Nanoscale Imaging using a Compact Laser Plasma Source of Soft X-rays and Extreme Ultraviolet (EUV)

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Abstracts: *Application of a compact laser plasma source of soft X-rays and extreme ultraviolet (EUV) in imaging with nanometer resolution is demonstrated. The source is based on a gas puff target irradiated with nanosecond laser pulses from a small commercial Nd:YAG laser. Soft X-ray radiation in the 'water window' range and EUV near 10nm is generated efficiently without production of target debris. Nanoscale imaging of biological samples as well as micro- and nanostructures using transmission soft X-ray and EUV microscopy based on Fresnel optics and soft X-ray contact microscopy is demonstrated.*

Soft X-ray and EUV microscopy provides information complementary to that obtained from optical, electron and atomic force microscopy techniques. Imaging of cellular structure and extended tissue in biological samples requires nanometer resolution and good sample penetration. It can be provided by current soft X-ray microscopic techniques operating in the 'water window' spectral range (wavelength: 2.3–4.4 nm; photon energy: 280–560 eV). The various techniques include transmission and scanning soft X-ray microscopy, 3D tomography, and soft X-ray contact microscopy. In this work a transmission soft X-ray microscope with a Fresnel zone plate and a contact soft X-ray microscope are presented. The microscopes are based on a compact laser plasma source with a double-stream gas puff target irradiated with a nanosecond laser pulses from a small Nd:YAG laser (4 ns/0.8J/10 Hz). The microscopes have been used for imaging of hydrated and dry biological samples with resolution less than 100 nm and relatively short exposition time.

Interest to nanoscale imaging in EUV spectral range is mainly connected with development of tools for inspection of masks for EUV lithography, however, it can be also useful for investigations of micro- and nanostructures, including nanowires and magnetic nanostructures. In this study a newly developed stand-alone desk-top EUV microscope is presented. The microscope is also based on a compact laser plasma EUV source and Fresnel optics. The experiments on imaging of different objects were performed and the spatial resolution below 50 nm was demonstrated. It was shown that the EUV microscopy can provide structural information that is not achievable by conventional optical or scanning electron microscopy techniques.