Study of Anhydrous Proton Conducting Hybrid Proton Exchange Membrane by Phase Mode Atomic Force Microscopy

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Among the various components of proton exchange membrane fuel cell (PEMFC), proton exchange membrane (PEM) is one of crucial component because it is a source of ohmic loss, which is directly related with proton conduction. In many research, the important issue for PEM is to enhance the proton conductivity at various conditions such as different relative humidity, gas pressure, and temperature. Developing PEM which has a high proton conductivity under low relative humidity is very important because it becomes a solution for developing efficient PEMFC by reducing power consumption of the BOP for water management.

Nafion membrane is composed of a hydrophobic PTFE backbone and hydrophilic perflouorinated pendant side chains ending with sulfonic acid moieties. The sulfonic acid moieties, when contact with water, it swells and forms hydrophilic domains [1, 2]. Therefore maintaining suitable water in the membrane is essential for enhancing proton conductivity. For this, many inorganic material hybridized with the Nafion is widely tried for improving proton conductivity by increasing water absorption on the membrane. Among various candidates for inorganic material/Nafion hybridization, silica meso-structured cellular foam (Si-MSU-F type) and mesostructured aluminosilicate with hexagonal network (Al-MCM-41 type) are hybridized with Nafion.

Experimental Approach

Morphological evolution of Si-MSU-F/Nafion and Al-MCM-41/Nafion are studied utilizing atomic force microscopy (AFM), which can map the morphology and material properties as nano-sized spacial resolution to understand electrically also mechanically. In this study, the AFM is operated at non-contact mode for minimizing sample damage. In addition, phase mode AFM is conducted for more detailed morphological differences of each membrane.

Figure 1 shows the topography and phase images of each membrane. Figure 1(a), (c), and (e) are topographies of pristine Nafion, Al-MCM-41/Nafion , and Si-MSU-F/Nafion, respectively. Figure 1(b), (d), and (f) are isphase imagies of prestine Nafion, Al-MCM-41/Nafion, and Si-MSU-F/Nafion, respectively. The images clearly show the morphological evolution of the membranes by hybridization. The topographies show that the morphology of the hybrid membranes becomes more rough than pristine Nafion. Moreover the roughness of each hybrid membrane is different with the order of 2~3 times and 10 times. In addition, phase images of the hybrid membrane show that the hexagonal networks form on the membrane.

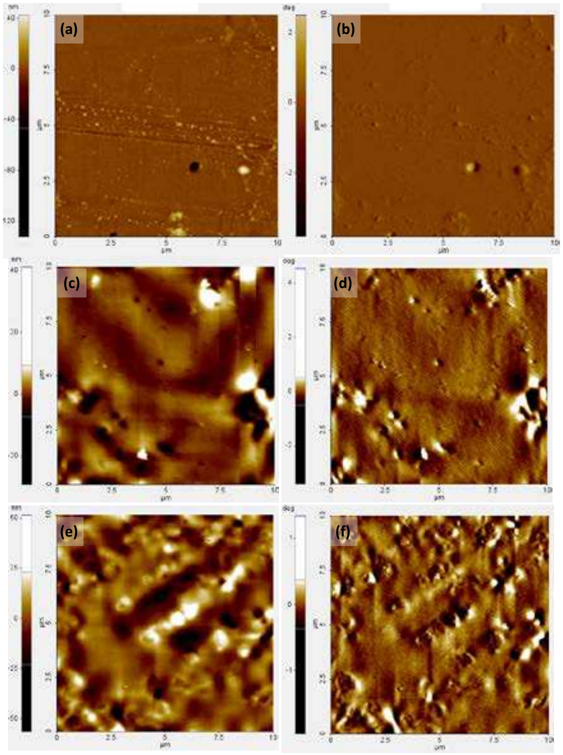

Figure 1. Topography and Phase image of pristine Nafion ((a), (b)), Al-MCM-41/Nafion ((c), (d)), and Si-MSU-F/Nafion ((e), (f)).

References

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