Magnetism as a Probe of Functional Materials

Speaker: Dr Sian Dutton
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Room: MAS2.06

Research in the Dutton group focuses on the synthesis and characterisation of functional energy materials. I will present results on our work developing low temperature magnetocalorics and using magnetic measurements to study the state of charge and health of rechargeable batteries.

Magnetic cooling relies on the magnetocaloric effect (MCE) where a change in the entropy on application of a magnetic field drives cooling during an adiabatic demagnetisation process. At low temperatures magnetic cooling is currently achieved using dilute magnetic salts with low magnetic ordering temperature - the magnetic ordering temperature is the limiting temperature to which cooling via MCE can be achieved. In this talk I will present recent work exploring complex oxides for solid state magnetic cooling applications. In particular I will focus on our work on Lanathide garnets[1-3] and low dimensional lanthanide borates.[4-5]

I will also discuss our recent work on using magnetic measurements to the structure and state of charge of cathodes in Li-ion batteries. Using three materials systems as examples I will demonstrate how magnetic susceptibility measurements can be used to obtain information on the structural disorder, and changes in oxidation state of redox active species on cycling. In the case of $MgMnB_2O_5$ evidence for multi-electron redox on demagnetization will be presented.[6] In the second example of the disordered rock-salt $Li_{1.25}Nb_{0.25}Mn_{0.5}O_2$ the relationship between the degree of local ordering and the magnetic susceptibility will be discussed.[7] Finally, for 811 NMC, $LiNi_{0.8}Mn_{0.1}Co_{0.1}O_2$ the sensitivity of magnetometry to small amounts of structural and compositional disorder and how this correlates with electrochemical performance will be presented. Changes in oxidation state of Ni and Co during the first charge as inferred from ex-situ measurements will also be presented.[8]

[1] Sackville-Hamilton *et al.* Journal of Physics: Condensed Matter, 26, 116001 (2014)
[2] Mukherjee *et al.* Journal of Physics: Condensed Matter, 29, 405808, (2017)
[3] Mukherjee *et al.* Physical Review B, 96, 140412(R) (2017)
[4] Mukherjee *et al.* Journal of Physics: Condensed Matter, 29, 405807 (2017)
[5] Mukherjee *et al.* Materials Research Bulletin, 98, 173 (2018)
[6] Glass *et al.* Chemistry of Materials, 29(7), 3118 (2017)
[7] Jones *et al.* Chemical Comm, 55, 9027 (2019)
[8] Mukherjee *et al.* in preparation