Hydrated Nafion membranes (acid form) exhibit both dielectric relaxation and dc conductance. The dielectric response in an alternating electric field contains contributions from the polarization of bound charges and the motion of free charges. Because of the latter, the dielectric response is frequently masked by electrode space-charge effects, especially at low frequencies. By inserting a layer of a non-dispersive insulator between the metal electrode and the Nafion sample, it is possible, in principle, to eliminate electrode space-charge effects and to observe the intrinsic dielectric relaxation processes of the Nafion membranes. In this study, the blocking effects of Teflon layers were investigated and the dielectric relaxation spectra at low temperatures (in the absence of water loss) were analyzed.

Dielectric relaxation studies of water-saturated Nafion 117 membranes were carried out over the frequency range of $10^2$ to $10^7$ Hz and at temperatures of $-140^\circ$C to $20^\circ$C. Gold-coated copper electrodes were used in a standard two-terminal cell. Nafion samples were sandwiched between layers of polytetrafluoroethylene (Teflon polymeric insulator) and showed unreasonably high dielectric constants and dielectric loss factors, which takes place in the hydrated ionic regions and at the interface between the Teflon spacers and the Nafion membrane. Careful analysis of the interfacial relaxation data reveals two activation energies of 35.3 kJ/mol above $-110^\circ$C, probably reflecting the glass transition of the aqueous domains. An activation energy of 80.3 kJ/mol (Fig. 4) was calculated for the water relaxation in saturated Nafion 117 membrane.

ACKNOWLEDGMENTS

The authors would like to thank Dr. James P. Runt and Mr. Xing Jin for their assistance in the dielectric relaxation experiments. The authors also gratefully acknowledge the support of this work by International Fuel Cells, Inc., through Subcontract No. 35400B and the US Department of Energy through Contract No. DE-FC04-02AL67608.

REFERENCES