Improved performance of a table-top actinic full-field microscope with EUV laser illumination

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We present the most recent results on a table-top actinic aerial microscope capable of imaging absorption defects on EUVL masks with a half-pitch spatial resolution of ~55 nm.
In this zone plate-based microscope, the images are generated by guiding the output of a compact EUV laser emitting at 13.2 nm by a Mo/Si multilayer coated flat mirror onto a condenser zone plate which focuses the light onto the sample at an angle of incidence of 6 degrees. The reflected light is collected by an off-axis zone plate objective, forming an image on a back illuminated CCD detector located parallel to the sample.
Our previous setup was based on a 1 μW average power Ni-like cadmium EUV laser with highly monochromatic pulses ($\Delta\lambda/\lambda < 1x10^{-4}$) and an average spectral brightness of brightness of $\sim 4\times10^{12}$ photons $mm^{-2}mrad^{-2}s^{-1}(0.01\%BW)^{-1}$. The condenser had an outer zone width of 100 nm and a diameter of 5 mm, with a working distance of ~40 mm at 13.2 nm wavelength. The off-axis objective zone plate had a diameter of 120 μm and a focal distance of ~1 mm at this wavelength. Its numerical aperture (NA=0.061) was chosen to emulate the imaging characteristics of a typical 4× stepper (NA = 0.25) used for EUV lithography. With this setup, images of a test pattern were obtained with exposure times of 20 seconds at a magnification of ~610× with each pixel on the CCD corresponding to 22 nm in the sample plane. The images had a measured spatial resolution of 55 nm and a field-of-view of $\sim 5\times5$ μm^2.
We will now present results following extensive upgrades to the microscope in order to improve the quality of the images in terms of illumination uniformity and reduce image exposure time.

These upgrades include a 10×-fold increase in the output of the table-top EUV laser and the design of new condenser zone plates for higher control on the uniformity of the illumination. The characteristics of this actinic imaging tool will be discussed in relation to the requirements established for EUVL mask inspection.

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