	Experiment title: *XRD and GISAXS investigations on ion beam induced Si surface ripples*	**Experiment number:** 20-02-645
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Report:

Nanopatterned templates are a popular tool for creating novel nanostructures and controlling the properties of thin films. Recently, nanoscale ripple patterns which form self-organized during low energy ion sputtering have been used as templates for the deposition of metallic thin films. It was shown, that these patterns can induce magnetic and optical anisotropies in the deposited films. A crucial parameter for the further application of these substrates, e.g. in CVD or MBE growth, is the thermal stability of the patterns. Therefore, the annealing behavior of ion induced ripple patterns on Si(100) has been studied *in-situ* by GISAXS.

The samples were fabricated by sputtering of Si(100) at room temperature with Ar^+ ions with energies between 300 and 800 eV. Due to the high fluxes used for the sputtering, the Si(100) surface gets amorphized by the ion impact and an amorphous top layer of few nanometer thickness is formed. After removal from the vacuum chamber, the amorphous Si surface develops a native oxide of ~ 1 nm thickness. Different so prepared ripple samples with periodicities ranging from ~ 20 to ~ 50 have been annealed in high vacuum for several hours at temperatures up to 800°C. During annealing, consecutive GISAXS profiles have been obtained by using a position sensitive detector.
Figure 1 depicts GISAXS profiles of one sample at different times during annealing at 750°C. The position and the intensity of the observed side peaks correspond to the periodicity (~ 30 nm) and the amplitude (~ 1 nm) of the ripple pattern, respectively. As can be seen clearly from Fig. 1, even after annealing for several hours, neither the periodicity nor the amplitude of the pattern has changed. This observation could also be confirmed by atomic force microscopy as shown in figure 2..

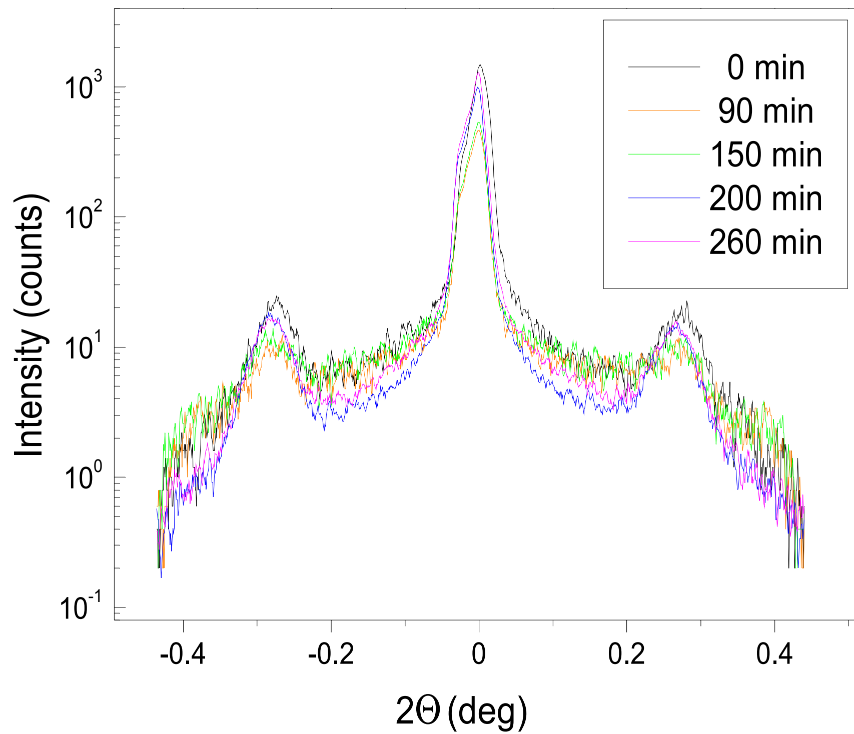

Fig. 1 GISAXS profiles taken at different times during annealing at 750°C.

These results are in contrast to previous observations on crystalline, oxide free ripple patterns where the ripple amplitude was found to decay within less than one hour of annealing at 667°C (cf. Erlebacher et al., Phys. Rev. Lett. **84**, 5800 (2000)). This discrepancy can be attributed to the lower thermal diffusivity of the amorphized and oxidized Si surface. Therefore, its enhanced thermal stability makes this type of rippled substrates promising templates for growth processes that require elevated temperatures but no crystalline substrates.

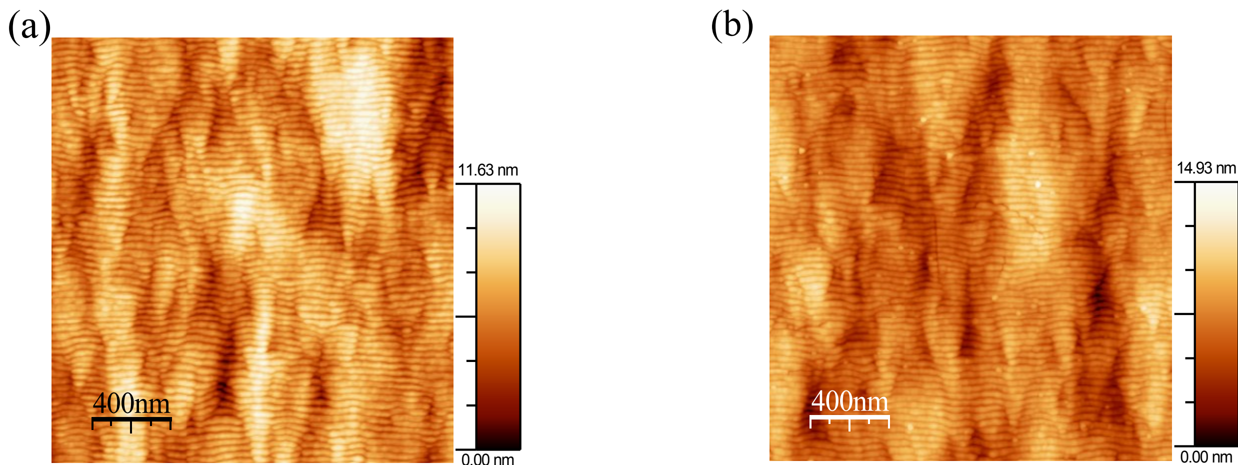

Fig. 2 AFM images of the sample of Fig. 1 before (a) and after (b) annealing for 4.5h at 750°C.