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DATASHEET

Smart STEM on Talos F200

Thermo Scientific Talos S/TEM

Image quality is often reduced by the influence of drift, vibrations or other instabilities during acquisition. This prevents users from obtaining high-quality S/TEM images, since only short exposure times can be chosen or beam damage occurs. Drift corrected frame integration (DCFI) is a new acquisition strategy that overcomes this problem, allowing imaging with high contrast and high signal-to-noise ratio. DCFI can be applied to both STEM and TEM imaging.

Successive STEM images are integrated during the acquisition, and drift is corrected using cross correlation methods between the images (Figure 1). Because the acquisition speed of cameras in TEM and the scan speed in STEM have been increased in modern electron microscopy, low-frequency drift and high-frequency interference artifacts can be suppressed by DCFI.

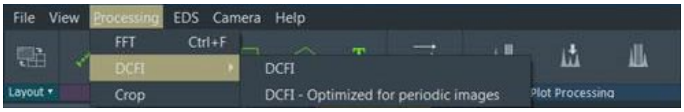
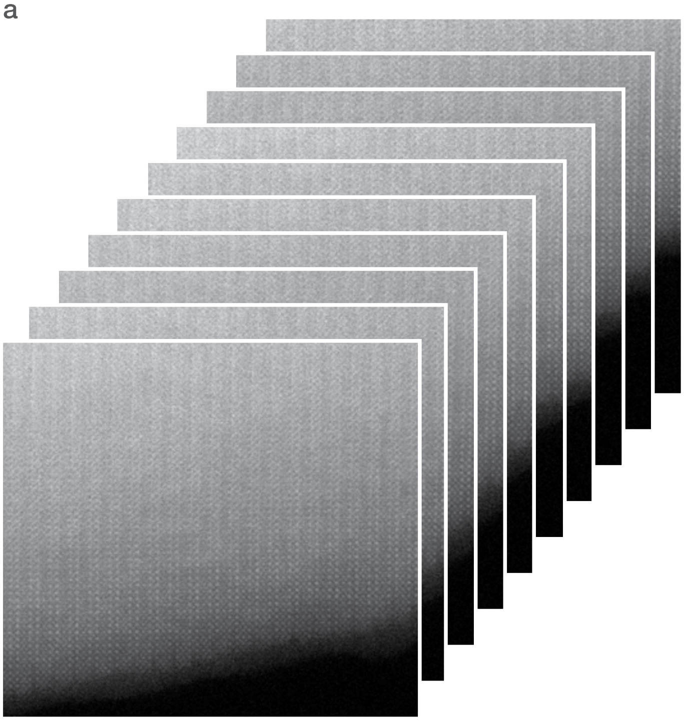


Figure 2: Velox UI interface

This acquisition method is embedded in Thermo Scientific™ Velox™ Software and can be activated in the user interface (Figure 2). The size of the images, number of images in the series and the acquisition speed per frame can be chosen freely to optimize the result. The integrated images are displayed live in the user interface to provide the operator the required feedback and to check the quality of the result immediately to increase throughput in research. Once the image series is acquired, the user simply navigates to the Processing window and selects 'Processing/DCFI' from the main menu. For periodic structures like high resolution images, the user should select the "optimize for periodic images" option. The meta data stored in the images documents the parameters used to optimize the image for offline inspection after the experiment.

a



b

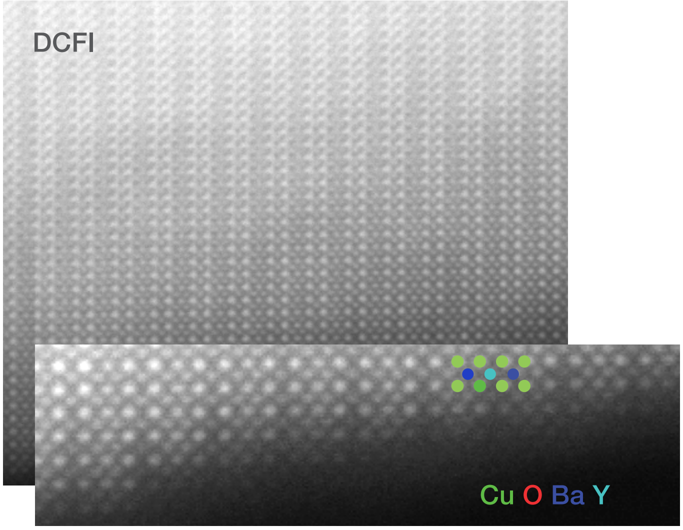


Figure 1: High resolution STEM image of Yttrium Barium Copper Oxide. Figure 1a shows 20 STEM images of the sample prior to applying DCFI; 1b shows the 20 correlated STEM images using DCFI. The zoom in clearly shows the column arrangement and position of the atoms at high S/N ratio.

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In this application note, we will demonstrate the capabilities of Smart STEM on yttrium barium copper oxide (Figure 1) and lithium titanate $LiTi_2O_4$ (Figure 3) using the Thermo Scientific™ Talos™ F200 S/TEM. The STEM images for both materials have been acquired with 25 frames per second.

Yttrium barium copper oxide is a material that exhibits superconductivity at high temperatures, finding use as small superconducting magnets used in magnetic resonance imaging (MRI) apparatuses, where they generate the large magnetic fields necessary to excite and then image atomic nuclei in body tissues. Other potential applications include wires for highly efficient superconducting magnets and low-loss electric power transmission lines, as well as advanced devices such as Josephson junctions and so-called SQUIDs (superconducting quantum interference devices).

Spinel lithium titanate is a compound containing lithium and titanium. It is an off-white powder at room temperature and is used as the anode component of fast recharging lithium-titanate batteries and as an additive in porcelain enamels and ceramic insulating bodies based on titanates.

a b

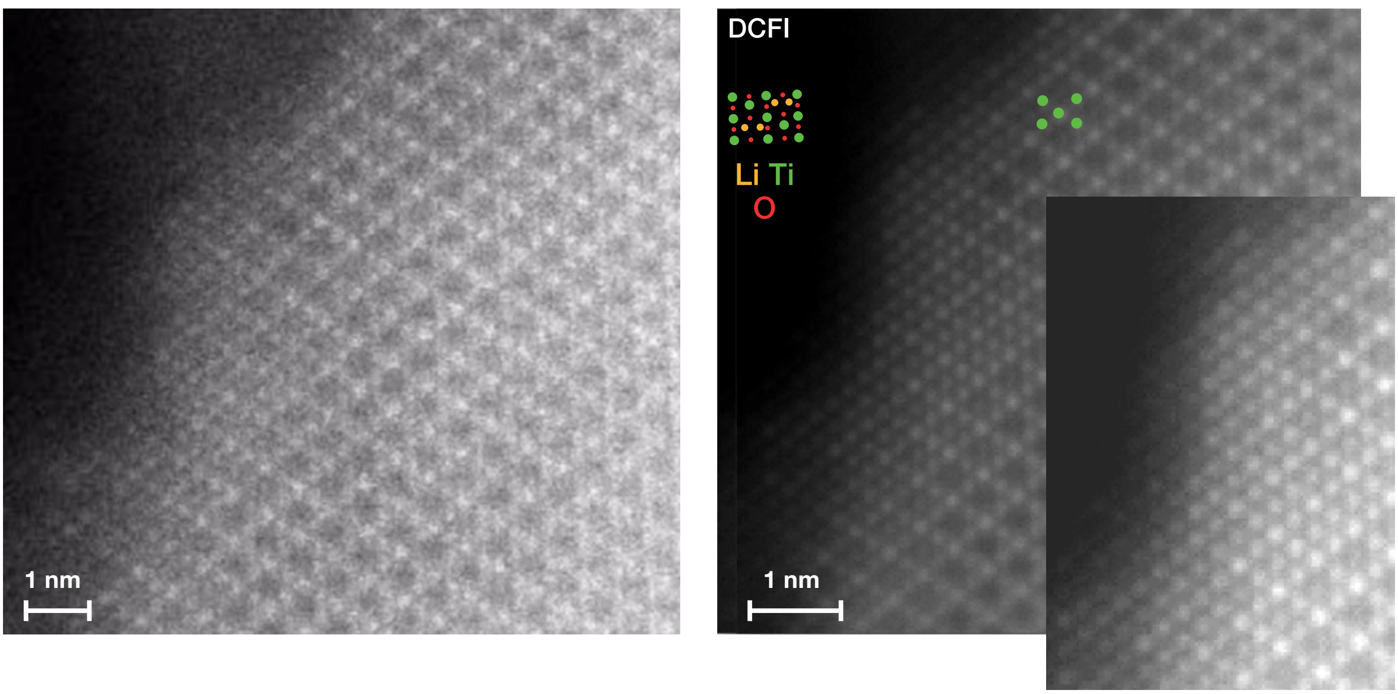

Figure 3: High resolution STEM image of Lithium Titanate $LiTi_2O_4$. Figure 2a shows one STEM image of the sample, 2b shows 20 correlated STEM images using DCFI. The zoom in clearly shows the column arrangement and position of the atoms at high S/N ratio.

Conclusion:

Both examples clearly show the benefits of using Smart STEM to correct drift in STEM imaging. The 20 correlated images using DCFI display a significant increase in overall image quality, in addition to exhibiting both high contrast and a high signal-to-noise ratio. These use cases demonstrate that by utilizing DCFI on Thermo Scientific instruments, researchers can gain better insights into the atomic structure and composition of their materials.

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