Introduction to Hydrogen Production, Distribution, and Use

Due to its high gravimetric energy density and carbon-free nature, hydrogen has the potential to act as an energy carrier in a low GHG-emissions future. Despite these fundamental advantages over carbon-based carriers, hydrogen still must overcome several technological barriers before it can be widely adopted.

Large-scale production of hydrogen is neither efficient nor carbon-free at the present time. Transportation and storage of hydrogen is difficult because of its low volumetric energy density. And hydrogen may offer pathways to higher conversion efficiencies than are available to traditional fuels, although those pathways are not currently cost effective.

GCEP is continuing to investigate the basic science and technology solutions to all three of hydrogen's main challenges. In addition to the work that has been completed on monitoring of bio-hydrogen conversion processes (2006), micro- and nano-scale fuel cells (2006), climate effects of hydrogen (2007), cyanobacteria-based hydrogen production (2007), solid-state NMR studies of oxide ion conducting ceramics for enhanced fuel cell performance (2008), and modeling, simulation and characterization of atomic force microscopy measurements for ionic transport and impedance in PEM fuel cells (2008), there are two ongoing projects in the area of hydrogen.

Professor James Swartz is designing an oxygen-tolerant hydrogenase protein. When this protein is incorporated into a living cell, it may enable the efficient production of hydrogen from sunlight and water, using biological agents as catalysts.

Professors Anders Nilsson, Bruce Clemens, and Hongjie Dai form an interdisciplinary team of faculty that is conducting research into C-H bonds in carbon nanotubes as an energy carrier. The idea is to form local stable C-H bonds using the electrolysis of water where the protons will be reduced upon interactions with the carbon nanotubes, storing hydrogen in a solid form.