Gratings on MEMS

M. Kuhn[1], C. Kaufmann[1], M. Flaspöhler[2], S. Krönert[3], T. Gessner[1], A. Hübler[2], J. Frühauf[3]
[1] Center for Microtechnologies
[2] Institute for Print and Media Technology
[3] Workgroup Materials in Electrical Engineering and Electronics
Chemnitz University of Technology, Germany

Introduction

Conventional image capturing systems work on the principle of RGB. Most common is the use of a red, green and blue filter to split the colour information. The filters used to separate the incoming light are relatively widebanded. That's why the whole colour space is not recordable with such devices. Promising is another approach, the use of diffractive optical elements like prisms or diffractive gratings. The integration of such elements on top of micro mirrors leads to small image capture devices with an increased colour space [1]. Furthermore the use of such elements in a miniaturised spectrometer was demonstrated [2]. This paper deals with the improvement of the gratings after the release of the first sensors.

Wet etching of blazed gratings in {112} Silicon

A possibility to fabricate micro optical Echelette gratings is the use of chemical wet etching. With utilization of the anisotropic etch behavior of silicon one get geometrically exactly defined shapes [3]. Our application needs a blaze angle of 20°. Therefore a special wafer with a {112} orientation is used. In comparison with a {100} wafer the silicon surface has an inclination of 35,26°. After the etch the embankments perpendicular to the flat have the profile like a saw tooth. They have an inclination of 90° respectively 19,48° (Figure 1 and 2).

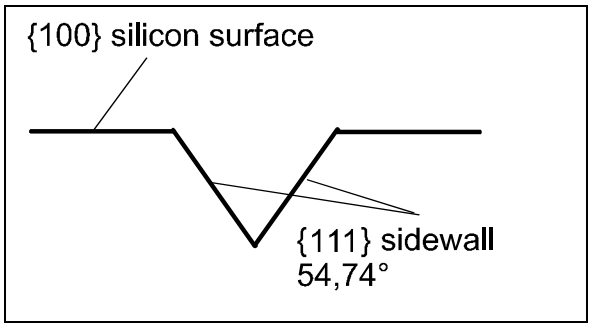

Figure 1: Sidewalls of a wet etched {100} wafer

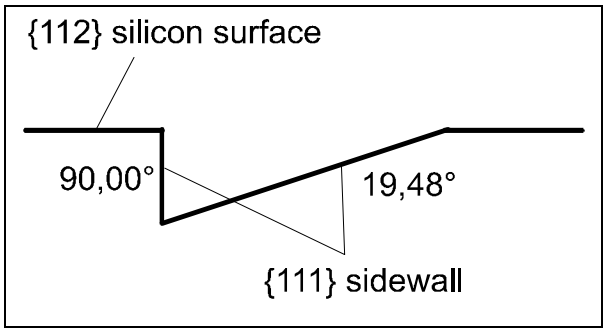

Figure 2: Sidewalls of a wet etched {112} wafer

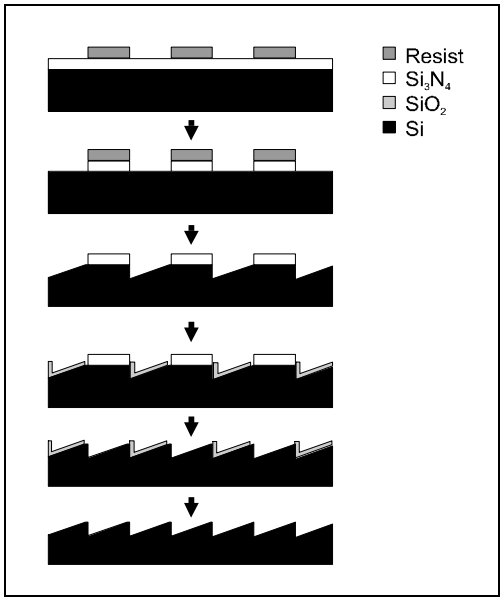

Figure 3: Fabrication process for Echelette gratings in {112} silicon

To fabricate micro optical gratings a special two-step etching process is used (Figure 3). The description correlates with a wanted grating period of 1 µm. A 40 nm layer of Si_3N_4 on the actuator wafer is dry etched using a mask with a grating period of 2 µm. Then the first grooves are wet etched into the silicon. After that the wafer is oxidised (100 nm SiO_2) in the grooves and the Si_3N_4 is removed. A second wet etch step followed by removing of the SiO_2 completes the grating, which has finally the wanted grating period of 1 µm. Important for an uniform grating is for instance a well defined photo-lithografical mask to compensate the so called "bird's beak". But in most cases these gratings have different groove widths. The successful preparation depends on many different

processes. Fig. 4 shows a SEM-Picture of such a wet etched grating.

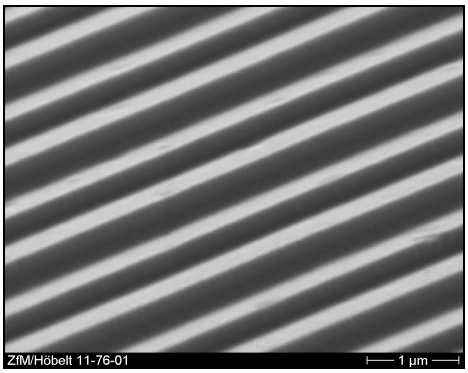

Figure 4: Grating with different groove widths

We found a solution to overcome the problems caused by the described two-step etching (Figure 5). The first steps of fabrication are the same as explained above. After wet etching and passivating of the second grooves only the oxide on the flat edge of the grooves is etched by RIE. So the oxide on the vertical sidewall is still there. With a final wet etch step two adjacent grooves fuses to form the final shape of the grating. After removing of the oxide on the sidewalls the grating is completed. To increase the reflectivity deposition of a coating layer, for instance aluminum, is possible. Figure 6 shows the fabricated grating from top, Figure 7 a cross section.

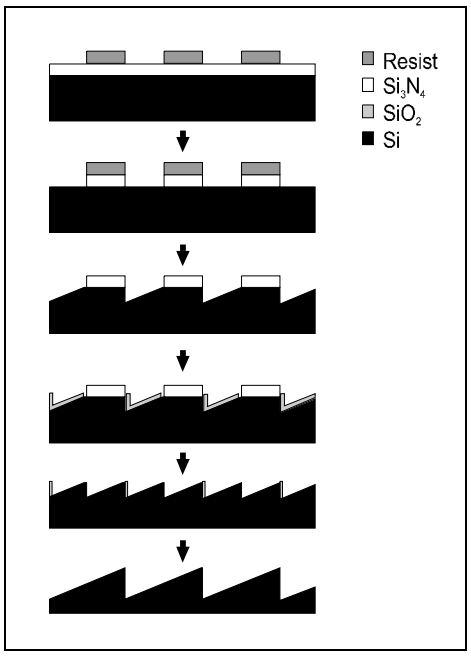

Figure 5: Fabrication process for gratings with equal groove widths

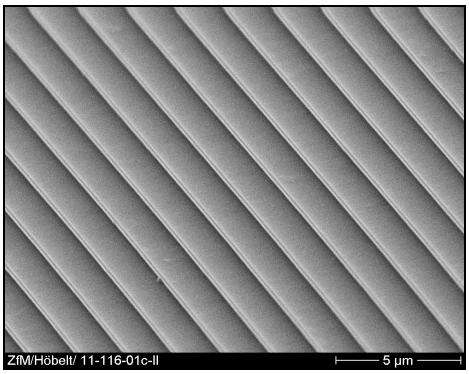

Figure 6: Grating with equal groove widths

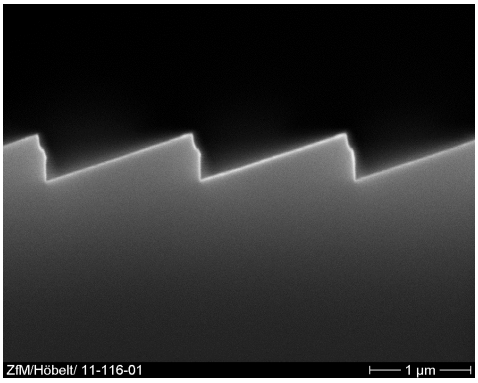

Figure 7: Cross section of the fabricated gratings with equal groove widths

Summary

We succeeded in overcoming the difficulties of grating fabrication. An improved technology for wet etched Echelette gratings was presented. It can be concluded that the gratings have in comparison to [3] equal groove widths. Therefore the optical performance is better. Thus should allow new applications of this gratings.

Acknowledgements

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References

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