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Preparation of microfocusing optics using synchrotron radiation sources

Franco Cerrina
Center for X-ray Lithography, University of Wisconsin, Madison, 3731 Schneider Drive, Stoughton, WI 53589-3097

X-rays are used for microfabrication of high-aspect ratio structures because of their high penetrating power and for microfabrication of integrated circuits because of their very high spatial resolution. An uncommon appli-cation is the development of phase-shifting optics for hard X-rays, where both requirements (high aspect ratio and high resolution) must be met at the same time. In the hard X-ray region (8 keV and up) conventional absorbing binary diffractive optics are very inefficient because of the low contrast of most elements. It is instead possible to achieve very high efficiency using phase-shifting optics. To achieve a phase shift of Pi, several microns of material are needed. At the same time, the spatial resolution is determined by the finest line in the pattern, of the order of 0.2-0.1 μm. This yields aspect ratios of 10-50, posing great challenges to microfabrication because the submicron dimensions require a much more delicate process than that found, for instance, in LIGA. We have overcome these hurdles, and succeeded in manufacturing Fresnel Phase Plates with 0.1 μm smallest features for operation at 8 keV. We use a combination of X-ray and electron-beam lithography to process the masks. In particular, the use of an X-ray aligner, capable of multiple exposures, has allowed us to fabricate multi-level FPPs, with “blazed” zone profile of efficiency approaching 80% in the first order focus. We will review the techniques that are at the basis of our fabrication process, describe our approach, and present some of the most recent results.