Advanced Applications of SEM-Based Electron Diffraction Techniques

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The scanning electron microscope (SEM) offers two complementary electron diffraction techniques, namely electron backscatter diffraction (EBSD) and electron channelling contrast imaging (ECCI). Both techniques are known since several decades and have developed the SEM into one of the most powerful tools for characterization of microstructures of crystalline materials. Disregarding the several decades of history, SEM diffraction techniques still undergo intensive developments, ever expanding them into new fields of application. We will mention in our talk some selected areas of development:

(i) Large area EBSD scans at high resolution allow statistically significant characterization of textures and phase fraction with similar or even better accuracy than x-ray diffraction can do.

(ii) The combination of EBSD-based orientation microscopy with serial sectioning using a focused ion beam (FIB) instrument enables comprehensive 3-dimensional materials characterization where for example grain boundaries and deformation structures can be described in a comprehensive and accurate manner.

(iii) The increase of angular resolution of EBSD measurements using pattern cross-correlation enables the determination of local elastic stresses and the description of small plastic strain by accurate characterization of geometrically necessary dislocations (GND).

(iv) The combination of ECCI and EBSD creates a new technique called “ECCI under controlled diffraction conditions, cECCI”. This technique enables a surprisingly high quality of high resolution lattice defect observations, including individual dislocations, stacking faults and nano-twins. The cECCI technique extends the SEM towards fields of research which were formerly exclusive TEM domains with the additional advantage that large areas and bulk materials can be observed.