Abstract Submitted
for the DFD06 Meeting of
The American Physical Society

3-D Numerical Simulation of Slug Flow in Micro-channel[1] CHEN FANG, CARLOS HIDROVO, FU-MIN WANG, JULIE STEINBRENNER, EON-SOO LEE, JOHN EATON, KENNETH GOODSON, Mechanical Engineering Department, Stanford University — Water management that ensures the effective removal of produced water in the microchannel at cathode is critical for the performance of Micro PEM fuel cells. The small dimension and the confined space of the channel leads to the importance of the surface force in determining the dynamics of liquid slugs inside it. The present study focuses on the simulation of the slug detachment process in the micro-channel, using a contact angle hysteresis model within the framework of VOF approach. Based on solving the nonlinear equations accounting for the relationship among volume fraction, interface position, and contact angle, a special model is developed to replicate the hysteresis effect. In addition, a special algorithm is introduced to simulate the thin liquid/gas films. A systematic comparison between experiment and simulation has been conducted and the quantitative match in terms of slug dimensions is achieved for a wide range of flow conditions. The simulation reveals that the contact angle distribution along the slug profile could be approximated using piecewise linear function. The calculation also shows that the contact angle hysteresis might be responsible for several phenomena observed in experiment, including slug instability and pre -detachment liquid film.

[1]Honda R&D Co.Ltd, Stanford Graduate Fellowship

Chen Fang
Mechanical Engineering Department, Stanford University

Date submitted: 05 Aug 2006 Electronic form version 1.4