SCANNING ELECTRON DIFFRACTION USING THE PNCCD (S)TEM CAMERA

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Abstract

Scanning electron diffraction (SED), performed in a STEM, is a powerful technique combining information in reciprocal space and real space to achieve nanoscale crystal cartography of materials structure. SED involves scanning a focused electron beam across a specimen and recording an electron diffraction pattern at each position to yield a 4D dataset comprising a 2D diffraction pattern at every position in the 2D scan region. Obtaining high quality data depends on fast acquisition, large dynamic range, and accurate recording of the location and intensity of diffraction spots.

Here, we present SED measurements using the pnCCD (S)TEM camera taking a Ti-Fe-Mo alloy for demonstration. The pnCCD (S)TEM camera provides fast acquisition of 2D camera images using a direct detecting, radiation hard pnCCD with 264x264 pixels [1]. Routinely, the readout speed is 1000 frames per second and can be further increased by binning and windowing. The large number of pixels and high readout speed of this camera enables the recording of high quality diffraction patterns in a short acquisition time. Further, the camera properties can be changed by modifying the voltages applied to the pnCCD providing several camera operation modes [2]. Considering scanning electron diffraction experiments, which are performed at high electron beam intensities, the combination of data recorded in two different camera operation modes allows a comprehensive diffraction pattern analysis with quantitative and spatial information.

The 4D datasets acquired with the pnCCD (S)TEM camera can be analysed in a number of ways [3], most simply by plotting the intensity of a subset of pixels as a function of probe position in flexible post-experiment schemes to obtain 'virtual diffraction images' or to perform differential phase contrast analysis. Using virtual diffraction images, the two phases existing in an ultra-fine lamellar microstructure [4] in this Ti-Fe-Mo alloy can be clearly discriminated.

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[3] P. Moeck et al, Crystal Research and Technology 46 (2011), p.589-606
[4] A.J. Knowles et al (2016), Proceedings of the 13th World Conference on Titanium

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