OPTICAL COHERENCE TOMOGRAPHY (OCT) WITH 2 NM AXIAL RESOLUTION USING A COMPACT LASER PLASMA SOFT X-RAY SOURCE

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Optical coherence tomography (OCT) is a well-established interferometric imaging technique providing high resolution cross-sectional views of objects (tomograms). The axial resolution of OCT is limited to about 1 µm when using infrared and optical wavelengths. An obvious way to improve the resolution is to shorten the wavelength of the probing light. Optical coherence tomography using broad bandwidth radiation in the nanometer spectral range (extreme ultraviolet and soft X-rays) has been proposed and demonstrated recently. This variant of OCT, referred to as XCT, allows for a reduction of the axial resolution from micrometers to a few nanometers. The XCT imaging with an axial resolution better than 8 nm was demonstrated using extreme ultraviolet and soft X-rays from a synchrotron. Tomographic imaging with an axial resolution of about 22 nm has been recently demonstrated using extreme ultraviolet from a laser-driven light source based on high-order harmonic generation (HHG). In this paper we present preliminary studies on XCT using broadband soft X-ray radiation from a compact laser plasma light source. The laser plasma was created as a result of interaction of nanosecond laser pulses with a gaseous target in a double-stream gas puff target approach. The use of the gas puff target instead of a solid allows to avoid the target debris problem associated with laser ablation of a solid material. The laser plasma source was optimized for efficient soft X-ray emission from the krypton/helium gas puff target in the spectral range from 1.5 nm to 5 nm. The coherence parameters of the soft X-ray radiation made possible to perform the XCT measurements of a bulk multilayer structure with 10 nm period and 40 % bottom layer thickness to period ratio, with an axial resolution of about 2 nm and detect multilayer interfaces up to a depth of about 100 nm. The experimental data are in agreement with OCT simulations performed on ideal multilayer structure. In the paper, detailed information about the source, its optimization, the optical system, XCT measurements and the results are presented and discussed. Planned works aimed at obtaining 3-D images using a compact laser plasma soft X-ray source will be shown.