Solid Oxide Fuel Cells

Increasing Efficiency with Conventional Fuels

by Eric D. Wachsman

Sir William Grove has been credited with inventing the fuel cell in 1839. That fuel cell, as with the majority of fuel cells developed since then, focused on the use of hydrogen as a fuel. As such, fuel cell technology has become synonymous with hydrogen technology in the public perception. As a result of this perception, the funding and advancement of fuel cell technology has risen and fallen with the popularity of a hydrogen-based economy replacing our current fossil fuel dependence.

However, the invention of the Nernst Glower later that century opened up the ability to consider fuels other than hydrogen. This discovery demonstrated that at high temperatures, oxygen-ions could be transported through a ceramic solid at rates comparable to hydrogen-ions in other (*e.g.*, acid and polymer) electrolytes at lower temperatures.

Solid oxide fuel cells (SOFCs) utilize the same basic high temperature oxygen-ion conducting ceramic for the electrolyte that Nernst used in his glower. This difference in conducting species allows for the potential use of almost any hydrocarbon fuel, since the oxygen-ion not only oxidizes hydrogen to H_2O, but can also oxidize carbon to CO_2.

Therefore, while SOFCs can also operate on hydrogen, their fuel flexibility makes them attractive for numerous applications that require currently available fuels. Moreover, the inherent high efficiency of SOFCs provides the opportunity to produce more work with less greenhouse gas (CO_2) emissions than conventional technologies (*e.g.*, the Carnot limited internal combustion engine). Because of this the development and use of SOFCs for stationary and portable applications continues to grow.

Three articles in this issue of *Interface* explore some of the advancements and issues for SOFCs. The need for new materials, fabrication processes, and design and testing of cell and stack components is summarized in the article "Solid Oxide Fuel Cell Commercialization, Research, and Challenges." Advancements in stationary applications are summarized in "The Role of Solid Oxide Fuel Cells in Advanced Hybrid Power Systems of the Future." In addition, advances toward portable applications are summarized in "Toward the Miniaturization of Solid Oxide Fuel Cells."

Finally, the growth of interest in SOFCs is reflected in the large and rapid growth of attendance in the ECS SOFC symposia. This symposium, first organized by Subhash Singhal in 1989 with the "First International Symposia on Solid Oxide Fuel Cells," has grown to be one of the largest symposia at ECS. The most recent symposium in Vienna, SOFC XI, has attracted almost 400 papers and has made this symposia *THE* place to be for anyone interested in the science and technology of SOFCs.

About the Author

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