Relazione finale di attività svolta, presso l'Istituto di Tecnologie Avanzate per l'Energia "Nicola Giordano" (CNR-ITAE) di Messina, dal Prof. Ramani nel'ambito del programma

"Development and characterization of ion containing polymers for electrochemical devices"

(Short-Term Mobility 2014)

06 July 2014 – 19 July 2014

The objectives of this project were: 1) to develop anion conducting polymer membranes; 2) to characterize the prepared membranes, with an emphasis on understanding the phenomena of anionic conduction, as well as cation group and backbone degradation; and 3) to use this understanding to enhance the performance of these materials in Anion Exchange membrane (AEM) fuel cells and electrolyzers

During this short term stay in July 2014, Vijay Ramani had sent previously prepared AEMs to Alessandra Carbone at CNR-ITAE. These were polysulfone, PPO and PEEK based AEMs. The AEMs were prepared at Vijay Ramani's laboratory at Illinois Institute of technology, Chicago. Separately, Alessandra Carbone had procured a commercial AEM FAA-3 from Fumatech, to set the baseline- These membranes were evaluated during the short term visit and will continue to be the focus of future collaboration.

(a)

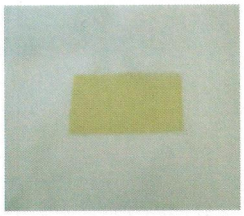

(b)

Fig.1 (a) Membranes supplied by Ramani's Lab and (b) Fumatech FAA

The first task accomplished during the short term visit program was the training of the scientists in CNR-ITAE on how to measure accurately the anion conductivity of the AEM. For this purpose, a special 4-point probe cell was designed and built, and used to evaluate the anion conductivity of the baseline Fumatech FAA membrane as the benchmark, and the other sample membranes. The conductivities were measured in the chloride ionic form, as it was made clear that the hydroxide ion form of the membrane may degrade even when the conductivity was being measured. The newly designed cell will remain at CNR-ITAE and will be used by the CNR-ITAE scientists in the future to continue to make the measurements of ionic conductivity for future AEMs that they will synthesize here, especially composite membranes.

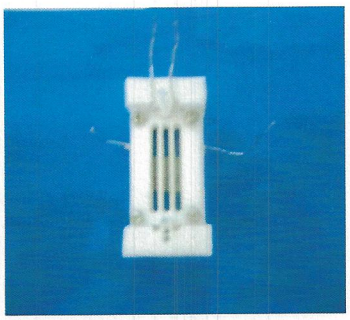


Fig.2 Conductivity cell

The second task that was accomplished during the short term program visit was the training of the scientists in Dr.Carbone's group on how to accurately measure the ion exchange capacity of the AEMs. So far, the usual techniques reported in the literature yielded erroneous results. Vijay Ramani's group has published on the use of the Volhard titration method to measure the anion IEC of AEMs. This method was transferred to the group at CNR – ITAE and the anion conductivity of several samples were measured. As an example of the success of the transfer of this characterization method, the chloride ion conductivity of the FAA commercial sample was measured and evaluated to be 1.43 mmol/g. As a comparison, the value reported by the manufacturer was 1.47 mmol/g, which confirmed the accuracy of the method. This method can henceforth be used at CNR-ITAE to characterize any new AEMs made here during the course of future collaborations and research projects.

The third task performed during the short term stay was the preparation and evaluation of membrane electrode assemblies (MEAs) using the various AEMs. Once again, as the starting point, the FAA membrane was selected. First, a sample of this membrane was redissolved to yield the ionomer binder for the electrode. Then, a catalyst ink was prepared by mixing platinum catalyst with the ionomer binder. The ink was sprayed onto a gas diffusion layer to yield the gas diffusion electrode. Then, the FAA membrane and the electrodes were treated in potassium hydroxide to exchange to the hydroxide ion form that the MEA was assembled in the fuel cell hardware. The testing of the MEA was initiated, and we are awaiting the results at the time of writing of the report. In future, the other AEM samples prepared by Vijay Ramani and handed to Dr. Carbone will also be used to prepare MEAs using the method described above, which was transferred to Dr. Carbone by Vijay Ramani.

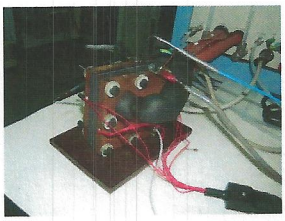
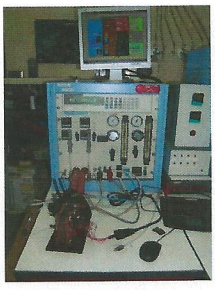
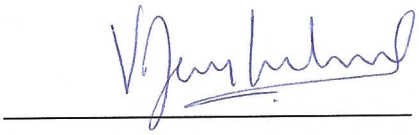

(a)

(b)

(c)

Fig.3 (a) prepared electrodes, (b) AEM single cell, (c) test station.

Finally, during this period, ideas were also exchanged regarding the best practices of preparing and testing PEFCs. Based on his decade of experience, Prof. Ramani has transferred new was to make Nafion based membranes and MEAs with exceptional mechanical properties, and also on how to thermally process the MEAs. This input will be helpful for future research projects.

Based on the ideas exchanged during this visit, several new avenues of future collaboration between Dr. Carbone and Dr. Ramani were identified. These include: 1) Composite anion exchange membranes for PEM fuel cells, 2) The use of AEMs for redox flow batteries, 3) Bipolar membranes for direct borohydride fuel cells, where Prof. Ramani provides the materials and CNR can build a small stack, and 4) AEM based fuel cell electrolyzers. The results achieved during the short term mobility program over 10 days will help initiate and sustain these research areas in the future.

Visiting Scientist



Vijay K. Ramani

Proposer/host

Alessandra Carbone