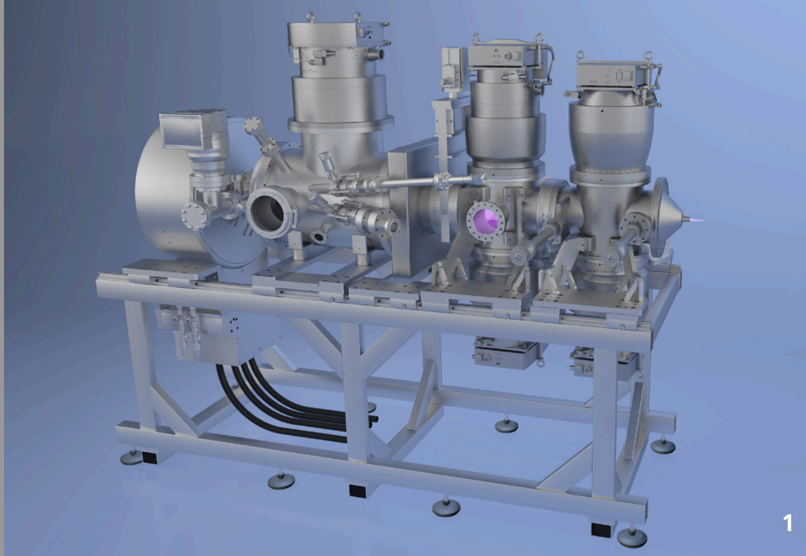

Subject to alterations in specifications and other technical information. 06/2022.

IRRADIATION SYSTEM FOR THE DEVELOPMENT OF OPTICAL COMPONENTS IN THE EXTREME ULTRAVIOLET

Task

The development of optical systems and components for extreme ultraviolet lithography (EUVL) requires lifetime tests at the operating wavelength around 13.5 nm and intensities that also occur during operation of the lithography systems. The thermal load capacity or the wear caused by EUV-induced contamination of the components can thus be determined and improved or reduced by suitable measures such as special coatings.

Method

The main components of the testing system are an EUV radiation source developed by Fraunhofer ILT, which is based on a xenon gas discharge, and a grazing-incidence collector with the sample to be irradiated at the focal point. When dimensioning the collector, Fraunhofer ILT had to take several requirements into account: spot size, average power, peak intensity and incidence angle as well as the volumetric emission properties of the beam source. Unbiased experimental conditions need a suppression of the working gas flow into the irradiation chamber to about 10^{-5} mbar l/s. Supported by Monte Carlo simulations of molecular flow in vacuum, the institute developed a differential pumping system to achieve this goal. The radiation source has an average EUV power of up to 700 W/2πsr in a spectral range of 10–18 nm (broadband). Of this, a radiation power of up to 40 W/2πsr is emitted in the region of particular interest for EUV lithography, around 13.5 nm in a spectral bandwidth of 0.27 nm (inband). The pulse repetition rate of the EUV source is up to 2500 Hz.

Results

The developed system consisting of source, collector module and pressure stage delivers an average irradiation power of up to 40 W/cm² (broadband) and about 4 W/cm² (inband) around a central wavelength of 13.5 nm with a spot diameter of 1.6 mm. A modified optical system allows the approximately homogeneous irradiation of an area with a diameter of about 4 mm at a correspondingly lower intensity. With differential pumping, a pressure of less than 10–7 mbar can be achieved at the sample position, minimizing interfering influences from residual gas contamination during the examination.

Applications

A spectral range from about 2 nm wavelength to the extreme ultraviolet at about 20 nm is covered when the operating parameters of the source and the collector are adjusted. The main field of application currently lies in lifetime tests of components for EUV lithography using an irradiation around a central wavelength of 13.5 nm.

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1 Source-collector system for irradiation experiments in the extreme ultraviolet.

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