Annealing temperature dependence of the electrically active profiles and surface roughness in multiple Al implanted 4H-SiC

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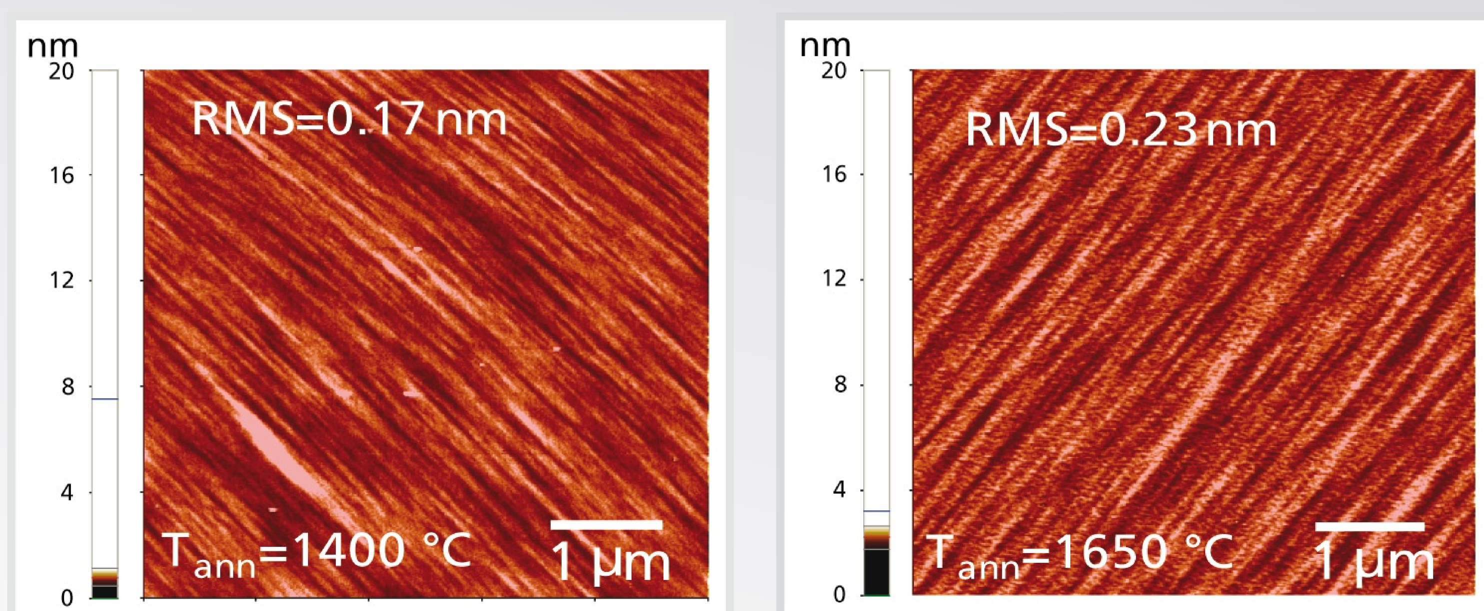
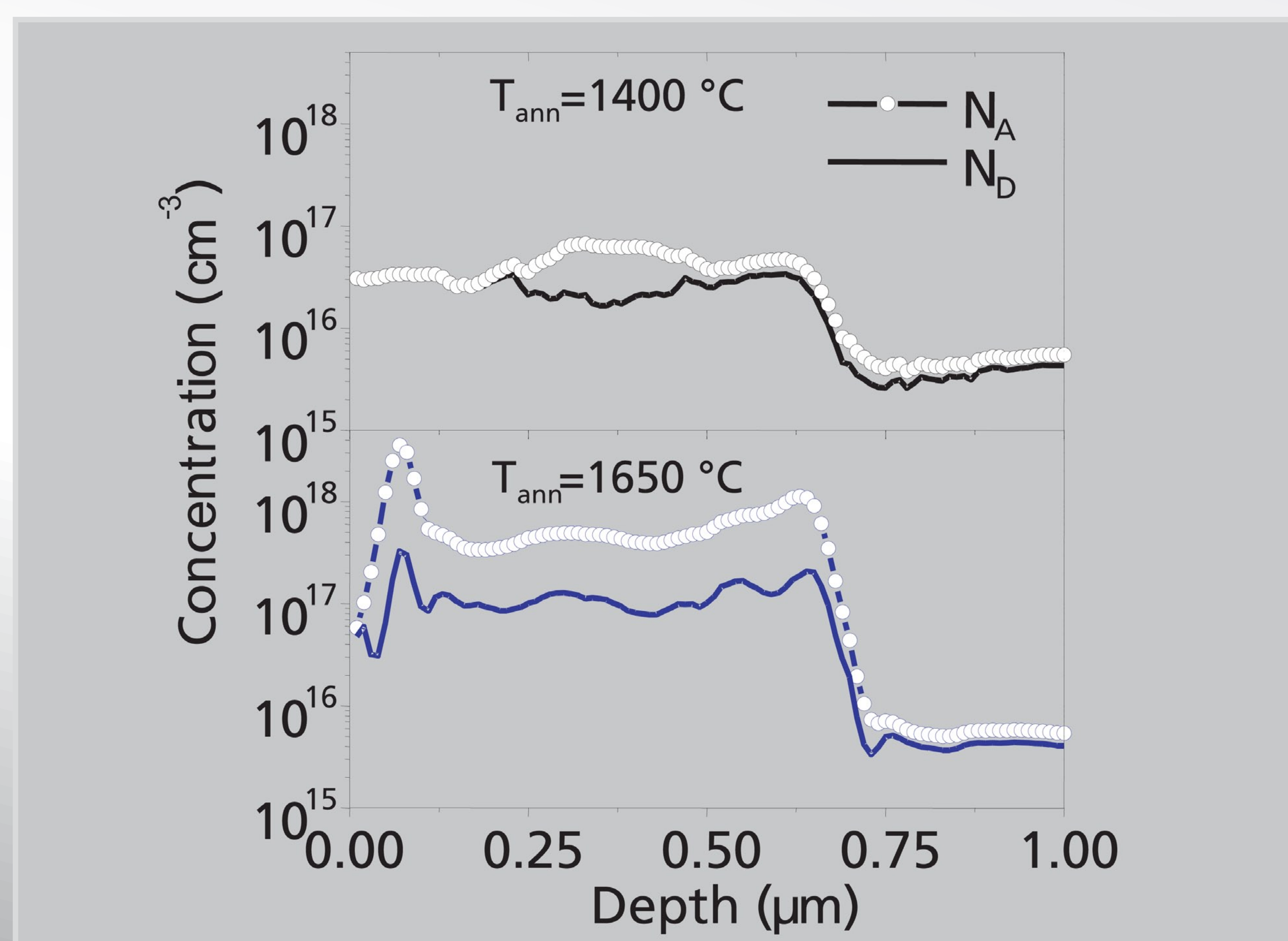
Abstract

The present work demonstrates the effect of the annealing temperature (from 1400 °C to 1650 °C) on the electrical activation of 4H-SiC implanted with multiple energy (from 40 to 550 keV) and medium dose (1×10^{13} cm^{-2}) Al ions. The evolution of the acceptors (N_A) and compensating donors (N_D) depth profiles was monitored by the combined use of scanning capacitance microscopy (SCM) and scanning spreading resistance microscopy (SSRM). We demonstrated that the electrical activation of the implanted layer with increasing annealing temperature is the result of the increase in the acceptors concentration and of the decrease in the N_D/N_A ratio. Atomic force microscopy (AFM) morphological analyses indicated that the surface quality is preserved even after the 1650 °C annealing process.



Tapping mode AFM images of the implanted samples after annealing at 1400 °C and 1650 °C, respectively. The RMS roughness values are also reported on the figures. Surface quality is preserved even after the 1650 °C annealing process. Samples annealed at 1400 °C, at 1500 °C and 1650 °C.



Concentration vs depth profiles of acceptors N_A and compensating donors N_D for the samples annealed at 1400 °C and 1650 °C. The reported profiles have been obtained by the joint application of SCM, yielding the N_A- N_D profile, and SSRM, yielding the resistivity profile.

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	1400 °C	1500 °C	1650 °C
D_A/D_{imp} (%)	4.9	16.3	74.8
D_D/D_A (%)	60.4	31.6	17.9

Percent activation (D_A/D_{imp}) and percent compensation (D_D/D_A) obtained for the samples annealed at 1400 °C, at 1500 °C and 1650 °C. The acceptors dose (D_A) and the compensating dose (D_D) are obtained from the N_A and N_D profiles. D_{imp} is the implanted dose.

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- The annealing step for this study has been done in a centrotherm furnace.
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