Assessing the use of CMOS technology in EBSD detectors and its impact on analysis speed and precision

Trimby, P.[1], Goulden, J.[1] and Bewick, A.[1]

[1] Oxford Instruments Nanoanalysis, United Kingdom

Charge coupled device (CCD) sensors have been used in commercial electron backscatter diffraction (EBSD) detectors for approximately 2 decades. These have enabled the relatively rapid collection of high resolution diffraction patterns with good signal to noise ratios. However, the acquisition rate of megapixel-resolution patterns is relatively slow - at best a few 10's patterns per second (pps), and pixel binning is required in order to achieve higher frame rates. Indeed, higher speed analyses with CCD-based detectors require use of a VGA-resolution sensor (maximum 640x480 pixel resolution) and significant pixel binning. The highest analysis speeds in excess of 1000 pps are only achieved using exceptionally low pattern resolutions of 40x30 pixels or lower. This lack of pattern detail has a severe detrimental effect on the quality of EBSD pattern indexing and angular precision, and as such is typically only suitable for the analysis of recrystallised metal samples.

Recent detector developments have, for the first time, utilised a complementary metal oxide semiconductor (CMOS) sensor [1]. In contrast to CCD sensors, CMOS sensors have a parallel read out that enables relatively high resolution images to be collected at high speeds, without recourse to significant pixel binning. This allows collection of 156x128 pixel resolution patterns at speeds in excess of 3000 pps: i.e. more than twice the speed and with 16 times more pixels than the fastest CCD-based analyses. The impact that this additional speed and pattern quality has on EBSD measurements is profound: deconvolution of overlapping patterns at grain boundaries is improved; phase discrimination at top speeds is more robust and the angular precision of measurements is significantly enhanced. The result of this technology shift is that high speed EBSD analyses are no longer constrained to simple, single phase materials; now it is possible to characterise complex, multi-phase deformed samples in a matter of minutes without requiring pattern averaging routines or detailed, offline processing algorithms. In this paper we present a detailed examination of the impact of CMOS technology on the angular precision of EBSD, as well as showing examples of effective high speed EBSD analyses of complex materials - see figure 1.

References

1. www.oxinst.com/symmetry

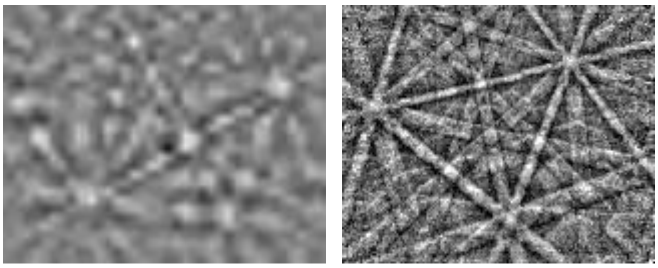

Figure 1a. EBSPs from Ni. Left - CCD based detector collected at 1500 pps. Right - CMOS based detector collected at 3000 pps.

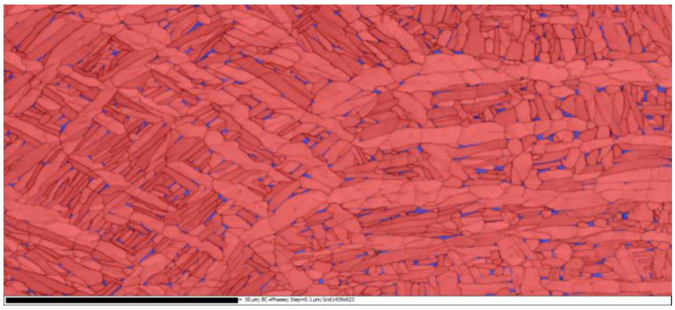

Figure 1b. Example phase map of a 2 phase Ti64 alloy collected using a CMOS based detector at 1000 pps. Red - alpha Ti, Blue - beta Ti. Raw data (approximately 99% indexing). Scale bar marks 50 um. Sample courtesy of Materials Consult, UK.