



TKD

## OPTIMUS 2

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Augmented On-Axis TKD in the SEM

Innovation with Integrity



# Unmatched Solution for Nanomaterials Characterization in the SEM

OPTIMUS 2 is an add-on option of the e-Flash EBSD detectors which makes the on-axis Transmission Kikuchi Diffraction (TKD) technique possible as well as STEM-like imaging on electron transparent samples in the SEM. Building on its predecessor's unrivalled performance, OPTIMUS 2 brings new analytical capabilities for in-situ experiments, vastly improved spatial resolution, data quality and data integrity.



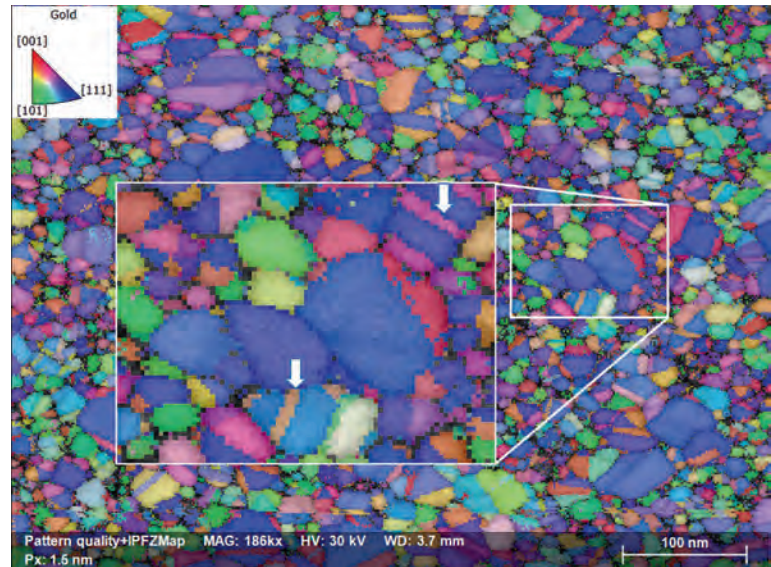
## New features of OPTIMUS 2

- OPTIMUS Vue screen with silicon diode at its center for Bright Field (BF) STEM-like imaging
- Advanced alloys for minimized interference with e-beam
- Additional new thin film in the screen active layer structure for improved signal quality
- Optimized screen frame design for an improved user experience

## Enabling nanoscale TKD mapping in the SEM

Available since 2015, on-axis TKD has offered the best spatial resolution capabilities during orientation mapping in a SEM. Bruker's latest TKD solution brings significant technology advances to push the limits of spatial resolution even further:

- OPTIMUS Vue screen provides the ideal conditions for optimizing beam focus and astigmatism to obtain the best spatial resolution settings before acquiring a TKD map.
- The new ESPRIT FILTKD software feature combined with on-axis TKD enables - for the first time ever - orientation mapping in ultra-high resolution (UHR) mode of SEMs with electron columns using full immersion lens (FIL) technology.



**Figure 1**

4 nm wide annealing twins resolved in a raw orientation map acquired from a gold thin film. Scale bar represents 100 nm.

## Fastest simultaneous TKD & EDS measurements on nanomaterials

Bruker's unique XFlash® FlatQUAD EDS detector with its ultra-high solid angle of up to 1.1 sr is the ideal low-kV EDS solution for characterizing nanoparticles or nanostructures in electron transparent samples. Unmatched spatial resolution and speed are achieved using the XFlash® FlatQUAD simultaneously with OPTIMUS 2 for the acquisition of maps containing elemental and crystal orientation data from electron transparent samples.

Accurate quantitative EDS analysis can be performed using methods designed for electron transparent samples:

- Cliff-Lorimer-factor method
- Zeta-factor method.

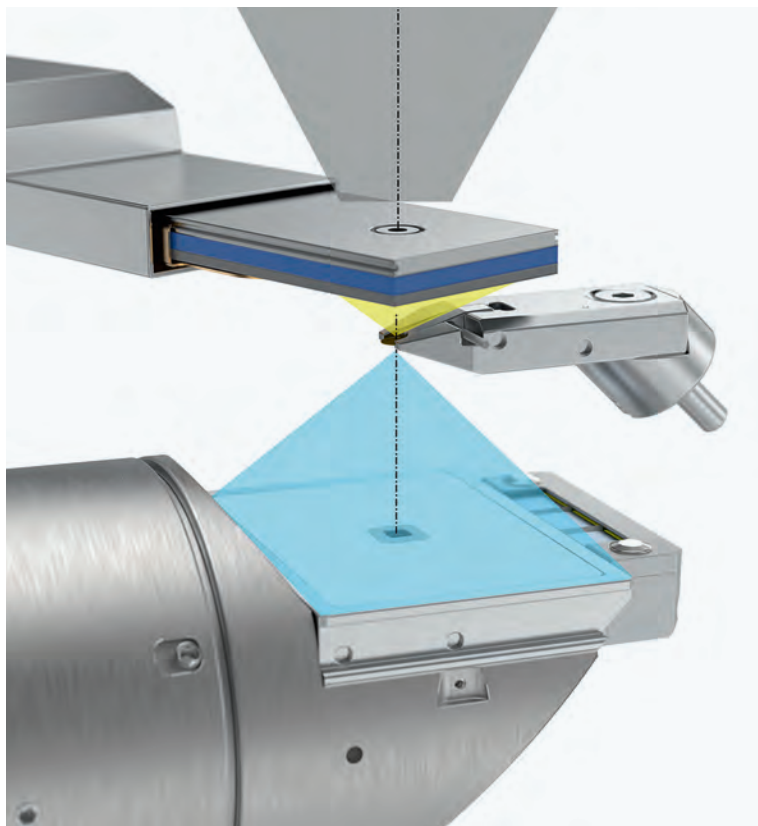
Combined EDS and TKD measurements are ideal for characterizing less-understood samples containing multiple crystallographic phases, e.g. precipitates, inclusions, etc.

The combined dataset can be used for offline phase identification and reanalysis, with great efficiency gains enabled by the ESPRIT capability of indexing up to 60,000 patterns/second.



**Figure 3**

False-color ARGUS™ image acquired with a pixel size of 1 nm from a gold thin film. Scale bar represents 50 nm.



**Figure 2**

Geometry setup for simultaneous TKD and EDS measurements with the XFlash® FlatQUAD detector (top), Bruker TKD sample holder (middle) and OPTIMUS 2 detector (bottom).

## Ultrafast visualization of electron transparent samples

OPTIMUS 2 has built-in ARGUS™ imaging capabilities:

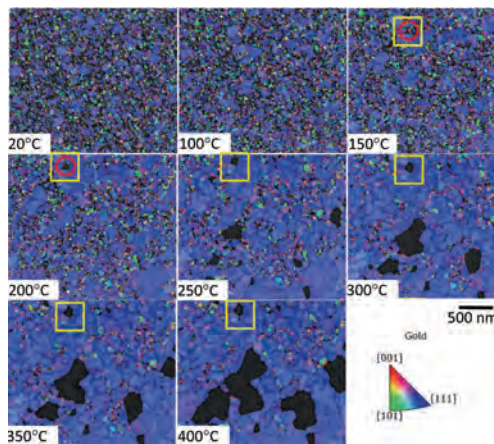
- Three Si diodes for acquiring high quality Dark Field (DF)-like images
- One Si diode at the screen's center to enable Bright Field (BF)-like imaging while in TKD mapping position
- Imaging at speeds of up to 125,000 pixels/second
- Fully automatic signal optimization to create images with unequalled quality and detail.

The new Bright Field (BF)-like imaging capability is particularly useful for drift correction during mapping as well as for near real-time visualization of samples during dynamic experiments like in-situ tensile testing and heating of electron transparent samples.

## Time resolved measurements (TRM) during dynamic experiments

OPTIMUS 2, with its new OPTIMUS Vue screen and the new ESPRIT TRM feature, represents the perfect, must-have combination of tools for in-situ experiments on electron transparent samples. Acquisition and saving of BF-like images and TKD maps is automatic and repeated for a user-defined duration of time, thus facilitating the capture of all-important microstructural changes happening during very dynamic experiments like in-situ heating and electrical biasing.

The ESPRIT TRM feature is also critically important for capturing changes in the microstructure of electron transparent samples during in-situ tensile testing performed with the Hysitron PI 89 PicoIndenter.



**Figure 4**  
Evolution of microstructure in a gold thin film revealed by a series of 8 orientation maps acquired at various temperatures from the same location on the sample. Results are courtesy of Alice Bastos Fanta, DTU Nanolab in Copenhagen, Denmark (<https://doi.org/10.1016/j.matchar.2018.03.026>).

## Specifications

- Effective spatial resolution down to 1.5 nm (dependent on SEM type, vacuum quality and room environment, e.g. vibrations, acoustics, etc.)
- Mapping speed: up to 520 patterns/second
- 3 + 1 Si diodes for DF-like and BF-like imaging at up to 125,000 pixels/second
- Automatic ARGUSTM signal optimization in ESPRIT software
- Low probe current operation (less than 2 nA even for high-speed mapping)
- Operating beam voltages: 5 kV – 30 kV
- Compatible with all eFlash detectors
- User replaceable phosphor screens
- High performance phosphor screen optimized for maximum signal efficiency and minimal beam interference
- Seamless combination with Hysitron PI 89 PicoIndenter for observation of electron transparent samples during in-situ tensile testing experiments

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