Emerging Techniques in Modern Microscopies

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Energy Filtered Imaging with the energy selecting in-lens Duo detector

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In SEM imaging, secondary electrons (SE) and backscattered electrons (BSE) of different energies are carrying different information, for example on the escape depth in the material and on the material itself [1]. Energy selective detection of SE and BSE in conventional SEM columns requires complex, separate detector systems. The Carl Zeiss In lens Duo detector is a compact in lens detector for the GEMINI SEM column that uses a tunable retarding grid to select, for instance, low loss BSE or high energy SE for image formation. In this study it is shown how the Carl Zeiss In lens duo detector can be used to select electrons depending on their energy for the image formation. Filtering Secondary electrons: High energy SE Energy filtering is achieved by setting the grid voltage of the in lens duo detector to different values and obtaining energy filtered SEM images (Fig.1 to 3). Contamination is a common and unwanted imaging artifact (Fig. 1) in the SEM. The use of a filtering detector can minimize this effect by selecting a mixed signal from high energy secondary electrons and back scattered electrons. In Fig 2 the energy selecting grid is set up to allow only high energy SEs and additionally all BSEs to form the energy filtered image. Using the in lens Duo detector this way enables a variation of the BSE and SE signal component with only one detector. The high energy component of the SEs is less effected by the sample surface[4]. Other examples can be found in recent publications. In a quantitative approach a variation of the detected electron is achieved by a systematic variation of the grid voltage and subsequent image acquisition. By simply subtracting those images from each other, topographic and material contrast can be separated in the resulting energy pass band filtered images [2] The Gemini lens has a unique property of spectroscopy due to the imaging of the secondary electrons onto the in lens detector. The dispersion caused by the chromatic aberration can be used for imaging p,n junctions [3] with secondary electrons. Filtering Backscattered electrons: Low loss BSE The underlying spectroscopic information of the low loss BSE imaging results in a strong material contrast (Fig3). Especially the energy filtering properties under low loss BSE imaging conditions were explored by H. Jaksch [1] and contrasts were shown which can not be explained with the common BSE contrast mechanism. In conclusion the In lens duo detector can be used as an energy filtering detector like the EsB detektor. It is capable of low loss BSE imaging and it can be used to select high energy SE for suppressing contamination effects in the SEM image.

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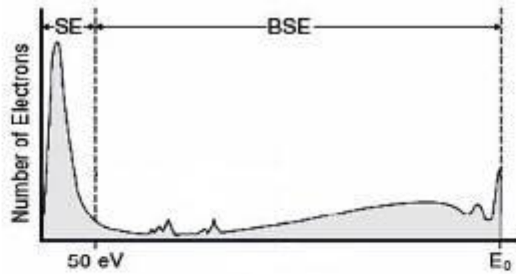


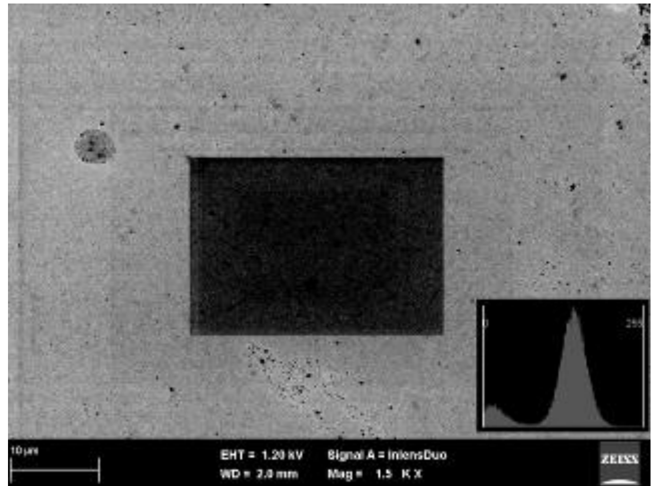
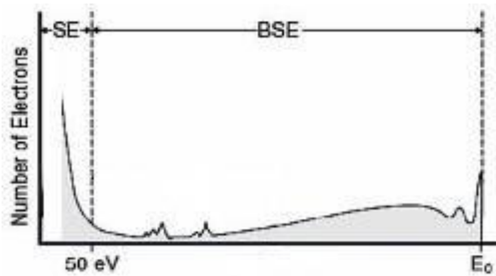


Figure 1. Schematic Spectrum of emitted electrons.(left) Unfiltered image of a Tungsten carbide sample using all the electrons from the spectrum. This imaging conditions are clearly showing a contaminated area in the middle of the image (right).



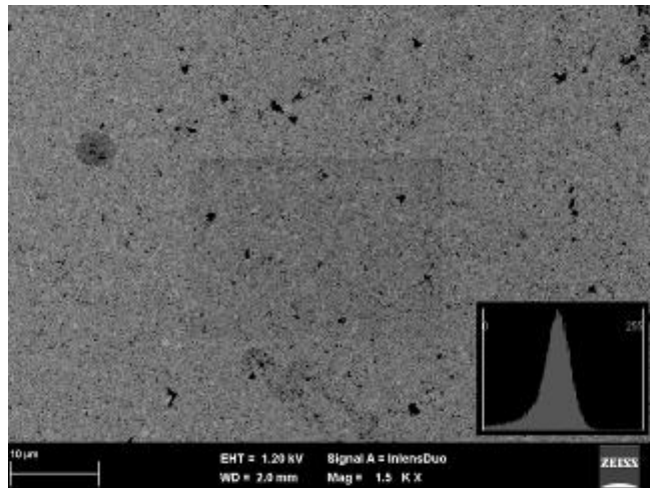
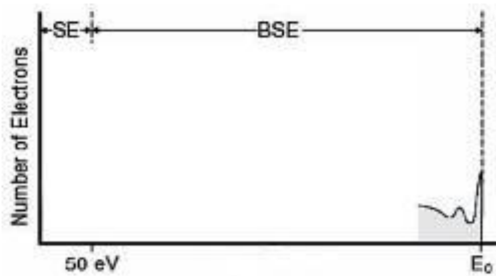


Figure 2. The low energy SEs are cut off by the in lens Duo detector (left).By simply applying a grid voltage only high energy SEs and all BSEs are used for imaging. The filtered image is less effected by the contamination (right).



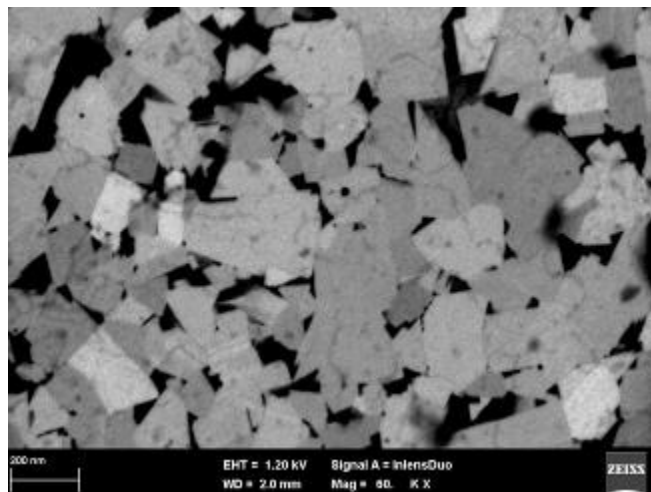


Figure 3. In this Experiment only low loss BSEs are used for imaging the Tungsten carbide sample (same as in Fig 1 and 2), providing a good material contrast (right).