Coherent X-ray Diffraction Imaging - ESRF

TEESMAT
Open Innovation Test Bed for Electrochemical Energy Storage Materials

Principle

A nanofocused, coherent X-ray beam diffracts off single crystals, providing 3D spatial and 3D crystallographic images.

Why is it useful ? This technique is useful for imaging strain inside single crystal nano objects. The coherent X-ray beam allows for 3D strain and 3D electron density maps to be obtained, revealing crystal defects and residual stress with spatial resolution approaching 5 nm, and with sub-angstrom strain resolution. The high penetration of X-rays allows this technique to be performed *in situ*, with some limitations.

How it works

The diffraction pattern from a nanocrystal illuminated with a coherent synchrotron X-ray beam can be inverse Fourier-transformed into a 3D image of the crystal. This image contains both intensity information (size & shape) and phase (strain) information.

What kind of sample ? Highly crystalline solids, such as cathode active materials. Must be radiation resistant. Electrochemical cell available.
Crystallite size must be in the range of 40 nm – 2 um, ideally ~500 nm.

Investigation time-scale : Typical imaging session of 10-30 minutes per image, with single experiments of 1-5 days. Scheduling needs to be planned months in advance.

Maturity level : Extremely challenging, in development

Grant Agreement
No 814106

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What can be seen

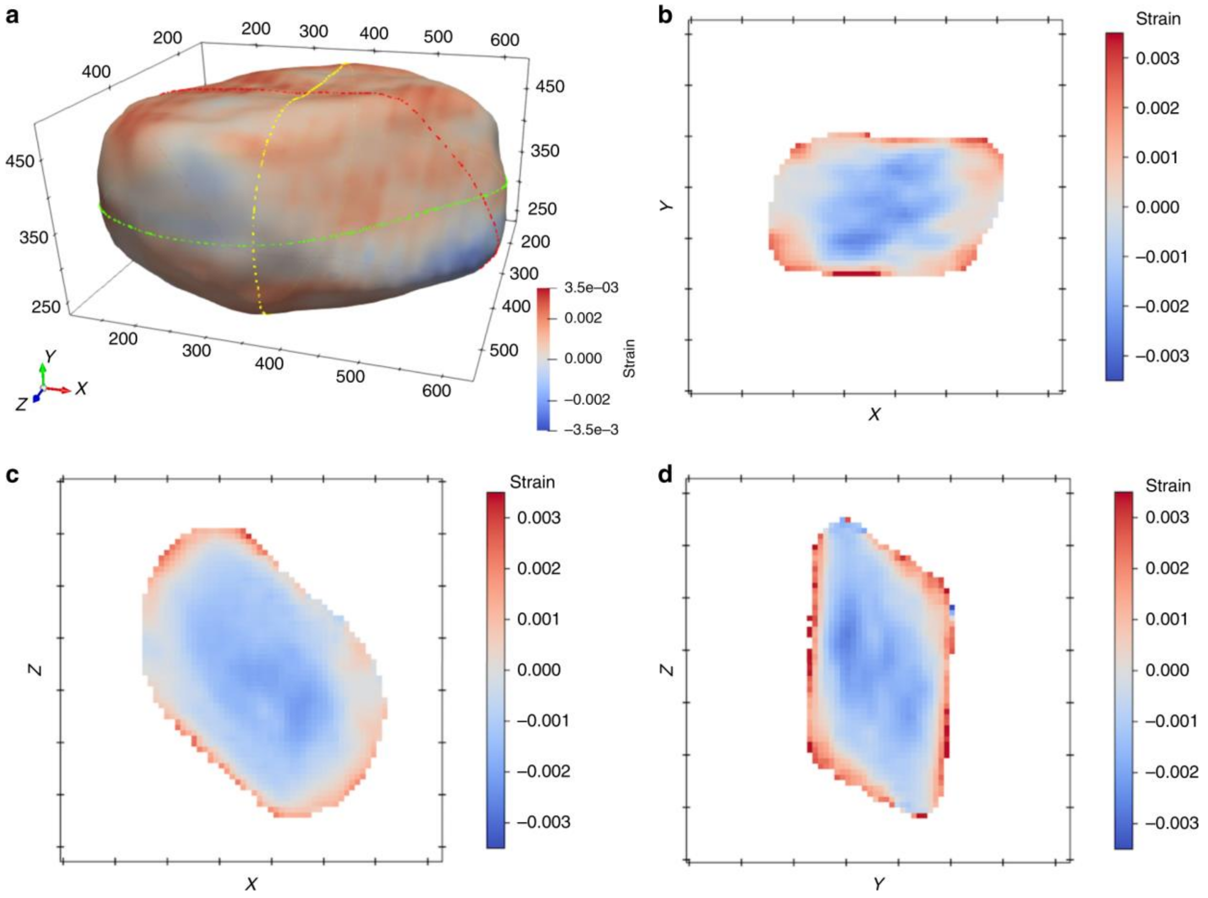

Figure 1. Bragg coherent diffractive imaging reveals the internal structure of a single crystallite from an Li_xNi0.2Mn0.6O_y cathode after 1-year cycling. **a** Three-dimensional rendering of the crystallite, where the color map denotes strain and corresponding cross sections through the 3D structure in the **b** XY, **c** XZ, and **d** YZ planes. Tick spacings along all axes correspond to 100 nm. Taken from *Nature Communications,* **10**, 5365 (2019).