Super-transport of Energy in Ultra-short Processes

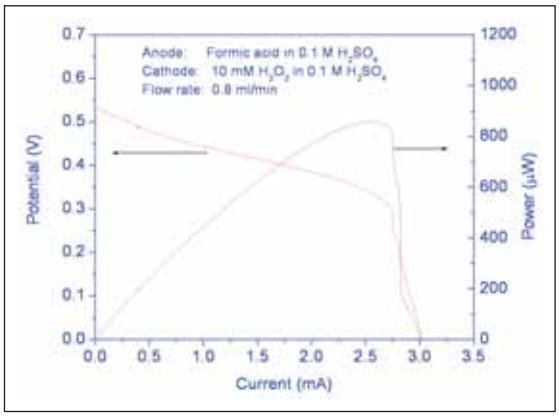
As ultra-short processes (10^{-12} s) of energy transport are considered, the finiteness of the speed of energy propagation can no longer be ignored, which is the case when the classical transport of energy is studied. If taken into account, the finiteness of the speed of energy propagation leads to a model of energy transport that is quite different from the classical models. It follows that when ultra-short processes energy is transported, the conducting properties of the transporting medium were increased by several orders of magnitude. In other words, energy is transported virtually without losses. A novel term has been coined to name this phenomenon "super-transport of energy". Depending of what form of energy is considered, the phenomenon can be manifested as super-heat transfer, superfluidity, superconductivity, or even super-transport of quantum waves.

The phenomenon can be explained if the mode of energy transport is considered. During long-time processes, energy is transported by diffusion (random collisions of particles constituting the transporting medium). In ultra-short transport processes, however, the diffusion transport is negligible (due to the lack of time for collisions) and the wave mode of transport dominates. Thus, although physical properties of the transporting medium remain the same, the rate of energy transport is much larger than during transport by diffusion.

The goal of the research work carried out by **Assoc Prof Vladimir V Kulish** from the **School of Mechanical and Aerospace Engineering (MAE)** is to experimentally confirm predictions following from the model.

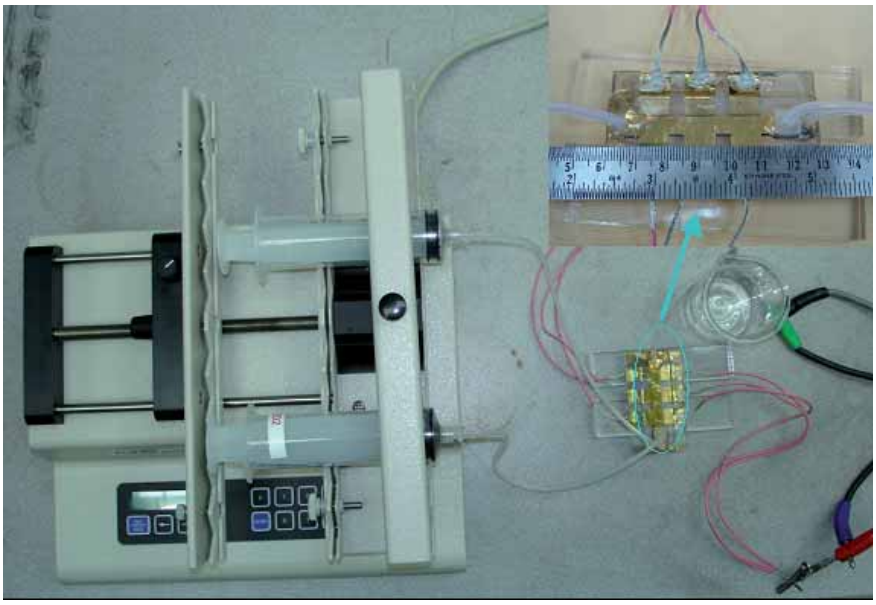
Development of a Membrane-less Micro Fuel Cell

Micro fuel cells have been long recognized as promising power sources for electronic devices with high power demand. One of the most challenging aspects in the miniaturization of fuel cells is associated with the polymer electrolyte membrane (PEM), which suffers from numerous problems including dehydration of the membrane, fuel crossover into the oxidizer and high cost. Hence, the membrane-less micro fuel cell which employs the laminar flow approach to create very thin diffusive interface as a membrane, has offered a new direction for micro fuel cells development without the use of PEM. **Ms Li Aidan** supervised by **Assoc Prof Chan Siew Hwa** and **Assoc Prof Nguyen Nam-Trung** from the **School of Mechanical & Aerospace Engineering (MAE)** is developing a high performance membrane-less fuel cell through optimizing the micro system design and improving the electrochemical reactions and transport phenomena in the liquid and liquid/liquid interface.



I-V curve and Power curve of the membrane-less fuel cell. The Fuel stream is 0.5 M formic acid in 0.1 M H_2SO_4 and the oxidant stream is 0.01 M H_2O_2 in 0.1 M H_2SO_4. The flow rate is 0.8 ml/min

A novel design prototype membrane-less micro fuel cell has been successfully developed. Two laminar streams, one contains formic acid as the fuel and the other contains hydrogen peroxide as the oxidant, flow in parallel along the anode and cathode electrodes that are bonded to the channel wall. The advantages of this design include low cost, easy fabrication and scaleable power output. Preliminary results show a maximum power density of 572 μW/cm^2 and the open circuit voltage as well as the kinetic behaviour of the electrodes are comparable to those macro fuel cell systems.



Membrane-less fuel cell system