Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

Nonlinear analysis of polymer electrolyte fuel cell dynamics with cathode two-phase flow MICHAEL BURKHOLDER, SHAWN LITSTER, Department of Mechanical Engineering, Carnegie Mellon University — Water management in polymer electrolyte fuel cells (PEFCs) must be optimized to minimize parasitic costs. Removing water with excessive air flow rates at low-current, low-power conditions can be very parasitic, but these conditions can be unstable from the two-phase slug flow in the cathode air-delivery microchannels that occurs from the intrinsically low air and water flow rates. In this work, we use nonlinear analysis to understand the effect that varying currents and air flow rates have on PEFC dynamics. We estimate the dimension and entropy invariants indicative of dynamical complexity and stability from a reconstructed state space embedded using PEFC voltage data. We show that the estimated invariants can be correlated to the channel two-phase flow regime. We also investigate autocorrelation in the voltage signal by using diffusion analysis to estimate Hurst exponents. Lastly, we propose a reduced order map for application to real time PEFC water management.

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Date submitted: 01 Aug 2013 Electronic form version 1.4