Operando characterization of battery anodes using mXRD and combined SAXS/WAXS

Sandrine Lyonnard, Samuel Tardif

CEA IRIG, Grenoble, France;

sandrine.lyonnard@cea.fr

Li-ion batteries are ubiquitous in our society. However, producing high performance, safe, and sustainable batteries remains a great challenge to foster the industrial development towards e-mobility, portable and stationnary applications. Materials engineering and new chemistries are key in this objective, as well as advanced characterization tools to probe the bulk & interfacial properties of active materials. In particular, investigations in *operando* mode, *e.g.* during battery cycling under realistic conditions, are currently attracting an enormous interest. Synchrotron techniques have been widely employed to probe in real-time a large variety of battery technologies, e.g. Li-ion and beyond, to observe and map the evolving structures, in relation to materials composition & design and battery operating conditions. In this talk, we will focus on the lithiation and ageing mechanisms in advanced electrodes, and show how operando X-rays (XRD/WAXS/SAXS) experiments can provide unique insights into the structural changes in graphite [1], silicon [2] and silicon-graphite [3-4] anodes with high time/spatial resolution. In particular, spatially-resolved mXRD gives access to 2D information in the depth of the electrode, as lithiation heterogeneities and phase distributions [1], while combined SAXS/WAXS allow to determine the sequential lithiation mechanism of active phases in a composite nanostructured material [3-4]. We will also adress the challenge to build beam-compatible battery cells, which is the pre-requisite to correlate real-time microscopic information to the electrochemical performance. Last, we will introduce the novel possibilities of performing 3D quantification of structural features evolutions in complex materials.

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