Special Feature: Popularizing Fuel Cell Vehicles: Designing and Controlling Electrochemical Reactions in the MEA

Overview

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At the end of 2014 and 175 years since Sir William Grove conducted the first ever proof-of-principle experiment involving a fuel cell, the Toyota Mirai made its debut as the world's first commercial fuel cell vehicle. Reflecting the properties of hydrogen as an energy carrier with a close affinity to renewable energy, fuel cells are regarded as a key device for helping to realize a sustainable energy society. To popularize fuel cell vehicles, it will be necessary to develop lower cost fuel cell systems with higher efficiency, power and durability. This special feature describes how research into fuel cell technology, particularly the membrane electrode assembly (MEA), has been performed to support and enhance the development of fuel cells.

The MEA, which consists of an electrolyte membrane and electrodes, is the site of electrochemical reactions between hydrogen and oxygen. The first article of this special feature outlines the ideal state for the interface between the platinum (Pt) catalyst and electrolyte ionomer based on investigations of electrocatalyst behavior on the surface and interface. The second article describes the modeling of mass transfer behavior in the MEA and shows that a major factor that determines the output power of a fuel cell exists on the interface between the catalyst and electrolyte ionomer. The third article covers electrolytic materials and outlines a new polymer electrolyte concept to achieve compatibility between ionic conductivity and membrane strength in a reciprocal relationship. The final article describes a precise evaluation method for the oxygen reduction reaction (ORR) required for catalyst design.