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), modeling, simulation and characterization of atomic force microscopy measurements for ionic transport and impedance in PEM fuel cells (2008), and designing of an oxygen-tolerant hydrogenase protein for efficient photobiological production of hydrogen (2009), there is currently one ongoing project in the area of hydrogen.

Professors Anders Nilsson, Bruce Clemens, and Hongjie Dai are conducting multidisciplinary research on carbon nanotube (CNT)-based storage devices where hydrogen is stored in the atomic form through the formation of C-H bonds. Platinum nanoparticle catalysts are used on the CNT surface to decrease the overpotential associated with the formation of the C-H bonds and the electrochemical production of hydrogen atoms is investigated to address the inefficiencies related to the dissociation of molecular hydrogen.