Galvanostatic current sweep for end-of-line catalyst layer characterization

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Hydrogen fuel cells convert chemical energy contained in hydrogen fuel directly into electric power, without emitting any pollutants, and on demand. This makes fuel cells a competitive technology for both stationary and mobile applications. Polymer electrolyte membrane fuel cells (PEMFC) are fitting for use in vehicles because they operate at relatively low temperatures and can rapidly vary their power output. However, high cost of PEMFC remains a barrier to widescale deployment of fuel cell vehicles.

The main challenge for cost reduction is associated with the ability to manufacture fuel cell stacks in large numbers at a rapid rate. The main bottleneck in the existing manufacturing process occurs at the end of the manufacturing line where diagnostic techniques, borrowed from R&D, are used to determine if the product meets market-ready quality standards. These techniques are time-consuming for end-of-line (EOL) testing in mass production and any improvements translate into significant cost reductions and increase in throughput.

Conventional diagnostic techniques can be applied to manufactured fuel cells only after they have gone through long break-in treatments. In this research, we aim to develop EOL test methods that can be applied to manufactured cells at the end of the manufacturing line, thereby eliminating the time spent on break-in of undetected faulty cells and reducing the complexity of the EOL test stations.

Cyclic voltammetry (CV) is a widely used in-situ technique for characterization of the electrode catalyst layer. CV is a potentiodynamic method that gives insight into the quality of the catalyst layer by measuring the electrochemically active surface area (ECSA). Being a potentiodynamic method, CV cannot be applied to full stacks consisting of many serially connected cells. For this reason, an alternative galvanostatic technique was used in this research to test both pre break in and post break in single cells to determine if this technique is a good fit for use in EOL testing. To quantify hydrogen gas crossover rate, used in ECSA calculations, a hydrogen/nitrogen concentration cell test is used as an alternative to commonly used potentiodynamic linear sweep voltammetry (LSV). Both-pre-break in and post-break-in experiments included CV analysis, used as a benchmark for ECSA, hydrogen crossover, and double layer capacitance estimates.

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