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Editorial

Frontiers of Energy Storage and Conversion

Jiajun Chen [1,*] and Venkataraman Thangadurai [2]

[1] Toyota Research Institute of North America,1555 Woodridge Avenue, Ann Arbor, MI 48105, USA

[2] Department of Chemistry, University of Calgary, 2500 University Dr. NW, Calgary, Alberta, Canada; E-Mail: vthangad@ucalgary.ca

* Author to whom correspondence should be addressed; E-Mail: jiajunchen03@yahoo.com; Tel.: +1-631-504-2579.

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This special issue of *Inorganics* features a Forum for novel materials and approaches for electrochemical energy storage and conversion. Diminishing non-renewable fossil fuels and the resulting unattainability of environment have made us search new sustainable energy resources and develop technology for efficient utilization of such resources. Green energy sources, such as solar, hydroelectric, thermal and wind energy are partially replacing fossil fuels as means to generate power. Inorganic (solid state) materials are key in the development of advanced devices for the efficient storage and conversion of energy. The grand challenge facing the inorganic chemist is to discover, design rationally and utilize advanced technological materials made from earth-abound elements for these energy storage and conversion processes. Recent spectacular progress in inorganic materials synthesis, characterization, and computational screening has greatly advanced this field, which drove us to edit this issue to provide a window to view the development of this field for the community. This special issue comprises research articles, which highlights some of the most recent advances in new materials for energy storage and conversion.

Rechargeable battery technology is a crucial approach to electrical energy storage. Lithium ion battery (LIB) technology offers the highest energy density among the rechargeable battery technologies, which has great potential for alternative forms of transportation, such as plug-in hybrid electric vehicles (PHEV) and all electric vehicles (EV) [1]. Intermetallic alloys and conversion compounds are promising anode materials for LIB technology. However, significant volume expansion limits their application as an anode [2–4]. In this context, Thoss *et al.* reported a novel amorphous compound with the initial composition of $Al_{43}Li_{43}Y_6Ni_8$ as an electrode [5]. Their new intermetallic amorphous alloys could partially overcome the adverse effects on performance that result from volume changes during electrochemical cycling. Remarkable electrochemical performance was achieved with high specific capacities of around 800 A h/kg in the first cycle. In many respects, the cathode is the bottleneck in the improvement of LIB technology [6]. In this issue, Jullien and Zaghib *et al.* concisely review the applications of Li cathode materials including olivine, layered transition-metal oxides and spinel frameworks [7]. Advantages and disadvantages of these three categories of cathodes are compared in terms of challenge in synthesis, stability of electrochemical performance, faradaic performance and security issues.

Development of high efficiency thermoelectric (TE) materials for devices is one of the most important topics in energy conversion. TE devices have the ability to convert waste heat into useful electricity. In this issue, Tritt *et al.* report an approach to improve $CoSb_3$-based skutterudites, an increasingly favourable thermoelectric material for mid to high temperature applications [8]. Their results shed light on the effect of indium on the performance of TE. Small amounts of In can be effective in increasing electrical conductivity in the multiple-filled $Ce_{0.1}InyYb_{0.2}Co_4Sb_{12}$, skutterudite.

Schäfer and Bobev *et al.* present a systematic investigation of the Cs–Na–Ga–Si, Rb–Na–Ga–Si, and Rb–Na–Zn–Si systems. Novel type-I clathrates with refined compositions and type-II clathrates were obtained [9]. Crystal structures of these two categories of compounds were carefully examined and determined. This fundamental research could lead to the potential application of intermetallics and solid-state structures with properties pertaining to thermoelectrics. Mg_2Si-based thermoelectric (TE) materials could be promising devices for heat-into-electricity-conversion in the mid-temperature range. Efficient synthesis for producing Mg_2Si powders at large scale is crucial for the successful exploitation of these materials. This approach is illustrated in the article by Wunderlich *et al* published in this issue. They report a new Sieverts' method to control the pressure, composition and temperature in the synthesis of Mg_2Si powders [10].

Smith and Slater *et al.* carried out investigations into the incorporation of phosphate into $BaCe_{1-y}A_yO_{3-y/2}$ (A = Y, Yb, In) for increasing proton conductivity [11]. These findings may have potential applications for solid oxide fuel cell (SOFC), where chemical energy can be converted directly into electrical energy.

In summary, this special issue underscores the ongoing importance of new materials and synthetic approaches in the creation and development of advanced energy storage and conversion solutions.

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Conflicts of Interest

The authors declare no conflict of interest

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