Recent progress in solid-state magnesium transport and interfacial stability

Brian J Ingram [(a,b)*], Baris Key[(a,b)], John T. Vaughey[(a,b)], Pieremanuele Canepa[(a,c)], Gopalakrishnan Sai Gautam[(a,c)], Gerbrand Ceder[(a,c)], Trevor J. Seguin[(a,c)], Ka-Cheong Lau[(a,b)], Chen Liao[(a,b)], Kristin A. Persson[(a,c)], Jordi Cabana[(a,d)], Nathan T. Hahn[(a,e)], and Kevin R. Zavadil[(a,e)]

(a) Joint Center for Energy Storage Research, Argonne, IL 60439, USA
(b) Argonne National Laboratory, Chemical Science and Engineering Department, Argonne IL 60439, USA
(c) Lawrence Berkeley National Laboratory, Materials Science Division, Berkeley CA 94720,
(d) USA University of Illinois Chicago, Department of Chemistry, 845 West Taylor Street, Chicago, IL 60607, USA
(e) Sandia National Laboratories, Material Physical and Chemical Sciences Center, Albuquerque, NM 87158, USA

* *E-mail of the Corresponding Author: ingram@anl.gov*

Enabling a clean mobile world through the electrification of vehicles is expected to require a next-generation energy storage technology with lower cost, higher energy storage density, and improved safety. Nonaqueous multivalent (MV) ion intercalation energy storage systems are a realistic candidate to provide these requirements. The benefit of high volumetric energy densities of these systems is realized by utilization of metallic anodes and high voltage, high capacity, high mobility cathodes. Solid-state diffusion and interfacial stability are critical phenomenon in the device performance, and of particular interest in magnesium-ion batteries. One particular challenge, addressed in this presentation is the solid-state mobility of Mg ions in cathode materials. The Joint Center for Energy Storage Research identified design principles for high mobility structures and enhanced anodic stability of electrolyte salts, demonstrated functional solid-state mobility of Mg cations, and validated expansion of the electrochemical window for active electrolytes. Materials selection and design are important factors in developing MV-ion battery cathodes; evidence will be discussed indicating that effective solid-state mobility of MV cations is available in a series of materials; thereby, encouraging further research into this rapidly expanding field of study. Furthermore, interfacial charge and mass transfer mechanisms are critical limiting factors in Mg-ion energy storage, thereby requiring stable electrolyte-cathode interactions. An enhanced anodic stability window of Mg-based electrolytes will be discussion in relation to potential limitations in performance.

Acknowledgements This work was supported by the Joint Center for Energy Storage Research (JCESR), an Energy Innovation Hub funded by the US Department of Energy (DOE), Office of Science, Basic Energy Sciences.