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Developing high numerical aperture EUV Lithography at FELs

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Extreme ultraviolet lithography (EUVL) is considered to be the future method of mass production of integrated circuits on chips. For long time, Free-Electron Lasers (FELs) have been proposed to accomplish the challenges of EUVL, i.e., a suitable power optical light source and the scanning speed of the wafer. According to this, we developed a two-steps EUVL experiment at FLASH using a Schwarzschild objective:
First, the Schwarzschild objective (SO) is aligned using at-wavelength wavefront sensor optimized for beams with a high numerical aperture. The phase measurements acquired with the wavefront sensor were analyzed using Fourier Demodulation (FD), an approach based on Fourier transformation analysis of repeating patterns. FD can recover the phase and the intensity and overcomes the measurement challenges of a SO pattern: 1) a huge magnification downstream the focus with attendant spherical aberration; 2) an obscuration of the central area; and 3) a discontinuous annular pattern divided into three lobes.
Secondly, the micrometer-sized focus of the Schwarzschild is used to demonstrate imaging. The Schwarzschild objective is used here in an on-axis geometry to image transparent samples on photosensitive material. Based on ray tracing, it is expected that the imprinted structures will have a resolution of approximately 100 nm (RMS focus-size). We will investigate state-of-the-art EUV components related to EUVL such as multilayer mirrors and photoresists submitted to intense EUV radiations.
Here the methods used in the first and the second step of this experiment will be presented and the results of the measurements will be discussed.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?

yes

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