3D Imaging and Structural Analysis of Large Volumes in Lithium-Ion Battery Materials and Fuel Cells Using Xe^+ Plasma FIB and SEM

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Lithium-ion batteries are complex 3-dimensional structures and their properties are determined by transport behavior within and between the different phases and particles present. Accurate 3D structural information on a representative length scale is required to accurately model and understand such structures, which for anode and cathode materials in Li batteries typically means 100-200µm width (1).

Plasma FIB (focused ion beam) is a new technology which achieves much higher beam currents than traditional Ga^+ FIB systems and thus enables much larger volumes to be analyzed in the same time using a slice-and-view technique, and high quality SEM images can be taken of each slice, to build up a high contrast 3D dataset. A 3D reconstruction of the sample structure is then made using segmentation by image contrast, to identify individual grains, different phases and void regions. From this reconstruction, detailed studies can be made of the particle size and connectivity, pore size and distribution, and hence likely transport behavior of ions or gas in or around the structure, including the tortuosity.

In this poster we present 3D data taken by Xe^+ Plasma FIB with between 100µm and 200µm field of view and 100nm slice width of Li battery anode and cathode (Fig. 1) material and a solid oxide fuel cell. No compromise is needed between field of view and resolution using this technique. Data segmentation and processing was performed using the Avizo software package.

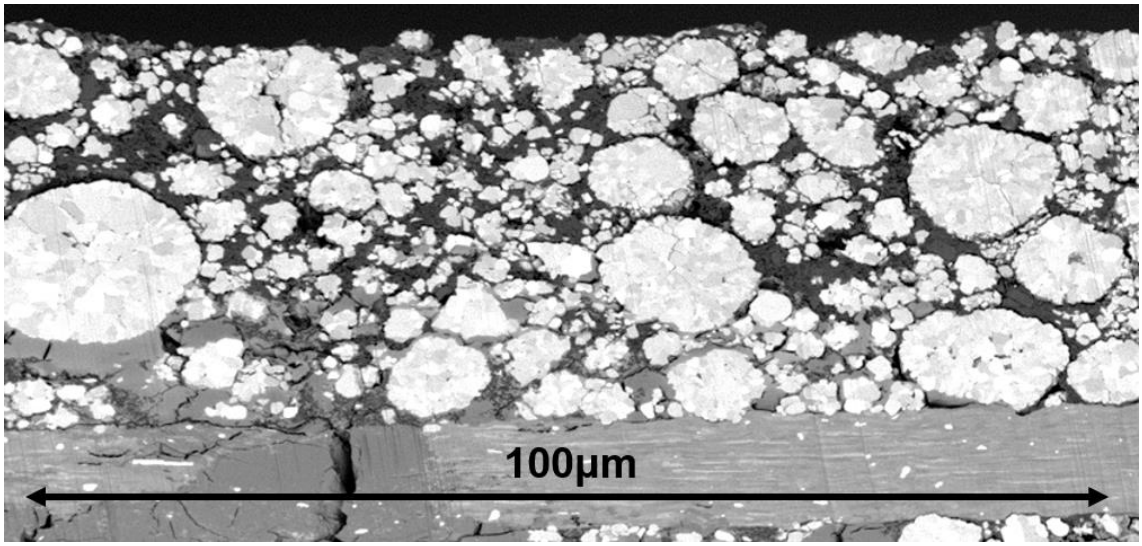

Fig 1: 100µm large field of view section through the 3D volume of active cathode material of a Li-ion battery.

References:

[1] Qiong Cai, Claire S. Adjiman and Nigel P. Brandon, Electrochimica Acta 56 (2011) 5804-5814