Grid-based holograms for matter waves lithography: fabrication parameters and resolution

Veronica P. Simonsen[1], Ingve Simonsen[2,3], Bodil Holst[4]

[1])PoreLab, NTNU – Norwegian University of Science and Technology, NO-7491 Trondheim, Norway
[2]) Department of Physics, NTNU Norwegian University of Science and Technology, NO-7491 Trondheim, Norway
[3])Surface du Verre et Interfaces, UMR 125 CNRS/Saint-Gobain, F-93303 Aubervilliers, France
[4]) Department of Physics and Technology, University of Bergen, Allégaten 55, NO-5007 Bergen, Norway

Grid-based binary holography (GBH) is an attractive method for patterning with light or matter waves. It is an approximate technique in which different holographic masks can be used to produce similar patterns. Mask-based pattern generation is a critical and costly step in microchip production. The next-generation extreme ultraviolet- (EUV) lithography instruments with a wavelength of 13.5 *nm* are currently under development. In principle, this should allow patterning down to a resolution of a few nanometers in a single exposure. However, lithography with metastable atoms has been suggested as a cost-effective, less-complex alternative to EUV lithography. The great advantage of atom lithography is that the kinetic energy of an atom is much less than that of a photon for the same wavelength. Until now no method has been available for making masks for atom lithography that can produce arbitrary, high-resolution patterns.

Here we present the resolution that can be achieved when making binary masks to create patterns in a target plane close to the mask with the use of an atom source. Through simulations, we investigate the diffraction and ideal size of the patterns formed by holographic masks using Bose-einstein condensates in an experimental setup. Our calculations are now being extended to consider all experimental key features.