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Means of mitigating the limits to characterization of radiation sensitive samples in an electron microscope.

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The scattering of the fast electrons by a sample in the transmission electron microscope (TEM) results in a measurable signal and also leads to sample damage. In an extreme case, the damage can be severe and can proceed faster than data can be collected. The fundamental limit on whether a measurement can be performed is set by the interaction cross section and collection efficiency for the desired signal and by the total damage cross section. Mitigation strategies involve selecting the strongest possible signal, modifying the microscope optics and hardware to maximize the collection efficiency and preparing the sample in a way that maximizes the signal. A major recent breakthrough is the practical implementation of Zernike-like imaging in a TEM. The Zernike-like imaging in a TEM increases the contrast by a factor of two to four compared to conventional bright field TEM. The corresponding decrease in the irradiation dose needed to obtain desired signal to noise ratio translates either to higher resolution in the images or less damage to the sample at the same resolution. The mechanism utilized in this case is the local charging of an uniform thin film placed in the back focal plane of the objective lens of a TEM. The application of the Zernike-like imaging in TEM range from imaging of magnetic fields in vacuum to imaging of DNA strands.

Author: MALAC, Marek

Presenter: MALAC, Marek

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