Fast 4D STEM with ARINA Hybrid-Pixel Detector

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Electron detection technology has been evolving over the last few years and improving TEM characterization in both Materials Sciences and Life Sciences, particularly when beam-sensitive samples are involved [1]. The hybrid-pixel detector (HPD) concept [2] has the distinctive advantage of a flexible design with respect to the sensor material and electronics, allowing the direct electron detection and counting optimization for a range of TEM experimental parameters (such as electron energy) and different applications.

Building on its successful HPD technology for X-ray detectors, DECTRIS fine-tuned its design to enable the precise detection of electrons. Its most recent development is an application-specific integrated circuit (ASIC) designed to allow read-out rates above 100 kHz and to perform electron counting up to 10 pA beam current per detector pixel with zero read-out noise [3].

ARINA detector combines this newly-designed ASIC with a flexible choice of sensor materials, an easy-to-use application programming interface (API), and a detector retraction mechanism, making it fit to most TEMs with electron energies from 30 to 300 keV and 4D STEM experiments requirements. Initial tests show that ARINA is suitable for flexible virtual STEM imaging with dwell time below 10 µs, allowing for flexible differential phase contrast (DPC) with atomic resolution (Figure 1), and electron diffraction experiments with high dynamic range for crystal phase/orientation mapping (Figure 2).

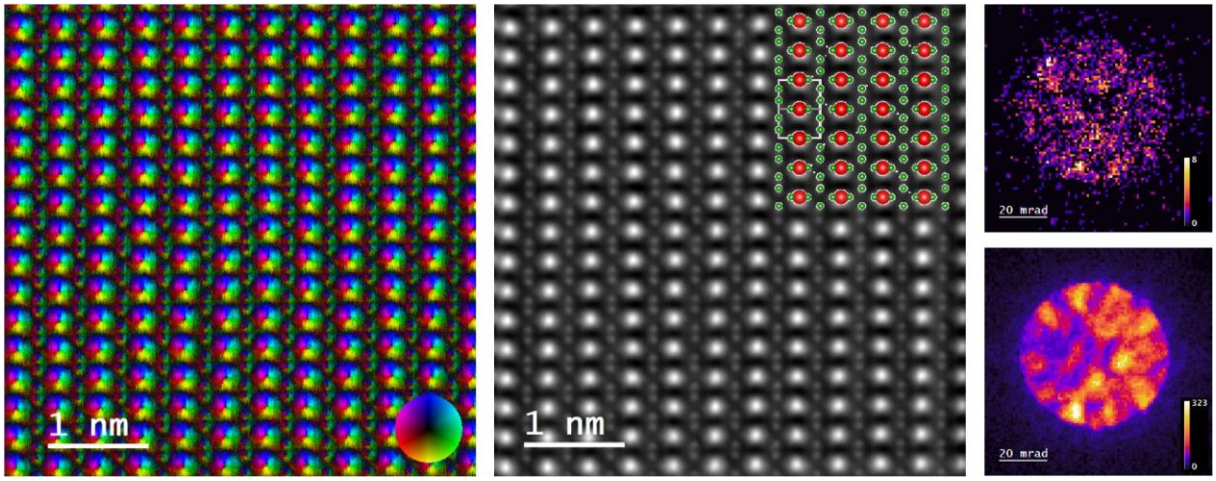

Figure 1. a) DPC and b) iCoM images calculated after a 10 s 4D STEM measurement with a SmB6 [110] sample. c) Example diffraction patterns extracted from the same 4D STEM dataset, for a single pixel with 10 µs acquisition (above) and for a 10x10 pixels integration. Collaboration: Mingjian Wu (FAU), Elisabeth Muller and Emiliya Poghosyan (PSI).

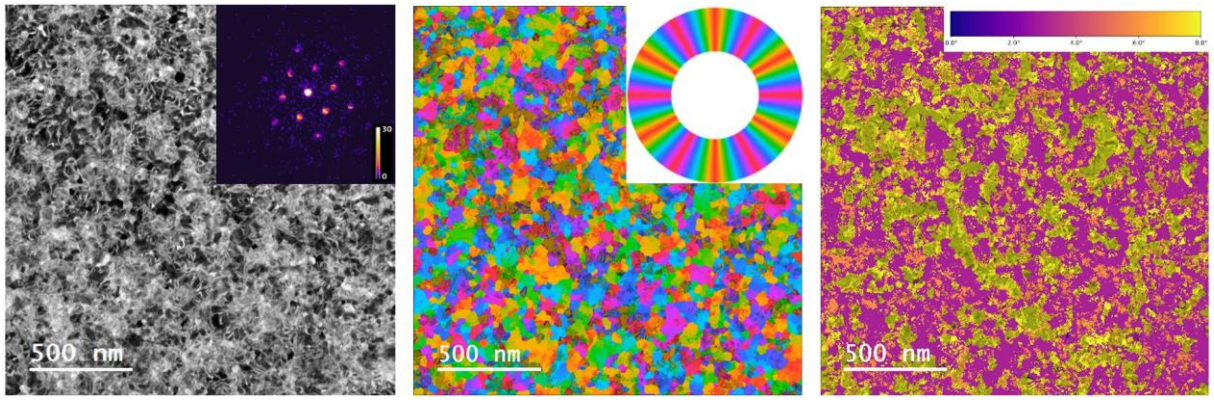

Figure 2. a) Virtual ADF image and (inset) single-pixel diffraction from the 4D STEM measurement with 50 µs dwell time of a AlN sample with columnar grain structure along the [0001] direction. b) In-plane rotation and c) out-of-plane tilt measured from the same experiment using ACOM package from py4DSTEM [4]. Collaboration: Mingjian Wu (FAU).

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