Sacrificial structures for deep reactive ion etching of high-aspect ratio kinoform silicon x-ray lenses

This article describes the realization of complex high-aspect ratio silicon structures with feature dimensions from 100 lm to 100nm by deep reactive ion etching using the Bosch process. As the exact shape of the sidewall profiles can be crucial for the proper functioning of a device, the authors investigated how sacrificial structures in the form of guarding walls and pillars may be utilized to facilitate accurate control of the etch profile. Unlike other sacrificial structuring approaches, no silicon-on-insulator substrates or multiple lithography steps are required. In addition, the safe removal of the sacrificial structures was accomplished by thermal oxidation and subsequent selective wet etching. The effects of the dimensions and relative placement of sacrificial walls and pillars on the etching result were determined through systematic experiments. The authors applied this process for exact sidewall control in the manufacture of x-ray lenses that are very sensitive to sidewall shape nonuniformities. Compound kinoform lenses for focusing hard x-rays with structure heights of 200 lm were manufactured, and the lenses were tested in terms of their focusing ability and refracting qualities using synchrotron radiation at a photon energy of 17 keV. A 180 lm long line focus with a waist of 430 nm at a focal length of 215mm was obtained.

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