Development and fabrication of V-grooves on silicon for autoalignment of optical fibers to integrated photonic devices

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Abstract
The objective of this project is to fabricate V-grooves on silicon and use them for the alignment of optical fibers to integrated photonic devices. Anisotropic wet etching will be employed. Subsequent alignment tests will be performed.

Key words:
V-grooves, optical fiber, alignment

Introduction
The recent rise and development of photonic devices have created a need for efficient alignment techniques of optical fibers to integrated devices. The Device Research Laboratory (LPD) - IFGW-UNICAMP currently uses micropositioners for alignment. This project aims to develop and fabricate V-grooves as an alternative method. The grooves will be fabricated on silicon wafers, using anisotropic wet etching. After, fiber-to-fiber coupling tests will be run to test the efficiency of the grooves for aligning.

Results and Discussion
The V-grooves were fabricated on a (100) oriented Si wafer with a thermally grown 500 nm layer of SiO₂ on top of it, using the following steps:

1. Through a spinner, photoresist (AZ3312) is spread uniformly over the wafer. This material is sensitive to UV radiation;
2. A mask with 100 μm wide stripes is placed on the sample. It lets UV light go through the stripes and protects the rest;
3. The sample is exposed to UV light;
4. The mask is taken off and, through a process called revelation, the exposed parts of AZ3312 are removed;
5. The SiO₂ layer suffers an isotropic etching of HF using the photoresist as mask, exposing the silicon;
6. Using SiO₂ as mask, the Si suffers an anisotropic etching of KOH, forming a V-groove due to the selectivity of the etching for the crystalline planes;
7. Finally, the rest of the SiO₂ layer is removed with HF.

The fabrication is illustrated in image 1.

The rate obtained for HF etching was 3.16 ± 0.12 μm/min and for KOH was 2.09 ± 0.08 μm/min. Using these rates, the V-grooves were successfully fabricated.

Image 1. Illustration of the process. The pink region on step 3 represents the area exposed to the UV light.

Conclusions
The project has been developed to implement V-grooves as an effective technique for autoalignment of optical fibers to photonic circuits. In order to fabricate the V-grooves, KOH and HF etching was employed. Etching rate for KOH and HF were determined as 2.09 ± 0.08 μm/min and 127 ± 4 nm/min, respectively. The first V-grooves were successfully fabricated and characterized by optical microscopy.

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