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Shape-Tuning of Ultra-Shallow EUV-Diffraction Gratings Fabricated via Ion Irradiation

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The operation of diffraction gratings in the EUV range frequently requires structures with heights in the range of a few nanometres. This is challenging to achieve via conventional etch processes, as those are often characterized by high rates of material removal. Hence, it is necessary to develop methods for fast and cost-efficient fabrication of such gratings. For this purpose, we utilize volume changes in solid materials after the irradiation with ions. So far, techniques relying on similar effects were limited to areas in the µm2 range [1]. We improve upon this by utilizing a broad ion source which allows us to achieve lateral scales of structured areas in the range of several tens of cm2.
During experiments, the whole sample is irradiated through a mask of photoresist directly attached to the sample surface. This mask was fabricated utilizing character projection electron beam lithography [2]. It shields part of the sample by decelerating impinging ions and enables the utilization of a broad ion beam. Compared to a direct write process with a focussed ion beam this reduces the writing time by at least two orders of magnitude.
In first systematic studies we investigated silicon irradiated with a broad beam of 30 keV helium ions for fluences ranging from 1016 to 1017 ions per cm2. Atomic force microscopy (AFM) was utilized to measure the dimensions of fabricated gratings. These gratings show sinusoidal profiles with heights in the range of 1 to 20 nm (fig. 1). Through variation of the ion species or angle of incidence during the irradiation, we were additionally able to tune the resulting structure shape from sinusoidal to rectangular (fig. 2). In conclusion, we present an easily controllable and reproducible technique to fabricate grating structures of various shapes with heights between 1 and 20 nm.

I plan to submit also conference proceedings

Yes

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