Table-Top X-ray Microscopy

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Abstract

X-ray microscopy in the water-window region (λ = 2.3-4.4 nm) is an attractive technique for high-resolution imaging. In this wavelength region state-of-the-art optics has demonstrated sub-20 nm resolution and the sample preparation techniques are maturing. Unfortunately present operational x-ray microscopes are based on synchrotron radiation sources, which limit their accessibility. Many biological investigators would benefit from having the x-ray microscope as a tool among other tools in their own laboratory. For this purpose we recently demonstrated the first compact x-ray microscope with sub-visible resolution.[1]

In this presentation we will describe a recently developed, flexible, compact x-ray microscope featuring operation at λ = 3.37 nm and λ = 2.48 nm. The microscope is based on a 100 Hz liquid-jet-target laser-plasma x-ray source, condenser optics, diffractive zone plate optics and CCD detection. The microscope can be operated at λ = 3.37 nm with a methanol-liquid-jet laser plasma[2] and a normal-incidence multilayer condenser[4]. With this arrangement we have resolved 40 nm L/S Ni gratings with good contrast at exposure times of ~1 min, a significant improvement compared to previous compact microscopes. This operation mode provides good contrast for thin carbon-containing objects. However, imaging of thick biological objects require operation in the lower part of the water window. Here we employ a liquid-nitrogen-jet laser plasma (λ = 2.48 nm)[3]. Since present normal-incidence multilayer mirrors neither have the required reflectivity nor the necessary uniformity at this wavelength instead a zone plate condenser[5] will be used. The sample holder will initially be positioned in a helium atmosphere with silicon nitride membranes separating it from the vacuum in the condenser and imaging module. The holder enables both dry and wet sample handling with simple sample replacement. Future systems will include cryo sample stages.

References

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