Calibration of a phase-shifting correcting layer for EUV optics, by in situ interferometry

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In the process of fabrication of mirror optics for EUV lithography, a final step of optics correction is anticipated, which takes place after the deposition of the multilayer coating, in particular because phase defects might be induced by local errors in the multilayer itself. The proposed correction process generally consists of modulating the thickness of an additional "transparent" layer, deposited onto the multilayer. The phase correction is therefore given by δ x thickness (δ, index decrement). However, to be effective, the correction process must use a well known material. Prior calibration is essential, preferably in the very conditions of the real correction process. These include the various parameters of the correcting material deposition, but also the presence of a similar multilayer underneath the layer used for correction. Therefore, the best calibration is obviously in terms of the phase shift produced by a correcting layer, tested in a double pass scheme including the reflection onto the underlying multilayer.

We have implemented such a calibration process by direct interferometry (at 13 nm), on multilayered plane substrates, overcoated with various amounts of the correcting material on selected zones. The interferometric arrangement consists of a Fresnel bimirror interferometer. Interferograms are recorded by a CCD camera. Each record provides a sample fringe pattern which is shifted with respect to a reference fringe pattern, by an amount proportional to the phase shift introduced by the additional layer. The phase shift is extracted from the interferograms by a simple image processing based on Fourier analysis. The estimated accuracy is at least $\lambda/100$ in terms of optical path difference.