Diffraction gratings fabricated by dynamic-exposed holography with a phase mask

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Diffraction gratings play important roles in basic research and industrial applications. Besides diffraction efficiency, the stray light level of gratings attracts increasing attention in the fields including high-end spectrometers, metrology, and so on. The line edge roughness (LER) of grating ridges contributes to the level of stray light of gratings. Much investigations concentrated on the simulation and characterization of the effect of the LER on the level of stray light. However, the fabrication method of gratings with smooth line edge are still limited and always anticipated. Earlier, during the investigation of the fabrication of soft X-ray varied-line-spacing gratings by using near-field-holography with an electron-beam-lithography-written phase mask [1], we proposed and demonstrated that dynamic-exposed holography [2] have offered great potentials to realize gratings with smooth line edge, which correspondingly reduce stray light level of gratings.

In this contribution, soft X-ray gratings with line density of ~ 3600 lines/mm were fabricated by static- and dynamic-exposed holography, respectively. The characterization data of both gratings indicates that gratings fabricated by dynamic-exposed holography exhibit not only smooth line edge (Fig. 1), smooth side wall, but also improved optical properties, including reduced stray light level, partially suppressed Rowland ghost from the phase mask (Fig. 2), and uniform diffraction efficiency over grating area of 50 mm × 30 mm (Fig. 3). The dynamic-exposed holography is a promising method for diffraction gratings with smooth line edge and improved optical properties.

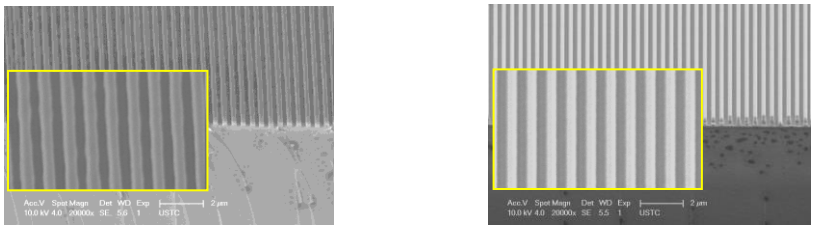

Fig. 1 SEM images of the resist gratings fabricated by (L) static- and (R) dynamic-exposed holography

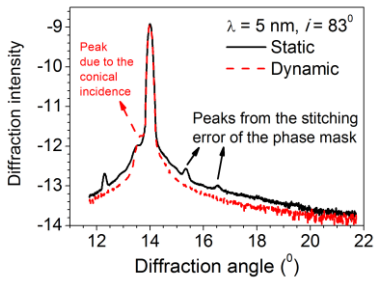

Fig. 2 Measured angular spectra of the diffraction intensity at the 0[th] order of the fabricated gratings as a function of diffraction angle at conical incidence.

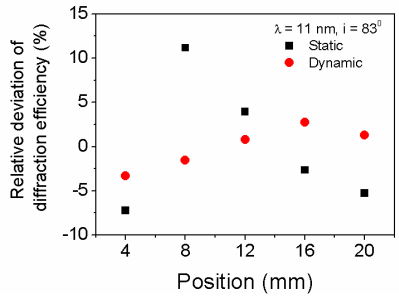

Fig. 3 Relative deviation of diffraction efficiency of the fabricated gratings at different positions along the direction of the grating vectors.

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References

1 Soft X-ray varied-line-spacing gratings fabricated by near-field holography using an electron beam lithography-written phase mask, accepted by *Journal of Synchrotron Radiation*.

2 Reducing Rowland ghosts in diffraction gratings by dynamic exposure near-field holography, *Optics Letters* **43**, 811 (2018).