General abstract

The investigation of proton transport is essential to explain the various biological systems, including interfacial proton transport. However, as commonly found in biomaterials, it is still unknown how carboxylic acid concentration affects interfacial proton conduction. A series of styrene-based polymers comprising of the carboxylic acid group were prepared to explore the effects of carboxylic acid group concentration on polymer thin films' electrical properties. The carboxylic acid group concentration influences the proton transport pathway of polymer thin film. The high concentration of carboxylic acid group polymer thin film provides an internal proton transport, while the low concentration of carboxylic acid group polymer thin film allows an interfacial proton transport. The studying of proton transport properties in field-effect transistors (FETs) is a promising candidate for bridging biological and electronic systems. The electrical properties' investigation in FETs without the effect of palladium (Pd) electrode reaction using an alternative (AC)-current is challenging. The FETs with parallel-shaped electrodes (PFETs) were successfully fabricated. The fabricated polymer with weak-acid functionalized and low water uptake ability was applied to the PFETs to examine the electrical properties of polymer thin film. However, the electrical response of polymer thin film was dominated by the electrode/ polymer thin film interfacial response due to the relatively low proton conductivity and high resistance of the fabricated polymer thin film. Therefore, the comb-shaped electrode FETs (CFETs) were developed with an extra-long channel width and short channel length. Without the dominated double layer capacitance response, the impedance response of polymer thin films on CFETs was successfully observed. This study overcomes the drawbacks of dominated double-layer capacitance response and the short circuit between two electrodes through the thin dielectric layer in the AC-impedance measurement method.

Keywords: Carboxylic acid; FETs; Interfacial proton transport; Internal proton transport; Impedance measurement