OPTIMIZING ULTRASONIC WELDING OF MEMBRANE ELECTRODE ASSEMBLY COMPONENTS

By

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ABSTRACT

Polymer Electrolyte Membrane Fuel Cells (PEMFC), which is currently the most popular type of fuel cell system, can be divided into high- and low-temperature varieties. Although there has been significant research and development effort on new PEMFC materials and architecture, manufacturing technology is still underdeveloped and has limited capacity, especially bonding of Membrane Electrode Assembly (MEA) components for the high-temperature variety. The conventional way of bonding the gasket and the electrode is by thermal pressing at a known pressure, temperature and time, but this process requires both significant time and energy. To improve this situation, this research focuses on an alternative bonding process, ultrasonic welding, which can potentially decrease the time and energy required by at least an order of magnitude. Bonding of electrode to gasket material by ultrasonic welding has been demonstrated by others, so this research addresses the challenges of working with actual fuel cell components and optimization of the process.

Production materials and processes used in ultrasonic welding experiments including woven carbon electrode, FEP-coated Kapton, steel rule cutting dies, a clicker press and specialized fixtures, and an ultrasonic welder including horn, anvils, and special gasket fixtures. The experimental work consisted of nine separate tests with each new one based what was learned from the previous test. The eighth test optimized the process for the initial size of electrode being used, which was a 21 mm^2. In the final test (i.e. ninth), the optimized parameters were modified for a larger electrode, 42mm^2, to show that the basic conclusions for a smaller welding footprint still applied to a larger one. The most important conclusion was that the weld strength between the gasket material and microlayer, if done properly, constitutes the maximum strength regardless of any further changes to welding parameters. Future testing should involve simulating and testing an actual station of the manufacturing line to validate the process.