DEPARTMENT OF MATERIALS
UNIVERSITY OF OXFORD

is pleased to announce the

HUME-ROTHERY MEMORIAL LECTURE 2016

to be given on

Tuesday, 19th April 2016 at 6:30 p.m.
Lecture Room 1, Thom Building, Department of Engineering Science

by

Professor Clare Grey FRS
Professor of Materials Chemistry
Department of Chemistry, University of Cambridge

“Following Function in Real Time:
Structure and Dynamics in Batteries and Supercapacitors”

Tea and biscuits will be served in the Holder Building Common Room from 6.00 p.m. The Lecture (6:30pm – 7:30pm) will be followed by a buffet supper in the Holder Building Common Room.

All are welcome (but please book in advance for the buffet supper).

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Abstract:

Following Function in Real Time: Structure and Dynamics in Batteries and Supercapacitors

The development of light, long-lasting rechargeable batteries has been an integral part of the portable electronics revolution. This revolution has transformed the way in which we communicate and transfer and access data globally. The invention of the lithium-ion (Li-ion) battery, a rechargeable battery in which lithium ions (Li\(^+\)) shuttle between two materials (LiCoO\(_2\) and graphitic carbon) has been an integral part of these advances. Rechargeable batteries are now poised to play an increasingly important role in transport and grid applications, but the introduction of these devices comes with different sets of challenges. Importantly, fundamental science is key to producing non-incremental advances and to develop new strategies for energy storage and conversion.

This talk will focus on our work on the development of methods that allow devices to be probed while they are operating (i.e., in-situ). This allows, for example, the transformations of the various cell components to be followed under realistic conditions without having to disassemble and take apart the cell. To this end, the application of new in and ex-situ Nuclear Magnetic Resonance (NMR), magnetic resonance imaging (MRI) and X-ray diffraction approaches to correlate structure and dynamics with function in lithium-ion and lithium air batteries and supercapacitors will be described. The in-situ approach allows processes to be captured, which are very difficult to detect directly by ex-situ methods. For example, we can detect side reactions involving the electrolyte and the electrode materials, sorption processes at the electrolyte-electrode interface, and processes that occur during extremely fast charging and discharging. Complementary Ex-situ NMR investigations allow more detailed structural studies to be performed, to correlate local and long-range structure with performance.

After a general overview of our in situ NMR and MRI studies on batteries and supercapacitors, this talk will focus on our recent work on olivines, spinels and Ge/Si anodes. The development of new NMR approaches to investigate paramagnetic battery materials, both in and ex situ, will be discussed, the approach making use of both theory and experiment. Although it is difficult to achieve high-resolution spectra from these paramagnetic materials in the in situ experiments, measurements of the relaxation time allow access to the dynamics of the lithium ions in real time as a function of state of charge. Finally, the use of NMR spectroscopy, in the study of disordered and amorphous anode materials will be described.