Channeling implantation for 4H-SiC

960 keV Al, P, B, N → 4H-SiC(0001), <0001> Direction

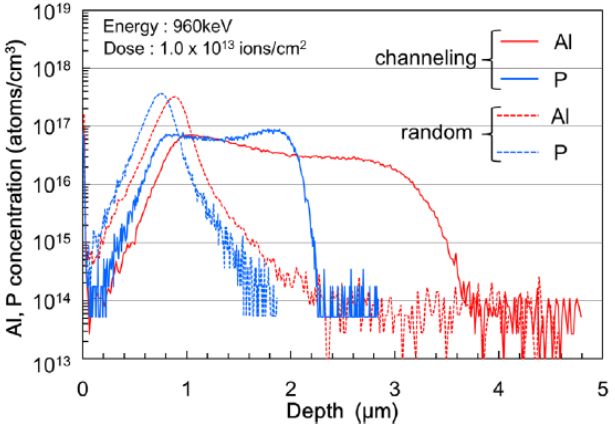


Fig. 1. (Color online) SIMS depth profile of Al and P for channeling and random implantation.

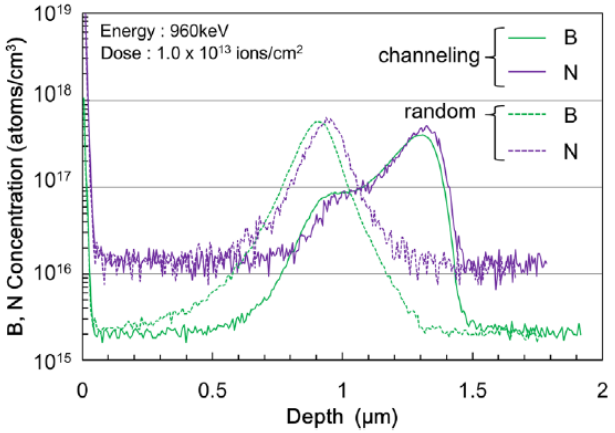
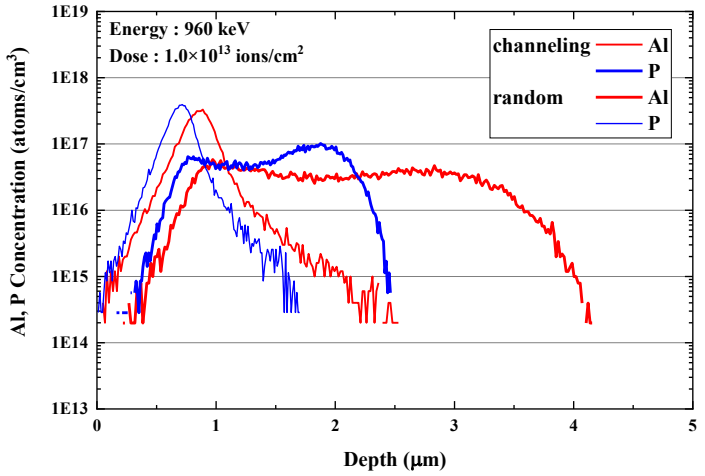
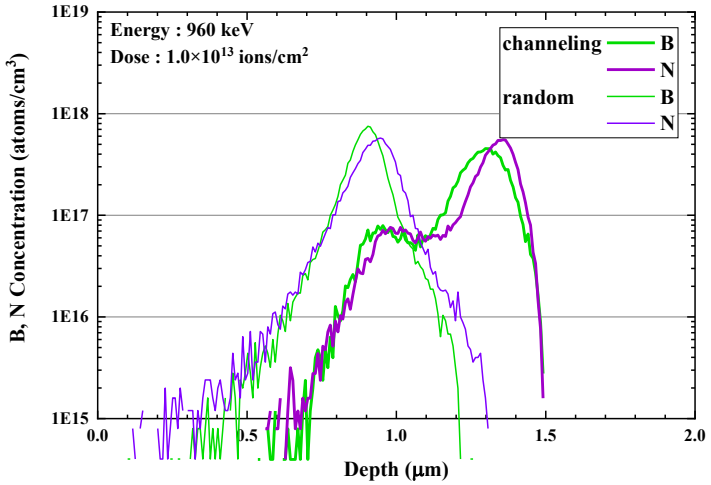


Fig. 2. (Color online) SIMS depth profile of B and N for channeling and random implantation.

Ref. R. Wada et al., JJAP 61, SC1033 (2022).





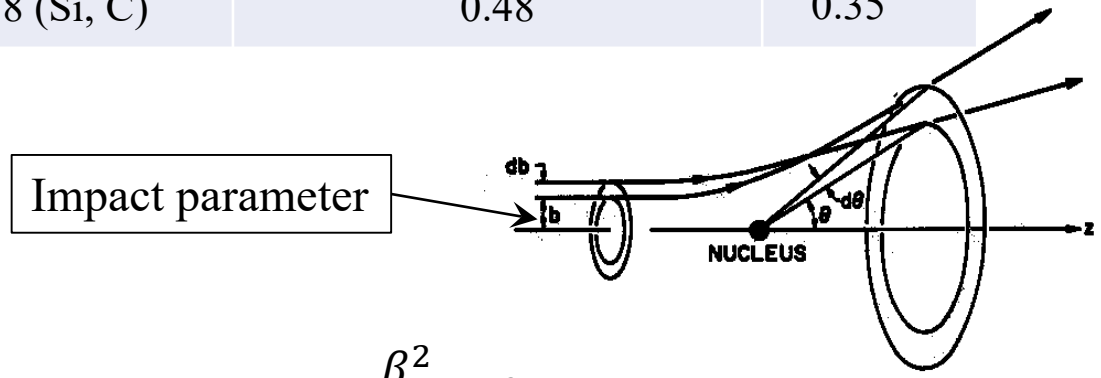
Simulation using scatGUI

Channeling : θ=0° , φ=0°
Random : θ=4° , φ=15°

Channeling implantation for 4H-SiC, main parameters assumed in scatGUI

960 keV Al, P, B, N → 4H-SiC(0001), <0001> direction

	Correction factor for electronic stopping (Se)	Coefficient used for impact-parameter-dependent stopping power $\beta = k/a\_screening$	divergence angle of beam (σ: std. dev.)
960 keV B → 4H-SiC	1.27 (Si, C)	0.38	0.3°
960 keV N → 4H-SiC	0.89 (Si, C)	0.31	0.3°
960 keV Al → 4H-SiC	1.0 (Si, C)	0.60	0.35°
960 keV P → 4H-SiC	0.8 (Si, C)	0.48	0.35°



Electronic stopping power of impact-parameter-dependent Oen-Robbinson type

E : Energy

b : impact parameter

β : attenuation coefficient

$$S_e(E,b) = S_{e,Ziegler}(E) \times \frac{\beta^2}{2\pi} e^{-\beta b} \quad ,\beta = k/a_m$$

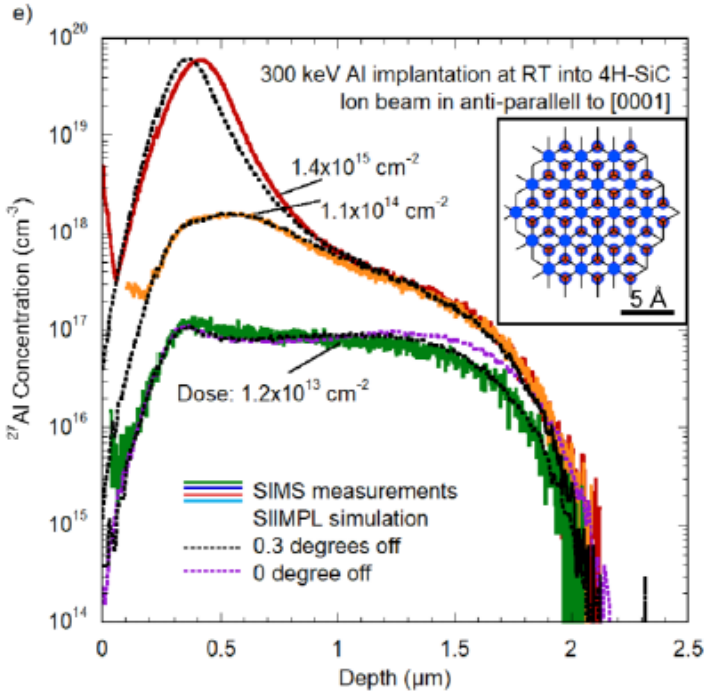
$$a_m = 0.8853\, a_0 \left(Z_1^{2/3} + Z_2^{2/3}\right)^{-1/2}$$

$$a_0 = 0.529\ \text{Å}$$

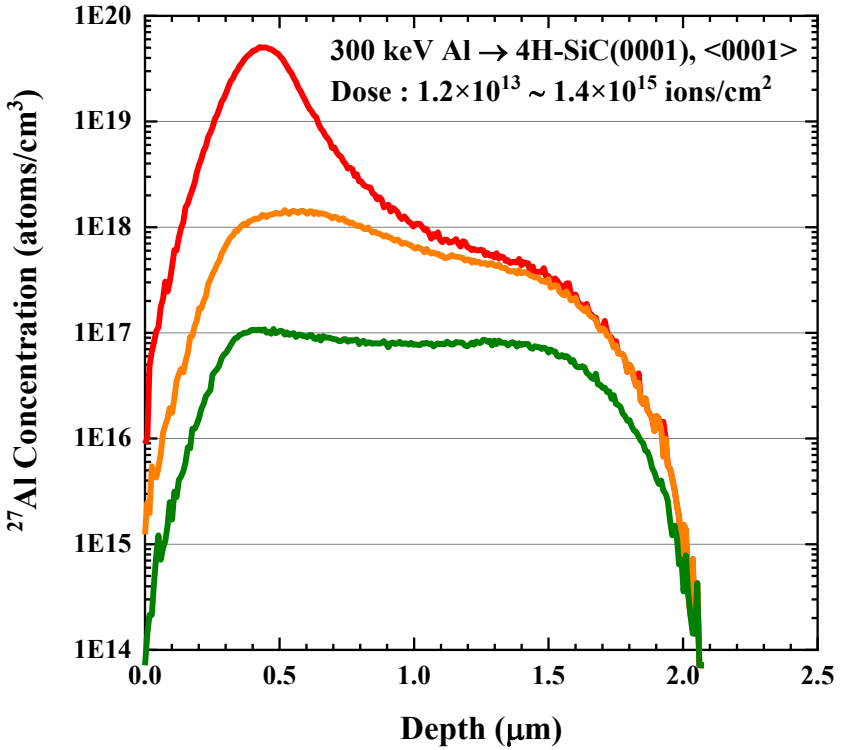
$$\int_0^{\infty} 2\pi b \frac{\beta^2}{2\pi} e^{-\beta b} db = 1$$

Example of high-dose channeling ion implantation into 4H-SiC

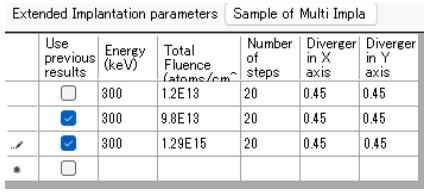
300 keV Al → 4H-SiC(0001), <0001>, 1.2E13～1.4E15/cm^2



Ref. M. K. Linnarsson et al., J. Appl. Phys. **130**, 075701 (2021).



Reproduction simulation in scatGUI



σ = 0.45°
β = 0.6/a_m
Se : 1.0倍
NRT : ×1.0

Calc.: Multiple implantations due to large change in distribution shape at low dose（The number of divisions is 20 for each)

1.2E13 + 9.8E13(1.1E14) + 1.29E15(1.4E15)