Structured Oxide-based Diesel Reforming Catalyst Development

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The U.S. Department of Energy is sponsoring the development of high temperature fuel cell power systems based on solid oxide technology through its Solid State Energy Conversion Alliance (SECA) program. Diesel-fueled auxiliary power units are an important market segment for solid oxide fuel cell systems. The development of a catalyst which is stable and active for converting diesel fuel to a hydrogen-rich gas stream is therefore an important aspect of the successful implementation of fuel cells for these applications. However, the high levels of sulfur and aromatic compounds commonly found in diesel fuel presents a key technical challenge because they are known poisons to traditional reforming catalysts.

The National Energy Technology Laboratory (NETL) has been developing reforming catalysts based on the pyrochlore crystal structure to overcome the catalyst deactivation problem. Researchers at NETL successfully demonstrated a Rh-substituted zirconate pyrochlore catalyst supported onto zirconium-doped ceria (ZDC) to be active and stable for the reforming of commercial diesel fuel for 1000 hrs under oxidative steam reforming conditions. Following this test, NETL has been collaborating with NexTech in order to develop an effective process to apply the optimized pyrochlore/ZDC catalyst onto a commercially representative form such as monolith. A square channel alumina monolith structure coated with an oxygen-conducting support, onto which the active pyrochlore phase was deposited, has been fabricated. NETL has recently completed a successful 93 hour testing of the fuel reforming catalyst in the monolithic form for reforming of commercial diesel fuel. Synthesis gas yields were stable and near those predicted by equilibrium for 93 hours time on stream. No indicators of catalyst degradation (olefin formation, pressure buildup, etc.) were observed when the run was discontinued. Graded bed approach was also evaluated in order to reduce the amount of expensive noble-metal catalyst needed for reforming diesel fuel. NETL-developed Ni, Ru, and Rh-substituted pyrochlore catalysts separately, and combined in the graded catalyst bed approach, have exhibited excellent hydrocarbon reforming performance. NETL plans to further the development and demonstrate the viability of the monolithic-based catalyst system through a long-term (>1000 hr) testing in Fall 2011/Spring 2012.