ROBL-CRG	**Experiment title:** Comparison of the strain profile due to implantation of Si into Si wafers of (100) and (111) orientation	**Experiment number:** 20_02_018
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Report:

The aim of the experiment is to measure the lattice expansion of MeV-ion-implanted Si. Especially the behaviour of n-doped (P) and p-doped (B) Si wafers with (001) and (111) surface planes should be compared. It can be assumed that the strain differs because of the crystallographic anisotropy of Young´s modulus. According Hook's law $\varepsilon = (1/E)\cdot\sigma$, for a given stress σ introduced by ion implantation different strain values ε (directed normally to the surface) results for different crystallographic orientation of the Si wafer due to different values of Young's modulus ($1/E_{<001>}=7.68\cdot10^{-12}$ m^2/N and $1/E_{<111>}=5.32\cdot10^{-12}$ m^2/N, that is for the same stress $\varepsilon_{<001>}=1.44\cdot\varepsilon_{<111>}$). This difference should result in a different gettering capability of the implanted layer for metallic impurities and may explain the observed „anomalous" metal gettering in the $R_P/2$ region [1].

The samples were implanted with $5x10^{15}$ cm^{-2} Si^+ of 3.5 MeV and studied in the as-implanted state and after an annealing at 800 °C or 900 °C for 30min. The maximum strain is in the range of $5\cdot10^{-4}$ and the depth distribution of the strain and implants reaches 3µm.

To extract the necessary data, reflections with net planes parallel and inclined to the surface of the sample are studied. In the following table the diffraction parameters for the used reflections are given for the x-ray wavelength λ=0.1608 nm, the maximum wavelength for realizing beam propagation through the goniometer for all the chosen reflections.

	(h k l)	2θ (°)	Incidence angle (°)	Inclination angle (°)
Surface (001)				
--- sym. Case	(0 0 4)	72.633	36.317	0.000
--- asym. Case	(1 1 3)	58.821	4.171 and 54.650	25.239
Surface (111)				
--- sym. Case	(1 1 1)	29.719	14.860	0.000
--- asym. Case	(1 3 3)	80.389	18.193 and 62.196	22.002

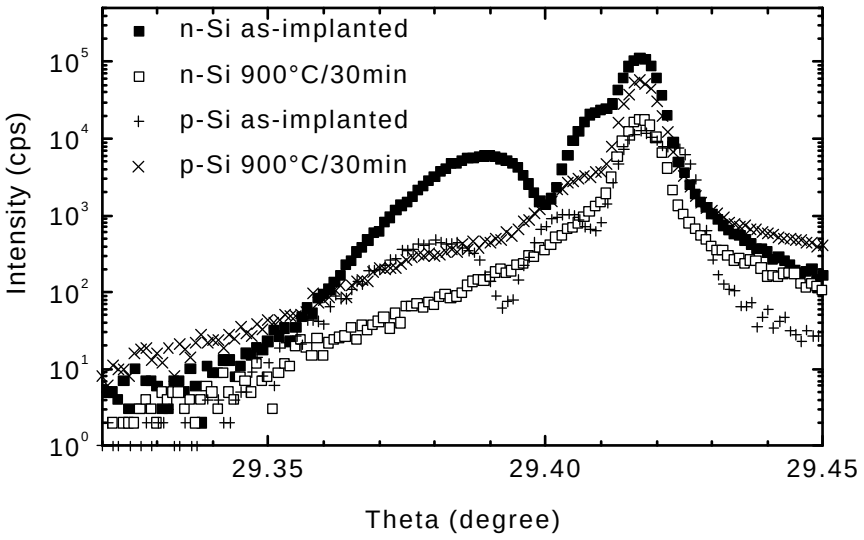

Fig. 1
Asymmetric Si(113) reflection for grazing incidence of the x-ray beam (λ = 0.1608 nm) for Si(001) wafers implanted with $5x10^{15}$ cm^{-2} Si^{+} of 3.5 MeV energy

In Fig. 1 diffracted intensities of the asymmetric Si(113) reflection are given. In this case, strain $\varepsilon_{\perp}$ as well as strain $\varepsilon_{\parallel}$ contribute to the measured signal. The strain measured in p-Si is approximately 20 % higher than that in n-Si and more stable against an annealing treatment. This is confirmed by other reflections, too. Wafers with (111) surface give a similar result. Significant different strain for (001) and (111) orientated wafers were not found because of the limited accuracy, but the first results in this long-term experiment will be used for optimization of forthcoming measurements.

[1] R. Kögler , R.A. Yankov, J.R. Kaschny, M. Posselt, A.B. Danilin and W. Skorupa, Nucl. Instrum. and Meth. B 142 (1998) 493.