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# Raman spectroscopy characterization of ion implanted 4H-SiC and its annealing effects

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## Introduction

P-type doping of 4H-SiC by implantation with very low resistivity is still a challenging process step in 4H-SiC device development. In order to further study p-type 4H-SiC prepared by ion implantation and annealing method, the characteristics of Al implanted 4H-SiC samples under different ion implantation doses and different annealing conditions were analyzed by the sheet resistance measurements and Raman spectroscopy.

## Experimental

- P-type 4H-SiC with different doses of $2.45\times10^{12}$ $cm^{-2}$ - $9.0\times10^{14}$ $cm^{-2}$.
- Laser Raman spectroscope XPLORA PLUS from HORIBA Scientific.
- Parameter setups: 532 nm, 2400 gr/mm, 50× long-focus objective lens and a 500 μm hole.

## Raman measurements

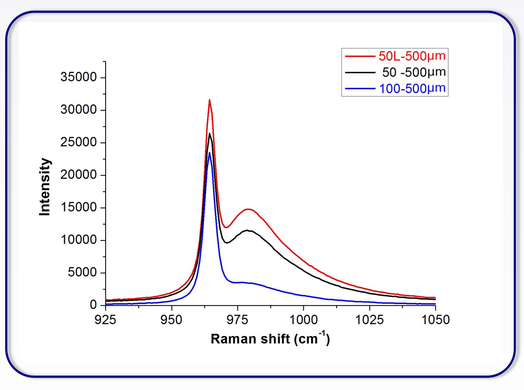



Fig 2. LO and LO+ Raman results for the same 4H-SiC sample using different objective lenses.

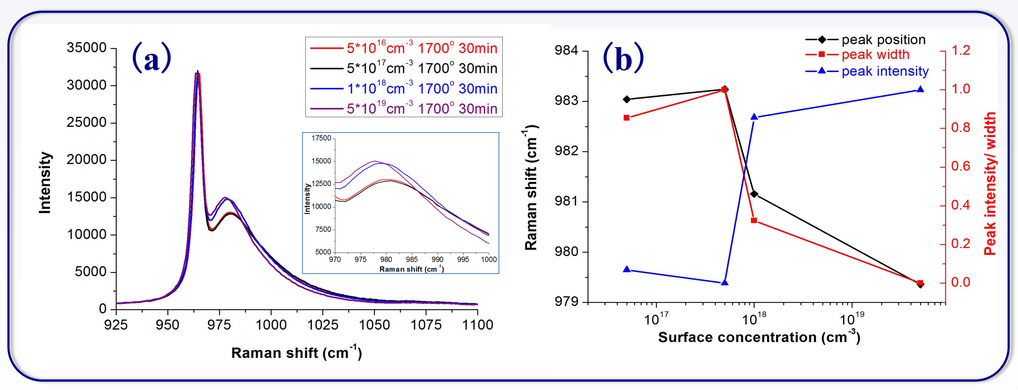



Fig 3. Raman results for Al-implanted 4H-SiC samples with different surface concentrations.

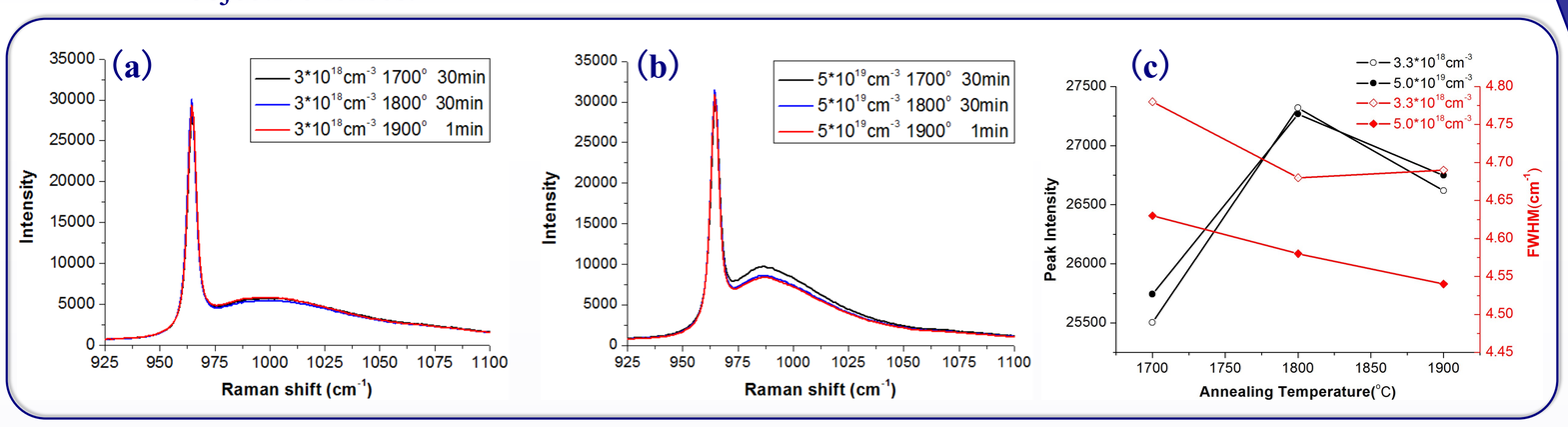



Fig 4. Raman results for Al-implanted 4H-SiC samples with different surface concentrations and annealing conditions.

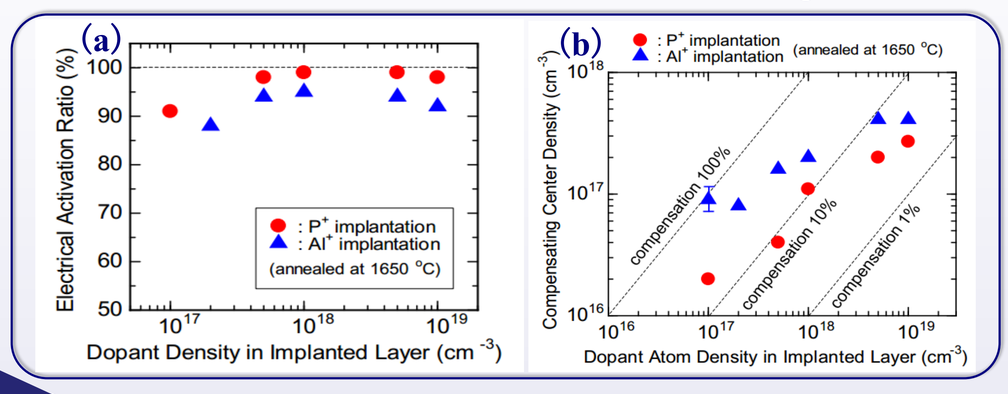
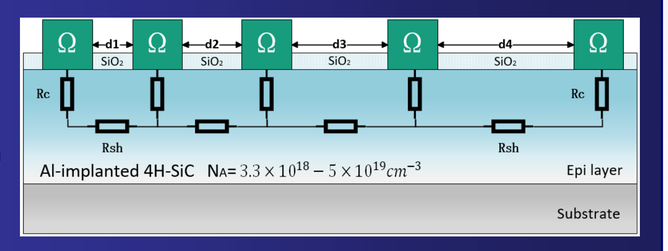



Fig 5. Changes in electrical activation rate and deep level defects with different ion implanted doses [1].

## Sheet resistance measurements



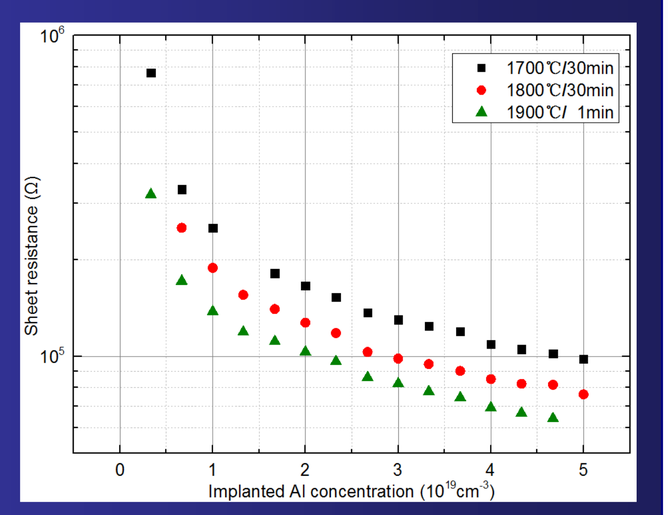




Fig. 1. Sheet resistance measurement of Al implanted p-type 4H-SiC. (a) Schematic diagram of Transfer Length Model (TLM) structure sample; (b) Sheet resistance changes with the concentration of Al ions implanted and the annealing conditions.

## Summary

Results showed that the Raman results can sensitively analyze the typical damages for different ion implantation and annealing fabrication conditions of p-type 4H-SiC.

1. The Raman characterization results were helpful to explain the sheet resistance variation for different ion implantation and annealing setups in experiments.
2. Annealing at 1800 ℃ for 30 minutes and annealing at 1900 ℃ for 1 minute have better lattice recovery effect than annealing at 1700 ℃ for 30 minutes.
3. Increasing the surface concentration above $10^{18}$ $cm^{-3}$ could well eliminate majority of the deep level defects in the 4H-SiC substrate, and the relevant Raman results showed better crystallinity.

## Acknowledgements

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