# The Mechanics of PEM Fuel Cell Stack Compression

Bryan Dallas
Composites Laboratory
Department of Mechanical Engineering
Temple University

Parsaoran Hutapea
Composites Laboratory
Department of Mechanical Engineering
Temple University

**The Mechanics of PEM Fuel Cell Stack Compression**

*Bryan Dallas and Parsaoran Hutapea*
*Composites Laboratory*
*Department of Mechanical Engineering*
*Temple University*

The decreasing performance of proton exchange membrane (PEM) fuel cells can be caused by changes in stack clamping pressure (i.e., compression). When the stack is compressed, the membrane electrode assembly (MEA) typically deforms 50 to 200 nm. Lee et al (Journal of Power Sources,84,45-51,1999) discusses that this nanoscale deformation causes changes to the porosity of the gas diffusion layer (GDL) which, in turn, alters the permeability and diffusion of the reactant gas and the transport of the liquid water in the MEA. However, the deformation also decreases electrical contact resistance, which suggests there is an optimization of how much the MEA should deform. The focus of the project is to assess the effects of compression and GDL nano-deformation on fuel cell performance. A testing system was constructed such that the stack compression can be altered without disassembling it. This is facilitated by a cell equipped with a compression plate with a compression adjuster and a dial gauge to measure the change in thickness of the MEA. This feature is essential since a cell's performance is altered considerably if it is disassembled and then reassembled, even if the clamping conditions are accurately reproduced. The fuel cell performance will be tested at different deformations and compared.

---

[1] Frank Oppenheimer

[2] Eric Mazur, Harvard University, http://mazur.harvard.edu/

[3] Elliot Aronson, University of Texas and University of California, http://www.jigsaw.org/

[4] Thielens, W., "The Disciplines and Undergraduate Lecturing," paper presented at an annual meeting of the American Educational Research Association, April 1987, Washington, DC, ED 286 436, 57 pp, MF-01, PC-03.

[5] Chickering, A. and Z. Gammons, "Seven Principles for Good Practice," *AAHE Bulletin*, 39: 3-7, March 1987, ED 282 491, p.6.

[6] Gangwer, Timothy, *Visual Impact, Visual Teaching: Using Images to Strengthen Learning*, Sage Pub, 2009

[7] Felder, R.M., and R. Brent, "Death by PowerPoint," *Chem. Engr. Education*, **39**(1), 28 (2005) www.ncsu.edu/felder-public/Columns/PowerPoint.pdf

[8] LoPiccolo, Orla, "What I See I Remember, What I Do I Understand" American Society of engineering Education, Middle Atlantic Section Fall 2010 Conference, Villanova University, PA.

[9] Paulson, Donald and Faust, Jennifer, Active Learning for the College Classroom, http://www.calstatela.edu/dept/chem/chem2/Active/main.htm

[10] Johnson, D. W., R. T. Johnson, and K. Smith, Active Learning: Cooperation in the College Classroom, Interaction Book Company, Edina, MN, 1991

[11] Ledlow, Susan, "Cooperative Learning in Higher Education," Center for learning and Teaching Excellence, http://clte.asu.edu/active/clinhighed.pdf

[12] Kohn, Alfie Kohn, "Punished by Rewards. The Trouble with Gold Stars, Incentive Plans, A's, Praise, and Other Bribes" (Boston: Houghton Mifflin, 1993 / 1999

[13] Aronson, Elliot, History of Jigsaw, Social Psychology Network, http://www.jigsaw.org/history.htm

[14] Mel Silberman, Active Learning to Teach Any Subject, P 111, Allyn and Bacon1996

[15] Criteria for Evaluating Engineering Technology Programs, ABET, 2011-2012 http://www.abet.org/Linked%20Documents-UPDATE/Criteria%20and%20PP/T001%2010-11%20TAC%20Criteria%2011-3-09.pdf

[16] Prince, M., "Does Active Learning Work? A Review of the Research," *J. Engr. Education*, **93**(3), 223 (2004)

www.ncsu.edu/felder-public/Papers/Prince_AL.pdf

[17] Dietrich, Suzanne W, Getting Started with Cooperative Learning in the Engineering Classroom http://clte.asu.edu/active/mainart.htm

[xviii] Slavin, R.E., "Cooperative learning: Theory, research, and practice" 1995, (2nd Ed.). Boston: Allyn & Bacon

[xix] Thompson, Marceline, and Pledger, Linda, "Cooperative Learning Versus traditional Lecture Format: A Preliminary Study", 1998, National Communications Association

[xx] Johnson, D.W., & Johnson, R.T. "Learning together and alone: Cooperative, competitive, and individualistic learning" (4th Ed.). 1994, Boston: Allyn & Bacon

[xxi] Rich, Y., Amir, Y., & Slavin, R.E. "Instructional strategies for improving children's cross-ethnic relations" 1986 Ramat Gan, Israel: Bar Ilan University, Institute for the Advancement of Social Integration in the Schools