Holcombe Department of Electrical and Computer Engineering Seminar Series

Electrochemical Energy Conversion and Storage: Nano Materials and Structures for the 4th Innovation of PEFC

Dr. Hyuk Chang
Vice President, SAIT
Samsung Electronics

Abstract

In this talk, energy industry trends in electrochemical energy conversion and storage technology will be introduced. In addition, more technical details will be discussed with regard to nano materials and structure for the development of PEFC.

Material development of sulfonated polymer-based proton conducting membranes in the 1960s initiated worldwide research efforts in Polymer Electrolyte Fuel Cell (PEFC) development, which is regarded as the 1st innovation in this promising technology of energy conversion devices with the potential to be highly efficient, environmentally benign and mobile. Since then, technology evolved and led to the 2nd and 3rd innovations in this field: highly efficient catalyst electrode structures (ionomer in the catalyst layer) in the early 1990s and low resistance membrane structures (ionomer in microporous membrane substrate) in the late 1990s, respectively. These three innovations, which were based on bulk properties of materials and structures, led PEFC technology to near-commercialization. However, PEFC technology is still not yet able to replace competing technologies due to issues of efficiency, cost, and lifetime, which are critical to energy conversion devices. It is anticipated that the technical solutions for the next inflection point will be based on nanotechnologies. As such, nanoscaled catalysts, nanocomposite membranes and nanostructured membrane electrode assembly (MEA) are the major approaches.

More specifically, SAIT conducts research in the following areas: i) Nanostructured catalyst with platinum nanoparticles of 3nm that enhance the catalyst activity. Also, the nanoporous carbon can be utilized as support material for controlling the catalyst particle size and distribution. The catalyst is functionalized for enhancing activity and stability, especially when oxygen reduction co-catalysts such as Ru-N complex and highly metal-interactive elements such as sulfur are embedded in the nanoporous carbon. ii) Nanocomposite hydrocarbon membranes with exfoliated clays. Especially in direct methanol fuel cells, these membranes provide high ionic conductivity and low methanol permeability because of their high degree of sulfonation and low resistance in 50um thin but mechanically durable membrane. iii) Nanostructured MEA with high surface density, which can reduce both ohmic and activation losses during polarization and enhance fuel efficiency, so that overall efficiency of fuel cell can be increased by more than 40%.

In this presentation, the author would like to introduce the above three nano-based approaches and discuss that nanotechnologies in materials and structures will bring about the fourth innovation, so that the PEFC technology will be ready to enter the commercial stationary, mobile, and massive vehicle markets in the near future.
Seminar – Friday, December 4, in 101 Riggs Hall
2:00 p.m. – 3:00 p.m.

Biography of Speaker

Hyuk Chang (Vice President, SAIT, Samsung Electronics) is a principal investigator of electrochemical energy conversion and storage research at Samsung Advanced Institute of Technology. SAIT is a corporate research center of Samsung Electronics and Chang is now the Lab Director of the Energy Lab at SAIT. He and his team are involved in the development of materials and systems for PEMFC and DMFC. He is also in charge of rechargeable battery technology for application in mobile devices and electric vehicles. He has over 80 technical publications in the field of electrochemical materials, nanophase materials and energy devices. He holds a Ph.D. in Metallurgical Engineering from the University of Utah (1990) and worked at the University of Illinois at Urbana-Champaign as a research associate prior to joining Samsung (1992). In 2002, he was named as a MASTER in his Institute for his research contribution in fuel cell technology. He is also a member of the world standardization committee in electrotechnology committee, IEC TC-105 for fuel cells.