Cryo-scanning transmission electron tomography of vitrified cells provides morphological and analytic information simultaneously

S.G. Wolf[1]*, P. Rez[2], D. Kirchenbuechler[3], Y. Mutsafi[4], B. Horowitz[4], L. Houben[1], D. Fass[4], M. Elbaum[3]

[1]Weizmann Institute of Science, Chemical Research Support, Rehovot Israel
[2]Arizona State University, Department of Physics, Tempe AZ, USA
[3]Weizmann Institute of Science, Department of Materials & Interfaces, Rehovot Israel
[4]Weizmann Institute of Science, Department of Structural Biology, Rehovot Israel

sharon.wolf@weizmann.ac.il

* Corresponding Author

Keywords: *cryo-electron tomography, cellular structure, scanning transmission electron microscopy, elemental analysis*

Tomography of intact, vitrified cells and tissues is an integral part of a multidimensional approach to structure/function studies in cell biology. Tomography using zero-loss energy-filtered transmission electron microscopy (zl-cryoTEM) allows for 3D imaging of vitrified tissue with sample thickness below ~300 nm. The limitation is due primarily to the mean-free path for inelastic electron scattering of biological material, which causes a severe loss of signal for thicker specimens. Severe damage to the sample from beam interaction precludes increasing dose to compensate.

We recently demonstrated that cryo-scanning transmission electron tomography (CSTET) provides tomographic reconstructions of vitrified cells with superior information transfer at high tilts and for thicker specimens than for zl-cryoTEM tomography (Wolf et al., 2014). Moreover dynamic focusing of the rastered beam provides in-focus imaging even far from the tilt axis. The STEM modality allows for selection of data collection from specific scattering angle ranges, and thus it is possible to highlight phosphorous, calcium or other heavy atoms embedded in biological specimens, and indeed even to quantify the amount of that element, while still maintaining the sample in the vitrified state.