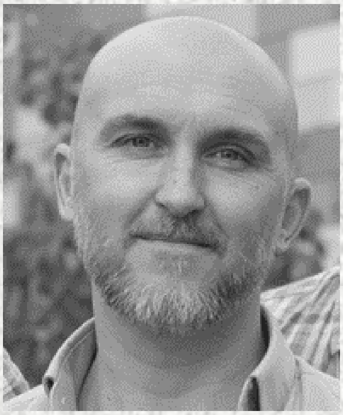
The 94th GREEN Seminar



Development of the lithium-air battery

Chair: Dr. Shoichi Matsuda (GREEN)

Dr. Lee Johnson

[Nottingham Applied Materials and Interfaces (NAMI) Group, The GSK Carbon Neutral Laboratories for Sustainable Chemistry, University of Nottingham, NG7 2TU, U.K.]

Lithium-ion batteries have delivered a revolution in portable electronics and have begun to unlock electrification of the automotive industry. However, intrinsic performance limitations mean that many applications will be out of reach for lithium-ion technology. We must explore alternatives if we are to have any hope of meeting the long-term needs for energy storage. The NAMI group is focused on tackling the underpinning chemical and materials challenges within next-generation energy devices and in particular batteries.

One such alternative is the Li-air (O2) battery; its theoretical specific energy exceeds that of Li-ion, but many hurdles hinder its realization. Early cell death, resulting in low capacity and limited rate capability, is one of the most significant problems. Studies of the processes at the positive electrode have shown that this is a result of passivating Li2O2 at the electrode surface, poor utilisation of the electrode structure, and degradation of the cell components. Here, we discuss recent advances made in our labs to understand the chemistry within the lithium-air battery and to combat the problems limiting its performance. For example, we have identified a redox mediator able to promote longer discharge and electrode compositions able to facilitate O¬¬2 transport throughout the positive electrode. New degradation processes have been identified, shedding further light on the failure mechanisms within the cells.

Venue: Large seminar room, 4F, Collaborative Research Bldg., Namiki-site

Date: Monday, December 18th, 2023

Time: 10:30-12:00

Contact: MATSUDA.Shoichi@nims.go.jp

The 94th GREEN Seminar

Effects of Added Water on the Performance of the Nonaqueous Li-O2 Battery

Chair: Dr. Shoichi Matsuda (GREEN)

Dr. Darren A. Walsh

[Nottingham Applied Materials and Interfaces (NAMI) Group, The GSK Carbon Neutral Laboratories for Sustainable Chemistry, University of Nottingham, NG7 2TU, U.K.]

The development of next-generation batteries that store more energy than in lithium-ion batteries could revolutionise the transportation sector. Of the next-generation technologies under consideration, Li-S and Li-O2 batteries are especially promising. The theoretical energy of the Li-O2 battery is 3600 Wh kg–1, drastically exceeding that of Li-ion, and is made possible by the fact that the battery "inhales" O2 as it discharges. A significant challenge hindering development of these batteries is that H2O and CO2 from air can degrade the cell performance if they access the electrolyte. Consequently, Li-O2 must be fed pure O2, rather than air, reducing the practical energy of the devices.

In this presentation, I will discuss the effects of deliberately-added water on oxygen electrochemistry in Li-O2 battery electrolytes. I will describe the use of pressure measurements to elucidate the mechanism of O2 reduction in the electrolytes and show that some battery electrolytes can tolerate significant concentrations of water, without a significantly-deleterious effect on cell performance. Specifically, I will demonstrate that some electrolyte solutions can tolerate up to 4.0 M added water while sustaining reversible O2/Li2O2 electrochemistry at the cathode of the battery. I will discuss the mechanism by which some electrolytes can tolerate water, offering a potential route towards the development of next-generation batteries with a reduced balance of plant and higher specific energy. Finally, I will discuss the development of a demonstrator that allows us to study the effects of atmospheric gases on cell performance at scale.

Venue: Large seminar room, 4F, Collaborative Research Bldg., Namiki-site

Date: Monday, December 18th, 2023

Time: 10:30-12:00

Contact: MATSUDA.Shoichi@nims.go.jp