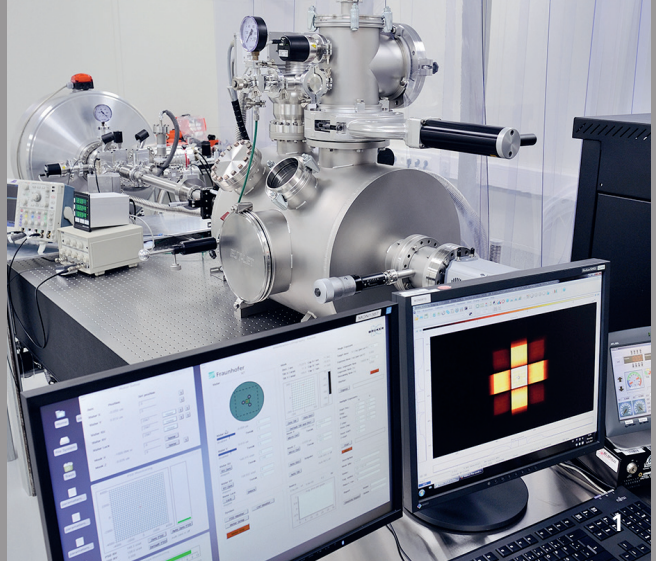

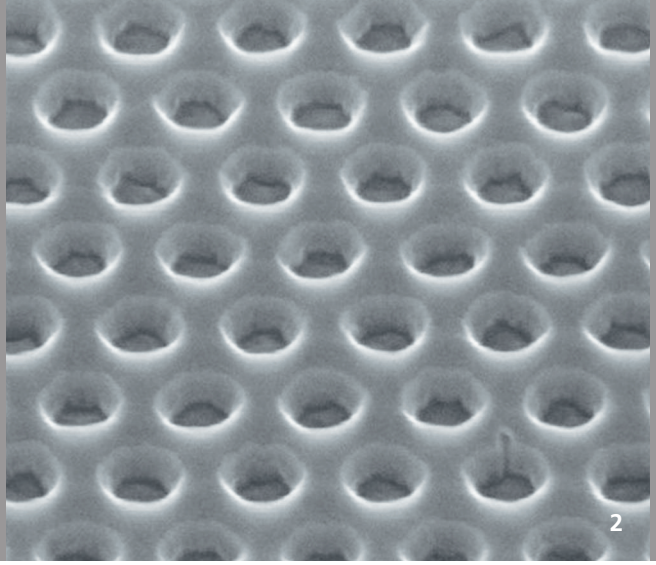

HIGHLY EFFICIENT TRANSMISSION GRATINGS FOR EUV APPLICATIONS

Task

Highly efficient transmission gratings are needed for spectroscopic and lithographic applications in the extreme ultraviolet radiation range (EUV wavelengths: 5 nm to 50 nm). The production of these special optical elements requires a suitable material selection and grating geometry. When the phase shift and absorption in the grating material are taken into account, intensities of the individual diffraction orders can be adjusted to the respective application. The periodicity of the lattice structures directly influences the achievable spectral resolution in spectroscopy and the minimum feature size in lithographic methods.

Method

The manufacturing process is based on the structuring of a polymer with electron-beam lithography. To achieve the required high aspect ratio for nanoscale structures, the processing is carried out on an ultrathin support membrane. Thus, it is possible to generate grating periods of 60 nm for line gratings and hole arrays over areas of several square millimeters. With an optimized grating design, diffraction efficiencies of over 50 percent have been achieved. The EUV Laboratory Exposure Tool (EUV-LET) can be used to characterize fabricated transmission masks. The intensities of the produced transmission masks can be measured down to the second diffraction order and the real grating efficiency and geometry calculated. Due to the high diffraction efficiencies, the transmission gratings produced are particularly suitable for interference lithography. With EUV-LET, these transmission gratings demonstrated a record resolution of 28 nm using achromatic Talbot lithography.

Results

The design, fabrication and characterization of customized, high-efficiency transmission gratings has been optimized for various EUV applications with a line density of up to 16,500 lines/mm.

Applications

These transmission gratings can be used for high-resolution spectroscopy and nanoscale lithography in research and industry.

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1 EUV Laboratory Exposure Tool (EUV-LET).

2 Hexagonal hole grating (period = 200 nm, SEM image).

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