NANOSCALE PHENOMENA STUDIED IN REAL-TIME: THE ROLE OF SMALL-ANGLE SCATTERING

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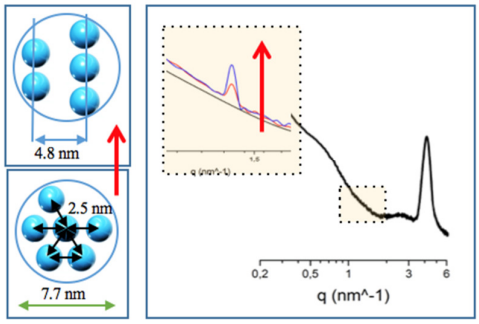
Nanoscale *morphology* has become an increasingly important topic in energy materials since much of the transport behaviour and the structural integrity issues rely on details near surfaces and at nanoscales/amorphous phases. Whereas diffraction is used to study the crystal structure of materials, small-angle scattering (SAS) is well suited to provide information on the size, shape and interaction of nanometer-sized objects. For instance, small-angle neutron scattering (SANS) has been successfully used to probe spatial inhomogeneity of the hydrogen concentration in metal hydrides or the lattice strain and dislocation during hydride phase formation.
More recently, the combination of SANS with *in-situ* small-angle X-ray scattering (SAXS) has been fundamental to investigate nanoscale composites for hydrogen storage, their kinetics and thermodynamics in relation to their morphological evolution.
The emerging relevance of SAS in the investigation of materials for energy storage is also related to an enhanced interest in the development of analytical methods to study batteries during operation, or *operando*. Indeed, typically, the performances of the electrochemical cell unit is measured with *ex-situ* X-ray or neutron diffraction measurements, by dismantling a battery at a chosen stage of charge/discharge. This way, the resulting picture of the chemical reactions is partial and far from the real-time working behaviour, especially when metastable phases formed during cycling relax to more stable states in *ex-situ* measurements. As will be discussed by presenting recent results, *operando* SAS offers the possibility to study particle related nanoscale effects within fully operational batteries, non-destructively and without disassembling the cell.



References

Sabrina Sartori, Kenneth D. Knudsen, (2016). Book chapter. ISBN 978-3-319-22792-4. *Neutron Scattering and Other Nuclear Techniques for Hydrogen in Materials.* ISSN 1868-0372.

Other references will be given during the presentation.

Sabrina Sartori is originally from Italy, where she earned her PhD in 2003. She joined the University of Oslo in 2013 as associate professor of Physics. She is also the leader of the Energy and Environment group at the University Graduate Center UNIK. In 2012-2013 she was awarded the Feinberg Foundation Visiting Faculty Program fellowship at the Weizmann Institute of Science, Israel. She organized the 1st Gordon Research Seminar on H-M Systems at Stonehill College, USA, in 2011. Among other, she is an expert member of the IEA Hydrogen Implementing Agreement Task 32, and one of the Directors of the Materials Research Society.