Effect of Cationic Contaminants on Polymer Electrolyte Fuel Cell Performance

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The objective of this work is to investigate the effect of cationic contaminants on polymer electrolyte fuel cell (PEFC) performance. Four foreign cations (Ba^{2+}, Ca^{2+}, Al^{3+}, K^{+}) were chosen as the contaminants in this study due to their prevalence and chemical structure (e.g. valence). Figure 1 shows the schematic diagram of experimental setup for the in-situ injection of cationic contaminants. After baseline test with DI water from the nebulizer, contaminants are injected into the cathode of the PEFC as perchlorate (ClO_4^-) salt solutions with dry air from the nebulizer. Recovery tests are done by switching back to DI water from the nebulizer. The current density and operating conditions are kept constant throughout the tests.

Figure 2 shows the cell voltage of the contaminated cells during the current hold test (1 A/cm^2). The cells with $Ba(ClO_4)_2$ and $Ca(ClO_4)_2$ injection exhibit a little cell voltage change during current hold. Compared with the above two cells, the cells with $Al(ClO_4)_3$ and $KClO_4$ injection show a lower cell performance with lower voltage and higher resistance. After recovery tests by switching back to DI water from the nebulizer, the cells which were contaminated with $Ba(ClO_4)_2$ and $Ca(ClO_4)_2$ have a tendency to recover portion of the lost performance; however, the cells with $Al(ClO_4)_3$ and $KClO_4$ injection don't recover even though the run time for contaminant injection is shorter than that of the above two cells.

To monitor the PEFC performance, the polarization curves before and after the contamination test are shown in Figure 3. As shown in Figure 3, comparing with the cells with $Ba(ClO_4)_2$ and $Ca(ClO_4)_2$ injection, the cells with $Al(ClO_4)_3$ and $KClO_4$ injection show a larger power density and cell voltage reduction after contaminant test.

Data collected from experiments as well as post-test characterization present evidence that cationic contaminations can cause multiple modes of performance loss, including loss of effective proton conductivity, mass transport loss as well as loss of electrochemically active surface area.

Acknowledgements

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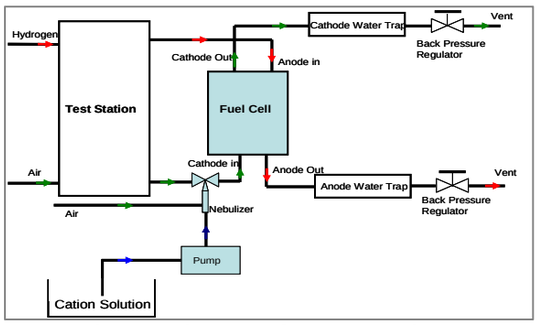

Figure 1. Schematic diagram of experimental setup.

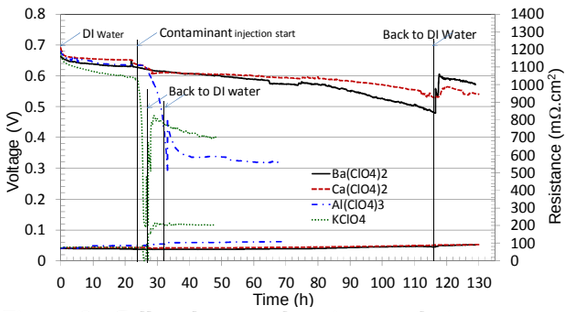

Figure 2. Cell voltage and resistance during constant current hold (1 A/cm^2).

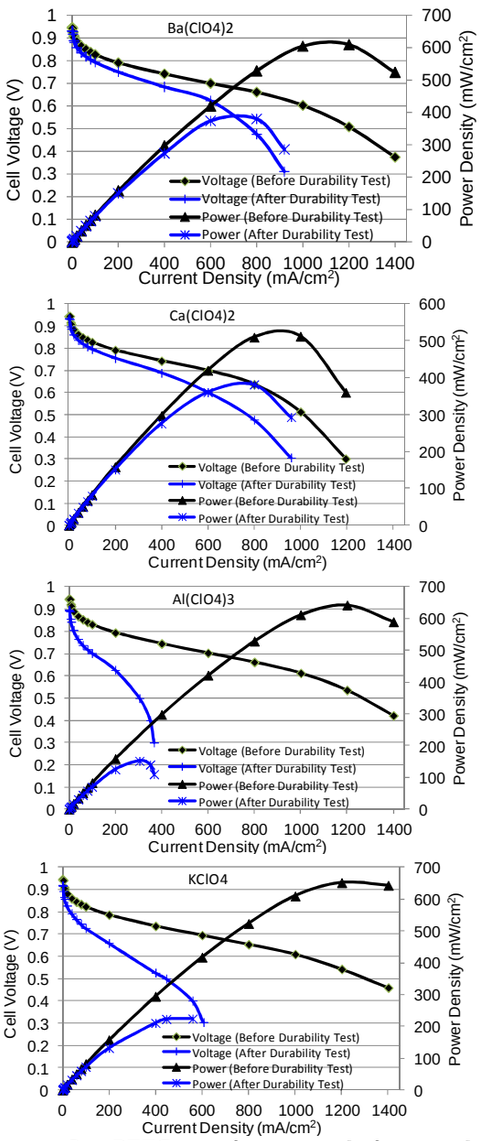

Figure 3. PEFC performance before and after contaminant injection.

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