Progress and prospects in coherent x-ray diffraction microscopy

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In this presentation we will briefly review the history and roots of Coherent x-ray diffraction microscopy (CXDM) and provide an introduction to the principles on which this increasingly popular technique is based. The motivation for developing a new imaging method must always be that it will enable important and otherwise impractical new investigations to be carried out. In the case of CXDM the new challenge that is already beginning to be met is to image objects in the one to about twenty micron size range in three dimensions at a resolving power of around 1000´1000´1000 voxels. Such objects are too big to be imaged at good resolution in the transmission electron microscope while their features are too small to be imaged in the light microscope. Nevertheless, success in this type of imaging will have a decisive impact on the growing activities of nano-science and nano-technology.

We provide a report of the progress in CXDM at the Advanced Light Source (ALS) and describe 3D imaging experiments in which radiation-hard objects of about 2 microns width were imaged at about 10 nm resolution. We also report significant progress in the more difficult task of applying CXDM to imaging frozen-hydrated biological samples.

Our efforts to develop the CXDM technique at the ALS have not gone unnoticed and the ALS community has decided to give highest priority to further develop the technique. Thus we are planning a major new initiative to install a new undulator and beam line on the ALS storage ring with advanced new experimental stations and infrastructure. We report our analyses of the scientific and technical issues involved in mounting this new project and in particular, we give discussions of our choices for the x-ray energy, spectral bandwidth, spectral flux and spatial coherence. We also give the conclusions of our study of the role of radiation damage in limiting the resolution of 3D experiments on frozen hydrated biological samples.