Manufacturing Study of Membrane Electrode Assembly with Support-less Pt Catalysts using Ultrasonic Spray Technique

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The authors had reported an ultrasonic spray fabrication study of sub-scale membrane electrode assemblies (MEA) with support-less Pt catalysts [1]. Such MEAs produced at USC demonstrated very high performance at high operating voltage, over 200 mA/cm^2 at 0.92V. To achieve this level of cell performance, platinum loading over 6 mgPt/cm^2 is typically required for the cathode of the MEA. The high cost associated with this type of MEA can be justified for fuel cell power plants in manned/unmanned space exploration and unmanned military applications. In this collaborative study between USC and TESI, the authors report a manufacturing study on the scaling up of the ultrasonic fabrication technique to produce full size MEA. The objective is to accurately quantify the production rate, the overall catalyst yielding, the uniformity, and the performance characteristics, etc.

Ultrasonic spray technique for MEA production has the advantage of high catalyst yielding, capability to build up functionally gradient electrode with almost continuous transition of electrode structure, less prone to clogging during continuously production, relatively easy process control and automation. Recently, ultrasonically sprayed sub-scale MEAs with even higher performance have been achieved at USC using a new ultrasonic spray head features higher atomization frequency. As shown in Figure 1, the dashed lines are the performance of MEAs fabricated with a 120 KHz ultrasonic spray head, as previously reported [1]; the solid line is the performance of MEA recently fabricated at USC with a 180 KHz ultrasonic spray head. Cell performance at high current density is notably improved.

The low deposition rate of a single nozzle ultrasonic spray system is a significant disadvantage. For practical production of full size MEAs, multiple-nozzle (under parallel spray operation) systems have to be used to boost the production rate. In this study, the production rate of single nozzle system to product large format MEA is investigated. Variable of interests related to the fabrication of large format MEA are quantified. These include the uniformity of electrode in terms of geometric thickness, platinum loading distribution, etc. The performance characteristics of large format MEAs fabricated at USC are tested in a multi-cell stack at TESI. The performance of large scale MEA is compared with that of sub-scale MEAs. This study can serve as a foundation for the design of an industrial scale MEA production facility via ultrasonic spray deposition technique.

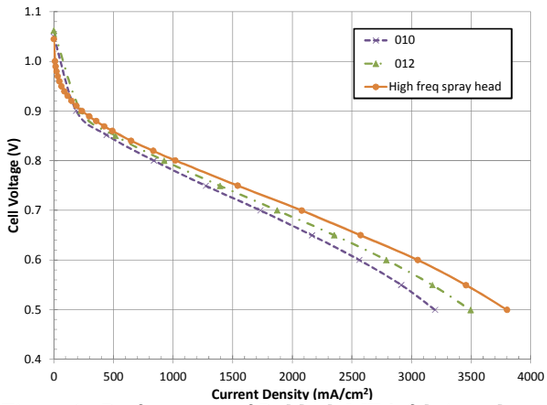

Figure 1. Performance of Pt-black MEA fabricated at USC using ultrasonic spray technique. All MEAs have 25 cm^2 active area with Pt loading from 6~8 mg/cm^2 on the cathode side. All tests were conducted using hydrogen and oxygen (stoich=3, 100% RH) at 3 atm back pressure and 80ºC.

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References:
[1] X. Huang, W.A. Rigdon, K. Billings, and T.I. Valdez, "Fabrication and Optimization of Membrane Electrode Assembly with Support-Less Platinum Catalysts for Space Applications," *ECS Trans*, **50** (2), 753-763, (2013).