ROBL-CRG	**Experiment title:** Observation of Extrinsic Stacking Faults in B implanted Si by CTR Scattering	**Experiment number**: **20_02_015**
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Names and affiliations of applicants (* indicates experimentalists):

Dr. T.H. Metzger , Prof. Dr. J. Peisl, I.Kegel*
Ludwig-Maximilians-Universität Muenchen
Sektion Physik, Geschwister-Scholl-Platz 1,
D-80539 Muenchen; Germany
Jim Patel SSRL Stanford university, USA
F. Berberich*, Forschungszentrum Rossendorf

Report: We have investigated the defect formation in Si after boron implantation at different annealing stages by grazing incidence diffuse x-ray scattering. The starting material was Si (001) implanted by 32 keV B to a dose of 6e15cm^{-2} and annealed for 15 minutes at 750°C to recrystallise the damaged near surface layer. The aim of the experiment was to study the transition from B-I clusters at 750°C to mainly extrinsic stacking faults (SF) which were found previously at annealing conditions of 1070°C and 10 seconds. The grazing incidence diffuse scattering was first measured in-situ in a furnace which allowed for temperatures up to 1500°C in a vacuum of about 10^{-7} Torr. The in-situ studies failed because the heat transfer between the heater and the sample was not good enough. Instead a set of 5 samples which had been treated ex-situ by rapid thermal annealing (RTA) at 1070°C for different times (10s, 20s, 40s, 80s, 120s) have been investigated. An intensity “slice” along [001] has been measured by use of a position sensitive detector (PSD) placed while the scattering vector pointed at the position (2.1 2.1 0). Here the diffuse intensity rod in [111] direction, which indicates the presence of SF on (111) planes is most pronounced as can be seen in Fig. 1 for all samples. Most surprisingly the SF grow and disappear in a very short time window of only 80 sec. At 10 sec the streak intensity is smaller than at 20 sec, the SFs are growing. The width of the streak along the exit angle is directly linked to the lateral extension of the SF and is easily converted in a SF diameter of 66 nm at 10 sec which continues to increase with time as shown in Fig.2.

At 40 sec the streak intensity decreases, indicating the dissolution of the SFs and at 80 sec the SFs have completely vanished.

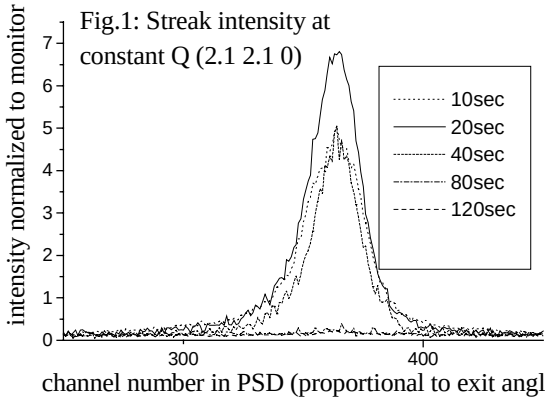

Fig.1: Streak intensity at constant Q (2.1 2.1 0)

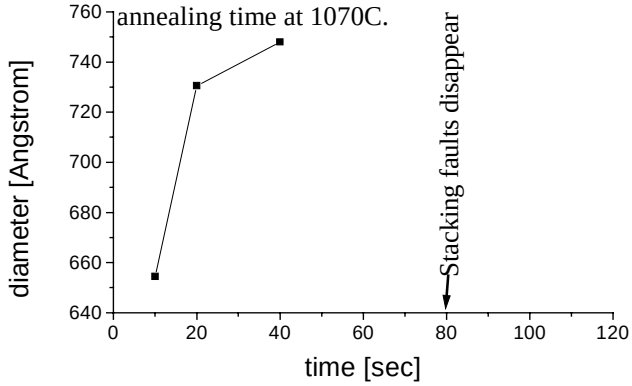

Fig.2: Stacking fault diameter deduced from the streak width of Fig. 1 as a function of annealing time at 1070C.

The integrated peak intensity in Fig. 1 is proportional to the number of SF which will be used, together with the SF diameter from Fig. 2, to study the growth kinetics of the SFs. Another important question is the depth distribution of the SFs. The intensity in the PSD was studied as a function of the incident angle, keeping the scattering vector constant at (2.1 2.1 0) as shown in Fig.3 for the different annealing times. The information on the depth distribution of the SF will be deduced from the functional dependence of the curves in Fig. 3. In conclusion: we have discovered stacking fault formation in B implanted Si which depends sensitively on the annealing temperature and time. The SF grow and disappear again in a short time window of only 80 sec. The trapping of the Si interstitial atoms in SFs provides a mechanism to explain the low transient enhanced diffusion of Boron at 1070°C, because free Si interstitials are needed for the interstitialcy mechanism of the anomalous fast B diffusion in B implanted Si. We have also found that at 750°C only a few SF are already present with a diameter of about 10nm.

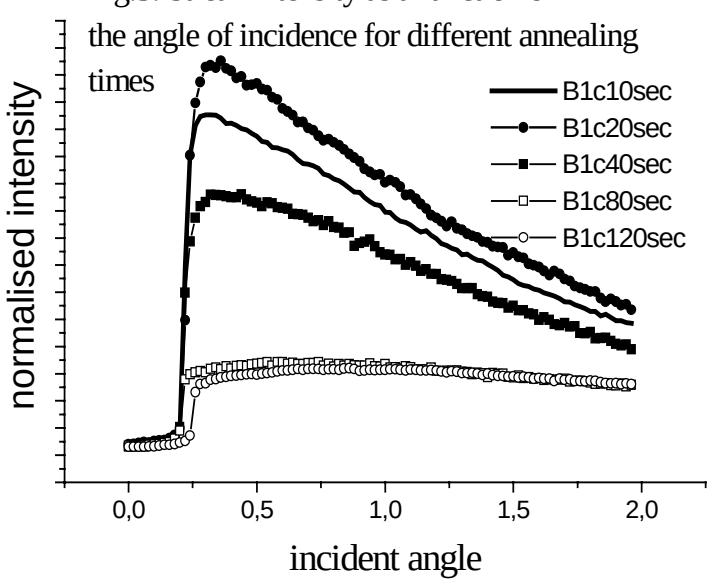

Fig.3: Streak intensity as a function of the angle of incidence for different annealing times