Fabrication of Nanoimprint-Lithography masters for optical nano gratings

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This paper describes the process chain for fabrication of 8" Nanoimprint-Lithography (NIL) masters with optical nano gratings by the use of an i-line wafer stepper and RIE etching for NIL master replication.
Process parameters for lithography and etching are evaluated to achieve NIL masters with a nano feature homogeneity of 400 nm lines and spaces (800 nm period) in different etch depths with an aspect ratio up to 2.5:1 (1000nm etch depth) over an 8" wafer. During evaluation, the RIE processes of Si and SiO_2 are investigated for the aimed etch depths.
Lithography of the nano gratings is done with an i-line wafer-stepper NIKON NSR 2205i11D and Fujifilm's photoresist OiR674/9 with a thickness of 900 nm. The RIE etching is done with a Centura 5200 etching tool from Applied Materials. By the use of the 900 nm OiR674/9 photoresist the RIE of SiO_2 shows promising results compared to the RIE of Si because of the etch selectivity and etch homogeneity. Therefore, 8" wafers with thermal SiO_2 are used for selective etching of the desired SiO_2 thickness down to the Si with CF_4, CHF_3 and Ar with an etch rate of 4 nm/s. After RIE process, the wafers are characterized with SEM and Bruker's InSight CAP automated AFM.
In Figure 1 an example of a fabricated 8" wafer with 400 nm SiO_2 etch depth is shown as wafer image and as detailed cross view of the nano gratings. In Figure 2 an AFM characterization of a fabricated 8" wafer with 200 nm SiO_2 and in figure 3 the AFM data of fabricated 8" wafers with 200 nm and 400 nm SiO_2 etch depth shows the distribution of etch depth and nano grating homogeneity over the 8" wafer. The characterized etch depths are 210 nm and 425 nm for the aimed 200 nm and 400 nm etch depths. The nano grating lines homogeneity over the 8" wafer is 410 nm.
With the fabricated NIL masters the replication process at EVG is evaluated which will be discussed in the paper.
In summary, we enable a process chain of 400 nm lines and spaces at 8" wafers for NIL master fabrication with good uniformity and homogeneity in SiO_2 up to an aspect ratio of 2.5:1.

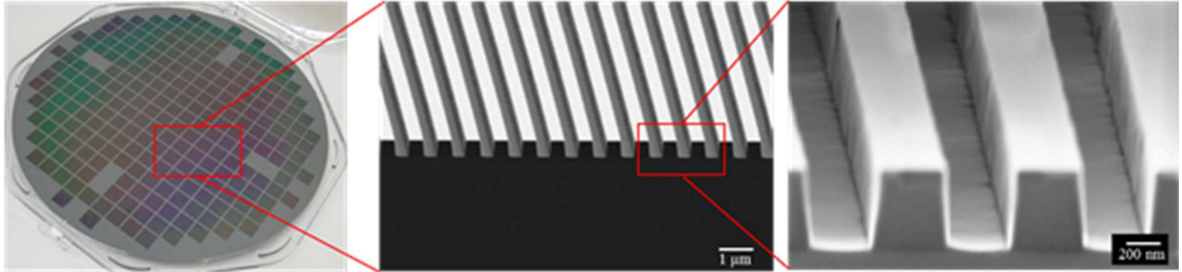

Figure 1: Fabricated 8" wafer with 400 nm etch depth and 400 nm lines and spaces as (left) wafer image, (middle) SEM cross-view and (right) detailed SEM cross-view.

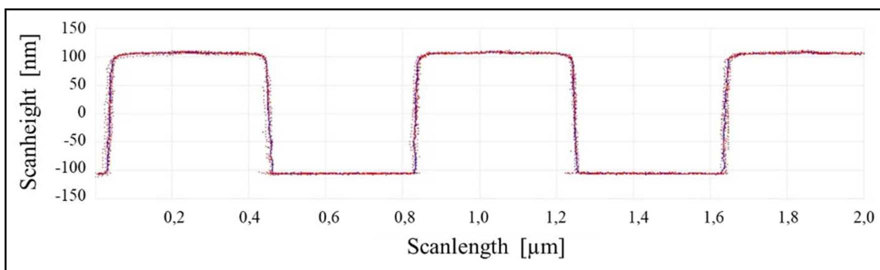

Figure 2: AFM Characterization of a fabricated 8" wafer with 200 nm etch depth and 400 nm lines and spaces of the 8 single scans per chip.

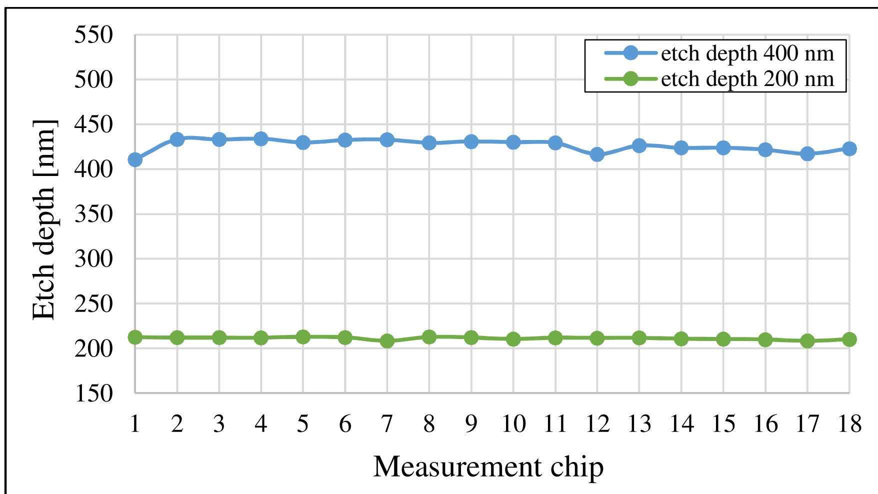

Figure 3: AFM Characterization of the fabricated 8" wafers with 200 nm and 400 nm etch depth and it's etch depth distribution at the 8" wafer parallel to the notch in the middle of the wafer.