ADVANCED MATERIALS FOR FUEL CELLS

This special issue of the Journal of Materials Research contains articles that were accepted in response to an invitation for manuscripts.

Introduction

Guest Editor:

Joshua L. Hertz
University of Delaware, Newark, Delaware 19716

Principal Editors:

Maria Luisa Di Vona
Università degli Studi di Roma Tor Vergata, Roma 00133, Italy

Philippe Knauth
Aix-Marseille Université, Marseille 13397, France

Harry L. Tuller
Massachusetts Institute of Technology, Cambridge, Massachusetts 02139

As readers of this journal are no doubt aware, the Materials Research Society is strongly committed to supporting and publicizing the materials science breakthroughs needed for a sustainable energy future. This commitment continues with the publication of this month's *Journal of Materials Research* Focus Issue on Advanced Materials for Fuel Cells. This issue follows recent *JMR* focus issues on Thermoelectric Materials (Aug. 2011) and Materials for Electrical Energy Storage (Aug. 2010). Fuel cells hold the promise of highly efficient conversion of chemical to electrical energy with a wide range of application areas. If the chemical energy is sourced sustainably, fuel cells can be part of a sustainable energy cycle, with significantly improved overall fuel cycle efficiency relative to combustion-based solutions.

Hydrogen fuel (perhaps derived from solar-based photolysis of water) is often mentioned in this regard, leading too often to a conflation of "fuel cell technology" with "hydrogen economy." While hydrogen is an advantageous fuel in many ways, a key benefit of many fuel cell types is the ability to oxidize petro- or bio-based fuels, either directly or after reforming of the fuel to simpler reactants. Thus, it is important to note that the technological needs of fuel cells, while significant, are not additionally burdened by those of hydrogen generation, transport, and storage. In this Focus Issue, we concentrate on materials advances specifically for fuel cells, without concern for fuel source or other balance-of-plant issues.

Fuel cells date to what are, essentially, the earliest days of electrochemistry[1]. In the 170 years since their discovery, cost considerations have placed fuel cells outside the reach of all but a few niche applications (manned space flight being one). This situation is rapidly changing. A number of commercialization efforts are currently underway, at power output levels from megawatts to milliwatts. Nevertheless, significant materials science breakthroughs must be achieved to render fuel cell technologies more economically competitive.

This issue purposely juxtaposes reports on the two leading fuel cell technologies: solid oxide fuel cells (SOFCs) and polymer electrolyte membrane fuel cells (PEMFCs). While these two types of fuel cells are based around entirely different materials sets, their technological needs are surprisingly similar: more resilient catalysts, higher performance electrolytes that can operate under more extreme conditions (most importantly lower temperatures for SOFCs and higher temperatures for PEMFCs), and devices based on more fundamental understanding of the relevant solid state ion transport and exchange processes. In addition, and in common with nearly all materials-based technologies, both of these fuel cell types need materials that are cheaper and longer lasting.

Eighteen articles are featured in this issue of *JMR,* representing both experimentation and modeling. SOFC topics include studies of perovskite and fluorite-based electroceramics, glass sealant materials, and the fundamental thermodynamics of relevant materials and structures. PEMFC topics include studies of novel electrolytes and catalyst supports, as well as modeling of transport properties and degradation of polymer electrolytes. This collection of papers can only provide a brief overview of current materials issues being addressed. Reports in these areas will no doubt continue to appear in future issues of *JMR*.

REFERENCES

1. W.R. Grove: On a gaseous voltaic battery. *The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science* **21**(140), 417–420 (1842).

DOI: 10.1557/jmr.2012.229

 © Materials Research Society 2012

https://doi.org/10.1557/jmr.2012.229 Published online by Cambridge University Press