Anhydrous Proton Conduction of Natural Aromatic Polymer: Preparation of Ligninsulfonic Acid-Heterocycle Composite and its Proton Conductivity

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Natural aromatic polymer ligninsulfonic acid (LS), which is a water-soluble acidic polymer, is a byproduct from the production of wood pulp using sulfite pulping. This material possesses a sulfonic acid group in its molecular structure. We demonstrated the utilization of LS as an anhydrous proton conductor. As a result, the LS showed the proton conductivity of $1.8 \times 10^{-8} \text{ S cm}^{-1}$ at 180 °C under anhydrous conditions. The anhydrous proton conductivity increased with the composite of the heterocyclic molecule and reached the maximum value of $9.1 \times 10^{-4} \text{ S cm}^{-1}$ at 80 mol% under similar conditions. The activation energy of the proton conduction was 0.2 – 1.4 eV which were one order of magnitude higher than that of the typical humidified perfluorinated membrane, and these values indicated the anhydrous proton conducting mechanism. The ligninsulfonic acid-heterocycle composite material may have the potential to be utilized as a novel proton conductor under anhydrous conditions.

Keywords: Anhydrous proton conduction, Ligninsulfonic acid, Composite material, Energy material, Heterocyclic molecule

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