TruePix EBSD Detector for the Apreo ChemiSEM

Electron backscatter diffraction (EBSD) is an increasingly critical technique for the analysis of phase composition and structure in advanced materials.

Despite this, widespread adoption of modern EBSD faces a number of challenges include the complexity of the workflow, the difficulty in analyzing beam-sensitive materials, and the need for extensive training or highly skilled operators. To address these challenges and provide greater access to EBSD, Thermo Fisher Scientific is introducing the Thermo Scientific™ TruePix™ EBSD Detector; a high-speed, high-sensitivity direct electron detection system. The TruePix Detector works seamlessly with the scanning electron microscopy and energy-dispersive spectroscopy (SEM-EDS) workflow of ChemiSEM Technology, enabling exceptional EBSD performance. The TruePix Detector is also supported by xTal View Software, which provides comprehensive EBSD acquisition and data processing. xTal Software supports on- and off-line analysis, reducing time to data while offering extensive post-processing and reliable indexing of all crystal systems.

Key features

- **Close integration** with the electron microscope for simplified analysis, short time to data, and safe operation
- **Beam-sensitive materials analysis**. Single electron counting enables precise dose control
- **Exceptional low-kV performance** allows for analysis with a smaller interaction volume and therefore higher spatial resolution
- **High sensitivity.** Equivalent >3,000 patterns per second per nA (pps/nA) on nickel
- **High throughput.** Capable of 2,000 patterns per second without binning

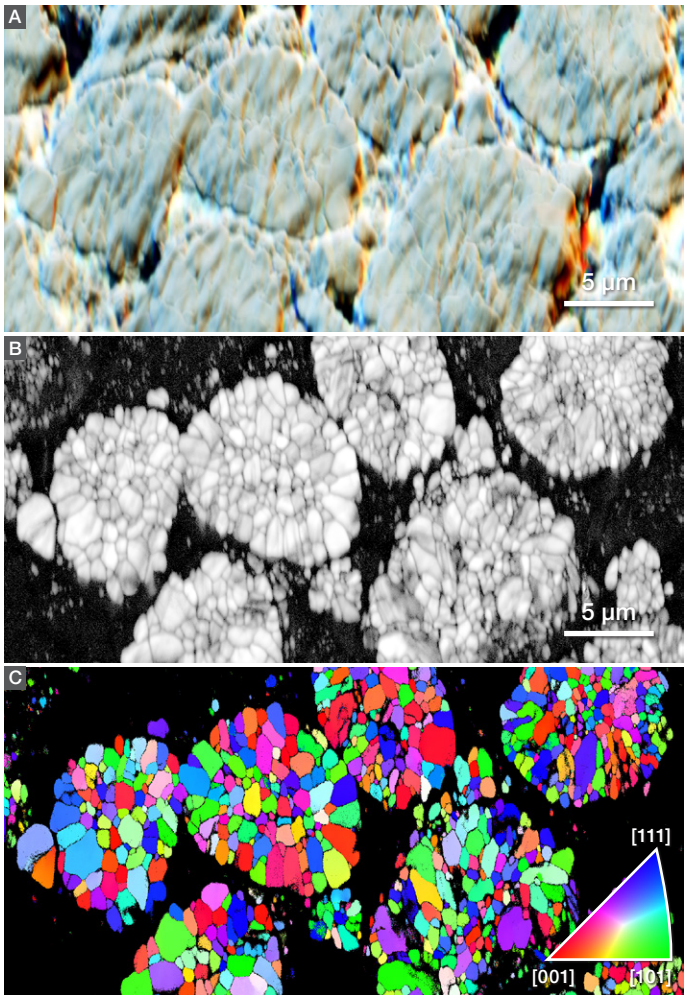

Figure 1. Battery NMC particles analyzed with the TruePix Detector. A) Color forescatter map. B) Pattern quality map. C) IPF (X) orientation map.

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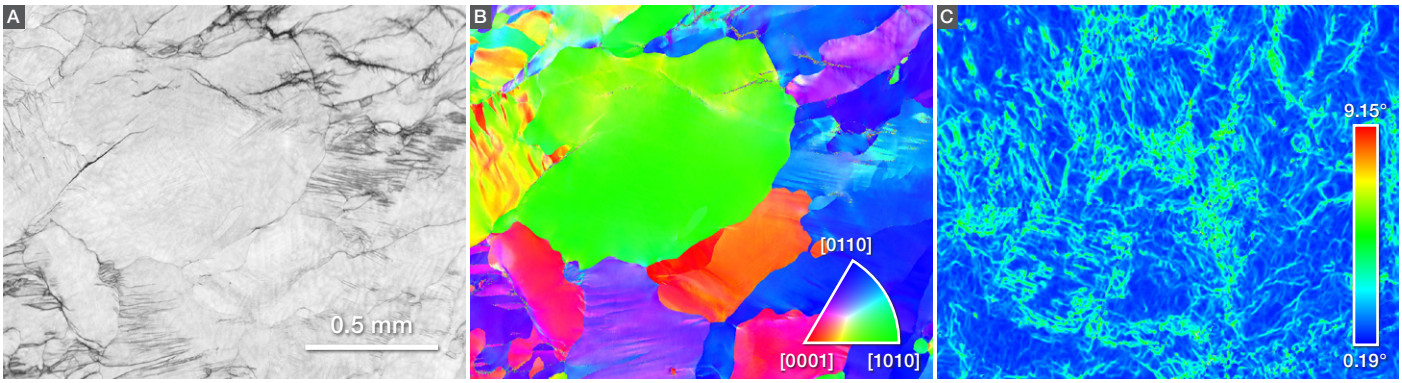

Figure 2. Deformed high-entropy alloy analyzed with the TruePix Detector. A) EBSD quality map. B) IPF (X) orientation map. C) Kernel-average misorientation strain map.

TruePix EBSD Detector specifications

Hybrid pixelated direct electron detector designed for EBSD.

Size	256 x 256 pixel (55 micrometer pixel size)
Readout	Zero readout noise, high signal to noise
Distortion	Zero distortion due to optical coupling or phosphor
Sensitivity	Single electron detection
	Equivalent >3,000 pps/nA on Ni
Throughput	2,000 patterns per second achieved without binning
Additional specifications	Fully automated insertion in under 20 seconds
	Mechanical shield protects the detector from plasma and other damage when retracted
	Optional dedicated EBSD specimen holder with integrated EBSD Faraday cup

The TruePix Detector enables a seamless workflow between the SEM, EDS, and EBSD analysis on a single computer. No external beam control or column communication is required, supporting fast and safe operation.

EBSD acquisition and processing with xTal View Software

xTal View Software is an intuitive on- and off-line EBSD analysis system, integrated seamlessly with the instrument's xT Microscope Control Software. All imaging, EDS, and EBSD parameters are controlled within a single system.

xTal View Software features

- Project-based file system
- Store sample and preparation notes in a single location
- Chamber scope shows the detector insertion position for safe operation
- Pan and zoom across all image types, through multiple quadrants

Detector setup

- Maximum exposure is determined before saturation, with automatic frame integration if exposure time exceeds the maximum exposure point
- Automatic pattern background removal based on electron counting
- Automated pattern center calibration for different camera insertion positions and working distances
- Median electron counts (MEC) is a new metric that is used to quantify the number of electrons in the EBSP, and is utilized for beam sensitive analysis
- Save processed or raw patterns during acquisition
- Saving raw or processed patters does not hinder acquisition speed
- Ability to turn beam off and retract detector once acquisition is complete

Band detection and indexing

- Indexing of all seven crystal systems and 11 Laue groups
- Simultaneous indexing of multiple phases
- Fast Fourier-transform-based surface quality metric
- Band-contrast pattern quality metric
- Index quality and hit rate metrics
- Automatic low-magnification pattern-center correction
- Kinematic simulation of best fit and overlays onto the EBSP
- Overlay of poles onto the EBSP

Phase databases

- Included structural databases: Thermo Fisher Scientific structural database (expert-validated database of 30,000 materials) as well as American Mineralogist structural databases
- Import of .cif files from any database
- Ability to create user-defined databases
- Advanced fuzzy search capability, with ability to search databases on the following parameters:
  - Name
  - Unit cell
  - Chemistry
  - Crystallography
  - Keywords
- View kinematic diffraction patterns, spherical Kikuchi patterns, and simulated unit cells
- Interactive rotation with simulated spherical patterns and unit cells, with the ability to extend to over 1,000 unit cells
- Display information about phase reference, unit cell parameters, Laue group, space group, and chemistry

Data acquisition

- Map and live point inspection modes
- Map resolution, step size, and area of analysis can be user defined
- Map resolution up to 2k by 2k in a single frame
- Collect maps from larger areas through a combination of stage movement and subsequent map stitching via Thermo Scientific Maps Software
- Display elapsed time, remaining time, and average indexing success (hit rate) during acquisition
- View all EBSPs with indexing confidence above a threshold value
- Option to view live patterns during acquisition and live point mode, including all overlayed bands and quality metrics
- Overlay of EDS maps from ChemiSEM analysis

Map display and reprocessing

- Greyscale, topographic and color FSD maps
- Median electron counts
- Surface, pattern, and index quality maps
- Euler orientation maps and IPF orientation maps (in X, Y, and Z)
- Phase maps
- Kernel-average misorientation (KAM)
- Overlay any combination of map types
- Pole figures to show how specific crystal planes and zones align with the specimen
  - Display of multiple pole figure in the same image (e.g. {100}, {110}, and {111} plane normals or <123> and <456> zones)
  - Display of pole figures as either scattered or contoured data
  - Contoured data with the same maximum intensity
  - Contoured pole figures with optional grey or rainbow color scales
  - Option to show both the upper and lower hemispheres for lower-symmetry Laue groups such as triclinic
  - Selectable projection planes
- Noise reduction based on pixel interpolation and outlier removal
- Grain detection with statistics including neighbor analysis, aspect ratio, grain size, and misorientation
- Grain boundary display or CSL boundary display
- Overlay of ellipsoids with major and minor axes per grain
- View grain distributions and misorientations as histograms including McKenzie disorientation angle plots
- Load/save entire project for offline analysis
- Export raw data
- Data export as .hdf5

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