3D X-ray microscopy for imaging in Material and Life sciences

Nicolas Gueninchault

X-ray microscopy (XRM) is a powerful sub-surface imaging technique that reveals the three-dimensional microstructure from a range of materials, non-destructively. Laboratory-based X-ray sources have been coupled with high resolution X-ray focusing and detection optics from synchrotron-based systems to acquire tomographic datasets with resolution down to 50 nm across a great span of sample dimensions [2]. More recently significant advances in lab sources that produce increased X-ray flux at improved source stability have enabled faster data acquisition, albeit quite slower in comparison to what the current state-of-the-art at synchrotrons is.

ZEISS 3D X-ray microscopes enable a diverse range of new studies in the life sciences, from observing unstained soft tissues to analyzing new biomaterials at the highest yet achievable resolutions, from the micron to nanometer scale. We will review recent technological developments within X-ray microscopy (XRM) for life sciences and consider a diverse range of applications including developmental biology and soft tissue imaging, bone science, and biomaterials.

The non-destructive nature of X-rays has made the technique widely appealing, with the potential for characterizing sample changes in “4D,” delivering 3D microstructural information on physically the same sample over time, as a function of sequential processing conditions or experimental treatments. Additionally, newer contrast modalities such as laboratory based X-ray diffraction contrast tomography has recently become available; allowing the nondestructive routine characterization of 3D crystallographic information on polycrystalline materials in a commercial laboratory X-ray microscope.