L-16 **Wed. 18. 06., 10^{20}-11^{00}**

High-resolution x-ray phase contrast microscopy with tender X-rays

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X-ray microscopy bridges the gap between light microscopy with a spatial resolution of about 500 nm and electron microscopy with resolutions down to 2 nm investigating biological samples. The strength of X-ray microscopy is the much higher penetration depths of X-rays compared to electrons which makes X-ray microscopy the ideal tool for 3D structure determinations in tomographic mode.

X-ray microscopy with biological samples is commonly performed with soft X-rays at energies around 500 eV in the so called water window between the K-absorption edges of carbon and oxygen. Thus it provides it very good absorption contrast. A major drawback of soft X-ray microscopy is the small depths of field which limits the isotropic resolution which can be achieved in tomographic experiments.

This limitation can be overcome by using X-rays with higher energies where samples become more transparent. Zernike phase contrast microscopy is a powerful technique for such samples which provide small absorption contrast only [1] and has been also successfully applied to X-ray microscopy [2].

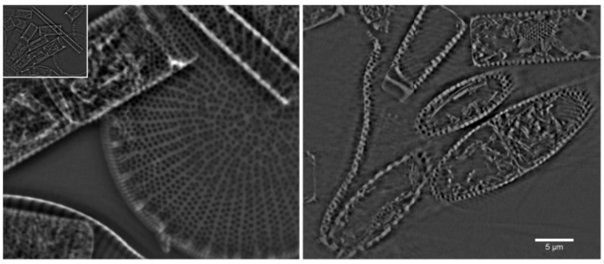

Figure 1. 2D radiography (left) and virtual slice (right) from the reconstructed tomographic volume of a fossile diatom obtained by X-ray Zernike phase contrast microscopy.

At beamline P11 at the PETRA III synchrotron in Hamburg (DESY) we have recently implemented a setup for X-ray Zernike phase contrast working with X-ray energies around 6.2 keV. We are currently working on an advanced setup which will be operated in vacuum at tender X-rays around 4 keV at a spatial resolution around 25 nm.

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[2] U. Neuhaeusler *et al.*, *J. Phys. D* **36** (2003) A79.

L-17 **Wed. 18. 06., 11^{30}-12^{10}**

Extreme ultraviolet and soft X-ray imaging with compact, table top laser plasma EUV and SXR sources

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Imaging with high spatial resolution is crucial in the development of nanotechnology. Manipulation of matter at the nanometer scale and the possibility of subsequent or "in situ" verification of the results of this manipulation are very important in these days, in which the direction of the development of science and technology is determined by the aspirations of the semiconductor industry, manifested in the possibility of producing ever smaller structures and more efficient devices. These aspirations of the computer industry translate well to other scientific fields such as nanotechnology, biology or materials science.

In this paper we present an overview of imaging techniques employing short wavelength extreme ultraviolet (EUV) and soft X-ray (SXR) compact, laser-plasma sources. The techniques, presented in this work, are EUV and SXR ("water-window") microscopy, EUV shadowgraphy and its direct extension to EUV tomography technique, capable of visualizing 3-D objects. EUV and SXR microscopy, employing photons with a wavelength of the order of nanometers to tens of nanometers, has a number of advantages compared to the widely used optical microscopy. It allows rendering images of objects, with spatial resolution better than 100nm, with shorter exposure times and high optical contrast in the short wavelength range, to gain additional information about the object.

At the Institute of Optoelectronics so far two experimental microscopes were developed, the first in the EUV range that is able to capture the magnified images of the objects with sizes less than 100nm [1], and the second one in the range of SXR, in the so-called "water window", which could render images of objects with sizes of about 1 micron, but allowing to obtain a high optical contrast for the observation of biological materials and samples having a relatively thickness of 40 microns [2]. Experimental microscope systems are extremely compact. Both of them can fit on top of the optical table 1.2x1.8m^2 in size. These systems have been used for imaging different samples, demonstrating the usefulness of EUV and SXR radiation for microscopy. Through the use of optical contrast in the field of EUV and SXR is possible to obtain additional, complementary information on the same sample, not available directly from the images from the optical microscopes and SEM, with better spatial resolution than in the case of optical microscopy.

It should be emphasized that there are a few constructions of this kind in the world, and to our knowledge, these are the only experimental microscopes of this type in Poland. These devices have a high chance of future commercialization and many potential applications in nanotechnology, biology and industry. In addition EUV and SXR microscopes in the near future may be implemented in form of beamlines, or "end-station", as imaging devices for Polish synchrotron SOLARIS, Cracow, or free electron laser POLFEL in Swierk, near Warsaw.

EUV shadowgraphy or radiography is well established technique capable of obtaining projection images of semitransparent or opaque objects. We used it here to investigate and optimize the gaseous targets for applications in laser-matter interaction experiments [3, 4].

An extension of this technique to 3-D is EUV tomography at 13.5nm lithographic wavelength recently reported in [5], where a set of angularly equidistant radiograms – projections were acquired and combined to produce a 3-D representation of a multi-jet gas puff target for potential applications in high order harmonic generation.

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