

SECTION 2 — PARTICLE INTERACTION WITH SOLIDS

2.1 Proton dechannelling in silicon

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The determination of the dechannelling dependence on the penetration depth, on the crystal temperature and on the ion energy seems to be one of the more powerful methods for studying the secondary channelling phenomena. It allows indeed a direct investigation of the changes in the transverse energy of a channelled particle.

Measurements have been performed by backscattering technique¹⁾ on the dechannelling rate as a function of the penetration depth for protons of 0.3, 0.6 and 1.5 MeV along $\langle 111 \rangle$ and $\langle 110 \rangle$ axes of silicon, at temperatures of 80, 143, 203, 300, 363 and 423 K. A set of typical plots, reported in Fig. 1, shows the variations of χ vs z for the different temperatures at 1.5 MeV energy. It can be noted that the trend of χ is quite linear vs z and χ starts from a non zero minimum value, namely χ_0 at null depth. Both χ_0 and the slopes of $\chi(z)$ are functions of the temperature, the dependence being stronger for the slopes.

The dechannelling, regarding the transition of particles from the aligned to the random beam, requires the explicit consideration of the changes in the ion transverse energy E_{\perp} .

As far as the electronic contribution can be neglected the scattering produced by the vibrating nuclei is the main responsible of the changes in the E_{\perp} of the ion; the dechannelled fraction should therefore be roughly proportional to the amount of the deviations from the continuous strong potential, i. e. to all the fluctuations by which the particle has been scattered. While the number of deviations is proportional to the penetration depth z , their intensity is pro-

portional to the mean square vibrational amplitude normal to the row, ρ^2 ; therefore the increase in E_{\perp} should be proportional to the product $z\rho^2$ ¹⁾. To test the significance of the above description, the $\chi - \chi_0$ measured at different temperatures have been reported in Fig. 2 vs the product $z\rho^2$ for 0.6 and 1.5 MeV protons in Si $\langle 111 \rangle$.

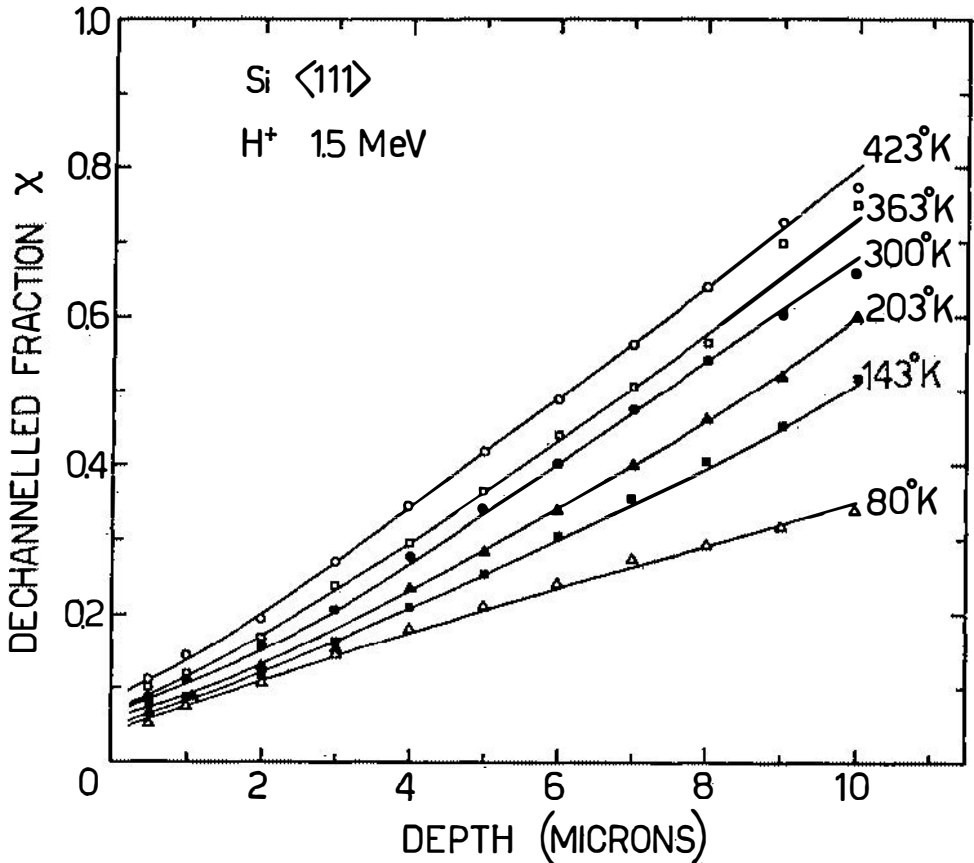


Fig. 1 Dechannelled fraction vs penetration.

A theoretical model has been developed to describe the dechanneling in terms of a steady increase in the transverse energy, accounting for both electronic and nuclear reduced multiple scattering. The initial transverse energy distribution of the particle just beneath the crystal surface has been computed including the experimental angular spread, and both the amorphous layer and the string scattering. The limiting transverse energy²⁾ for the channelled to random transition has been taken from the experimental $\psi_{1/2}(T)$ values.

The computed dechannelled fractions agree reasonably with the experimental ones and justify their temperature and energy dependence.

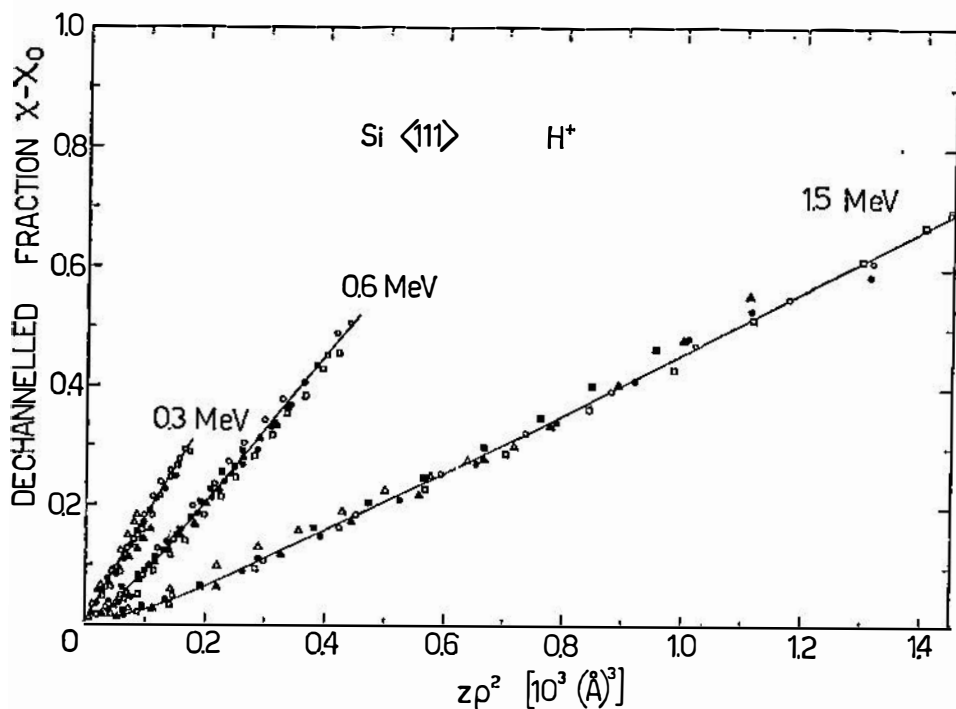


Fig. 2 Dechannelled fraction vs $z\rho^2$.

References

- 1) G. Foti, F. Grasso and E. Rimini, *Lettere Nuovo Cimento* 7 (1969) 941;
- 2) J. Lindhard, *Kgl. Danske Videnskab Selskab Mat. Fys. Medd.* 34 (1965) 14.

2.2 The study of amorphization of germanium caused by ion irradiation

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