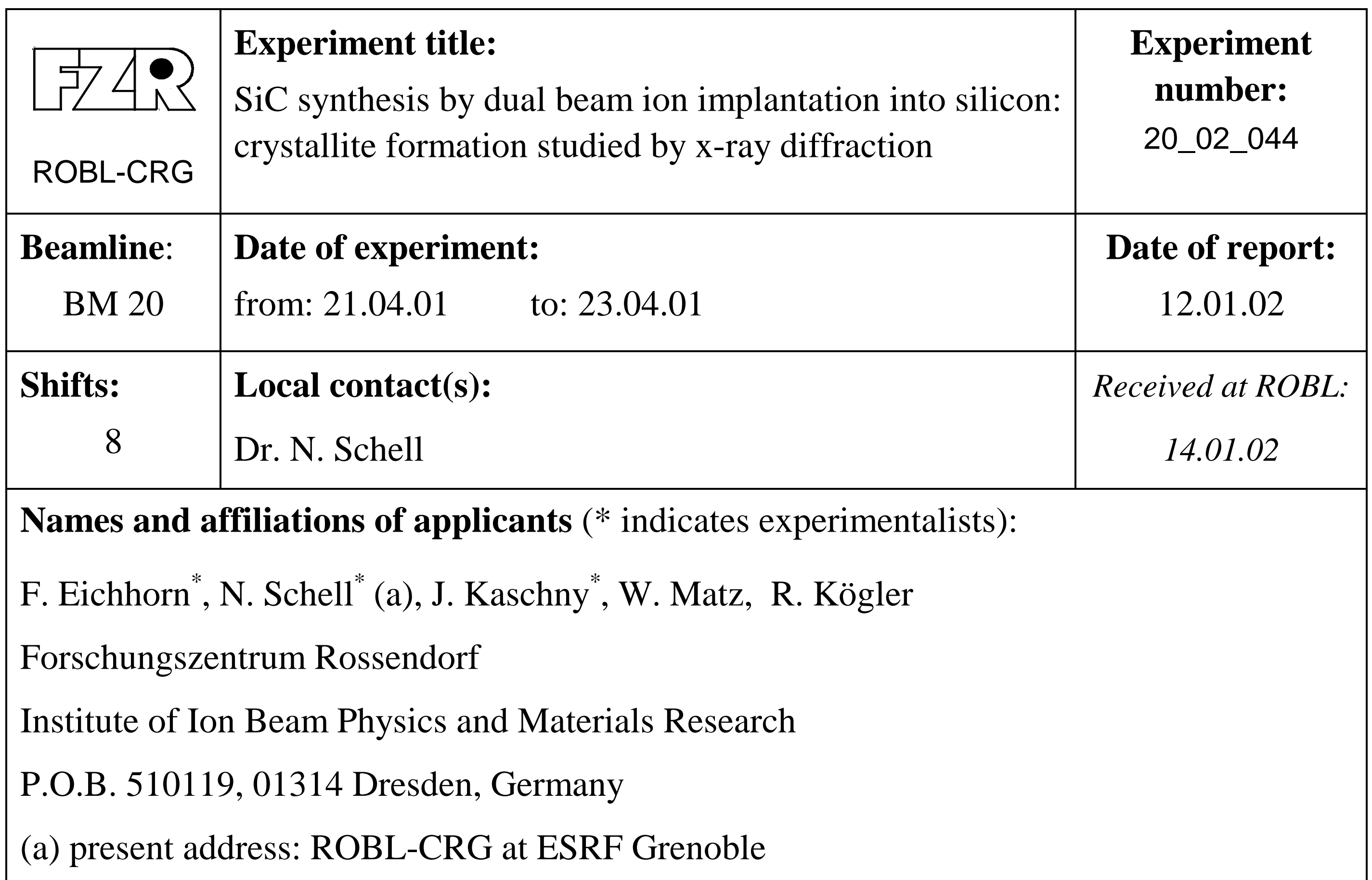

ROBL-CRG	**Experiment title:** SiC synthesis by dual beam ion implantation into silicon: crystallite formation studied by x-ray diffraction	**Experiment number:** 20_02_044
Beamline: BM 20	**Date of experiment:** from: 21.04.01 to: 23.04.01	**Date of report:** 12.01.02
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Report:

The aim of the measurements was to analyze the effect of an additional (double) Si ion implantation on the growth of SiC crystallites in Si in comparison with the usual ion beam synthesis. Properties to be determined are the amount of grown SiC, the orientation of the crystallites in the Si matrix, the deformation in the SiC precipitates and in the surrounding Si matrix.

n-type Si(001) was implanted with 8.4×10^{16} cm^{-2} C ions of 360 keV at 450 °C (sample Z22). Additionally, the material was implanted with Si ions under conditions given in the following table.

Sample name	Energy (keV)	Fluence (10^{16} cm^{-2})	Remarks
Z22	-	-	only C
Z32	1500	2.01	simultaneous implantation
Z72	1500	1.64	subsequent implantation
Z82	500	0.59	simultaneous implantation
Z42	500	0.54	subsequent implantation

Si ions with an energy of 1500 keV completely penetrate the layer of the implanted carbon atoms (maximum C concentration in a depth of 870 nm, maximum Si concentration in a depth of 1770 nm), whereas Si ions with an energy of 500 keV are stopped in nearly the same depth (maximum Si concentration in a depth of 830 nm) like the C ions.

Typical results can be concluded from the figures with the 3C-SiC(111) diffraction line (the wavelength used was 0.15382 nm) characterizing the formation of 3C-SiC and the shape of the Si(111) diffraction line characterizing the deformation of the Si matrix:

(i) In comparison with the pure carbon implantation (Z22, black symbols), SiC is formed in a higher amount if high energy Si ions which penetrate the carbon layer are simultaneously implanted (Z32, red symbols). The SiC crystallites are strained with $\Delta d/d = 0.012$ and have diameters of (4.5 ± 0.4) nm in sample Z22 and (4.9 ± 0.2) nm in sample Z32, respectively.

(ii) If the high energy Si implantation succeeds the C implantation, then the formerly grown SiC is obviously destroyed (Z72, green symbols). Furthermore, the Si matrix is deformed producing a considerable diffuse intensity.

(iii) By implantation of low energy Si ions (the Si atoms are stopped in nearly the same region as the C atoms) only a poor amount of SiC crystallites is formed. Their size seems to be smaller. A significant difference between the effect of a simultaneous (Z82, blue symbols) or subsequent (Z42, magenta symbols) Si implantation is not observed.

(iv) The grown 3C-SiC crystallites have the same crystallographic orientation as the Si matrix. Randomly oriented crystals or other SiC polytypes were not observed.