDOT:PSS/PDC organogels and corresponding fibers with outstanding mechanical performance and significantly improved conductivity were prepared. The obtained conductive organogel and its fibers were successfully applied to stretching/compressing sensors and temperature detectors.

In Chapter 4, a PVA/TEMPO-cellulose/carbonized C_{60}-based nanosphere hydrogel was prepared. Attributed to the rich π-electrons, controllable morphology, and high specific surface area, C_{60}-based carbonized spheres (CS) are applicable to carbon electrode materials in energy storage devices. However, there are few reports about the effects of porous carbon nanospheres on solid electrolytes due to the hydrophobicity of carbonized nanospheres. Therefore, in this chapter, CS was introduced into PVA/TEMPO-cellulose-based hydrogels via electrostatic interactions with the carboxyl groups of the TEMPO-cellulose to investigate the effect of highly mesoporous channels on the supercapacitor device performance. The performance of the supercapacitor was improved due to the enhanced ionic diffusion of electrolytes through the nanospace. Moreover, the mechanical properties of the prepared hydrogel were also greatly improved due to the deformability of CS, which effectively suppressed stress concentration and crack growth.

In Chapter 5, the unique effects of wooden biomass-derived cellulose and PDC on the fabrication of non-covalently crosslinked conductive organogels and hydrogels were summarized. Moreover, the prospect of the future demands of conductive gels was put forward. First, improving the stability of the gels by enhancing the solvent-retention and anti-freezing abilities would expand the applications of conductive gels in the future. Second, it is of great significance to develop environmentally-friendly alternatives to petrol-derived materials for the fabrication of future conductive gels. Third, by combining the green solvent concept with environmentally-friendly crosslinking methods, a new generation of green conductive gels based on biomass-derived materials could be developed.