ADVANCED CHARACTERIZATION OF THE STRUCTURAL MODIFICATIONS INDUCED IN RECTIFIER DIODES UNDER WORKING CONDITIONS

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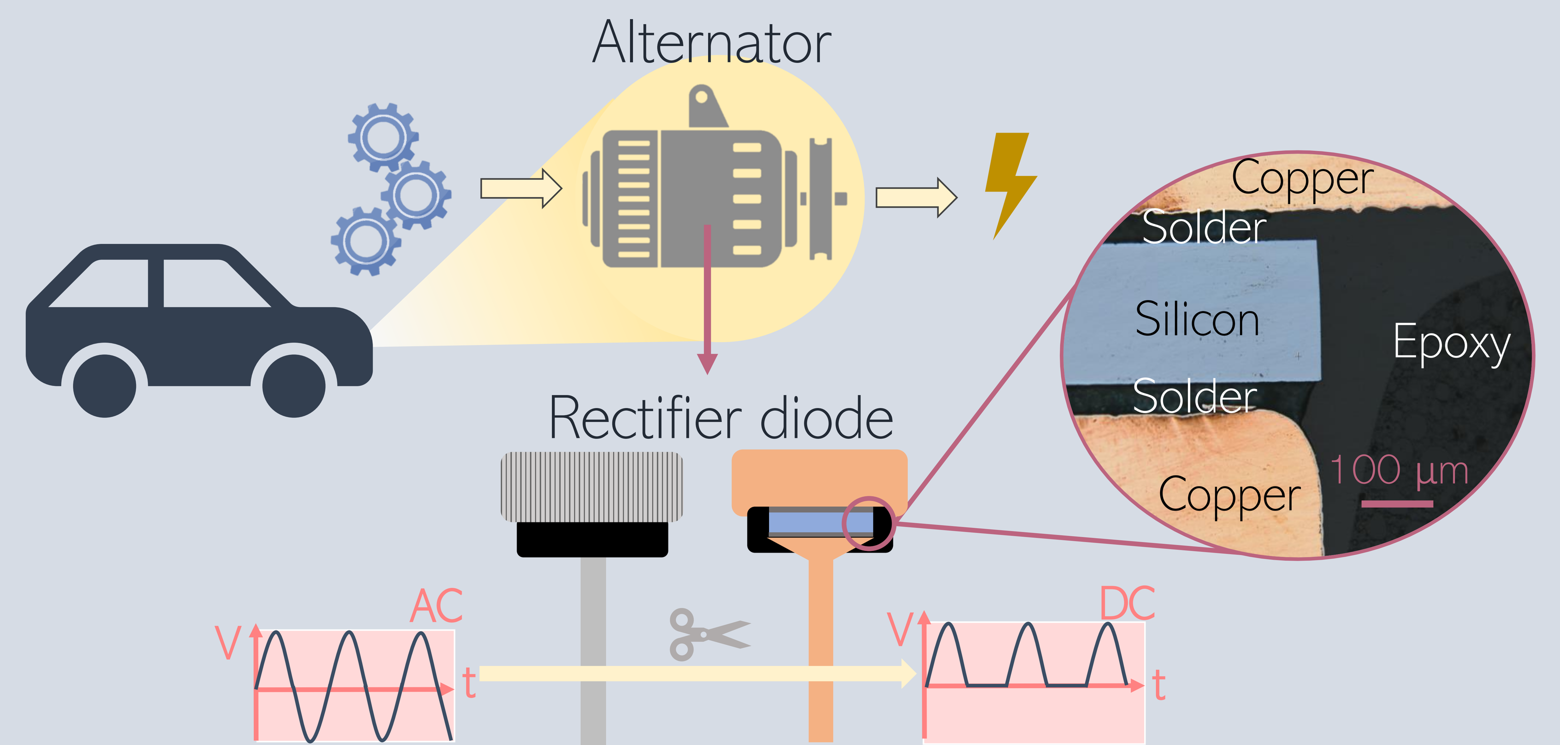
INTRODUCTION

Rectifier diodes have great importance in the automotive industry. Their main function is to transform the AC generated in the alternator of the vehicles into DC in order to make it suitable for the vehicle power supply. The high current reached during their performance induces the device overheating of the device and, consequently, the appearance of interfacial stress associated with the mismatch of the thermal expansion coefficient of each component, which may affect the behavior of the diodes.

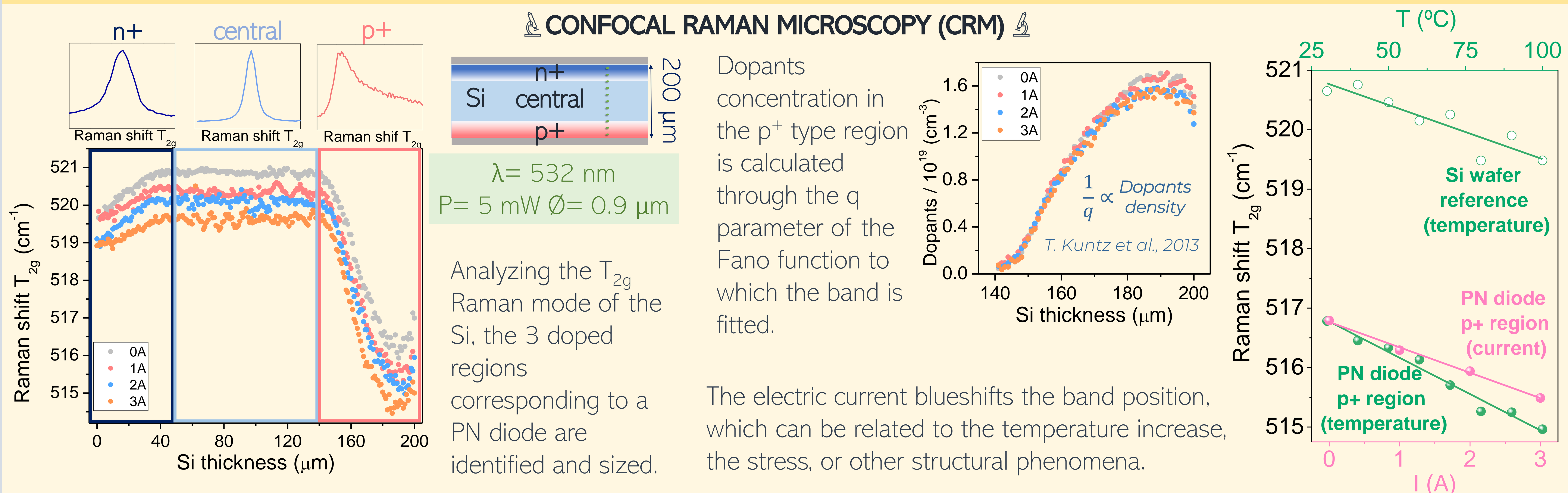


OBJECTIVE

The aim of this work is to comprehend the phenomenology occurring at the different interfaces of the active semiconductor chip of PN-type diodes when an electric current is flowing through the device in direct polarization.

RESULTS

CONFOCAL RAMAN MICROSCOPY (CRM)



Analyzing the T_{2g} Raman mode of the Si, the 3 doped regions corresponding to a PN diode are identified and sized.

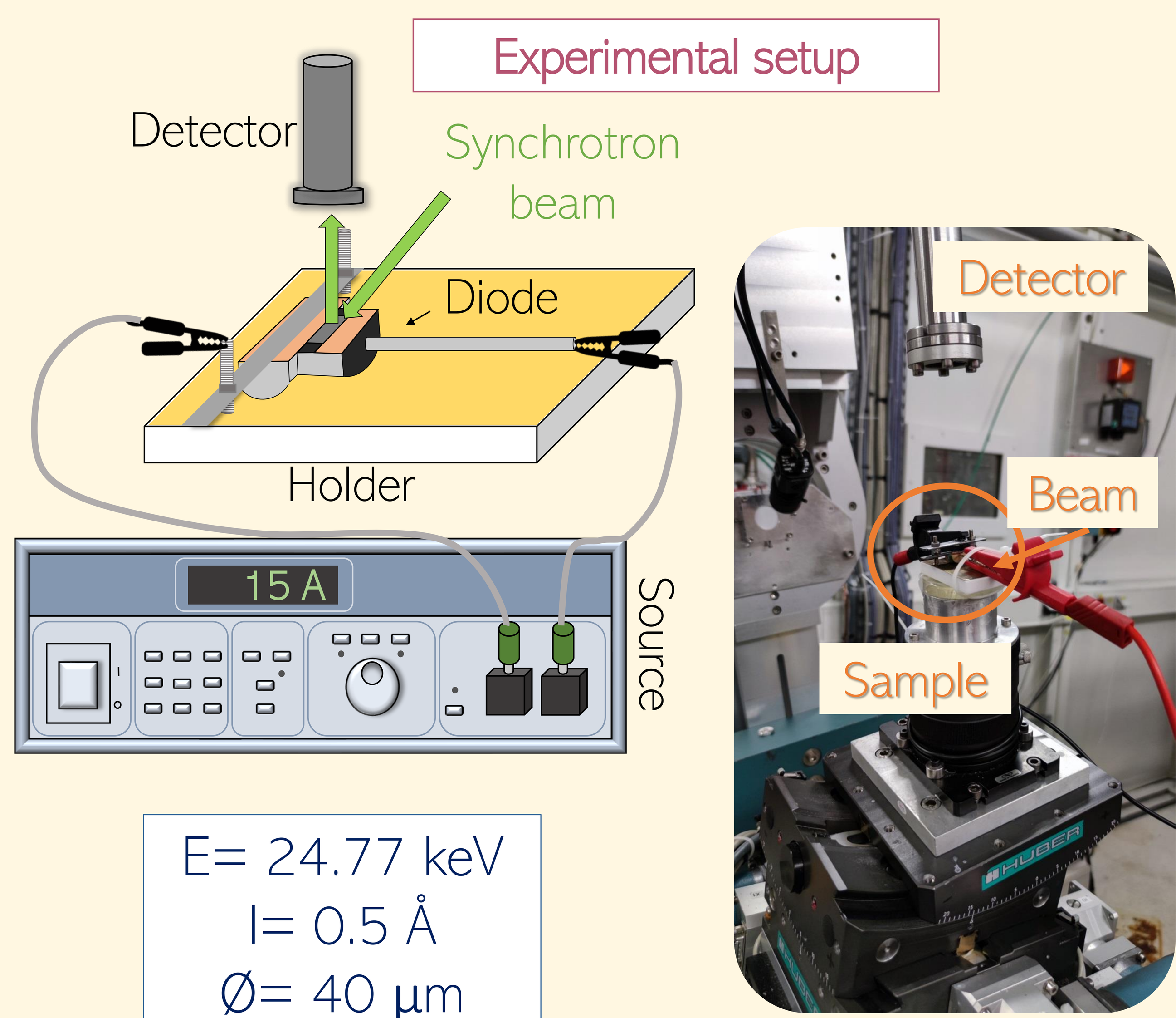
Dopants concentration in the p^+ type region is calculated through the q parameter of the Fano function to which the band is fitted.

The electric current blueshifts the band position, which can be related to the temperature increase, the stress, or other structural phenomena.

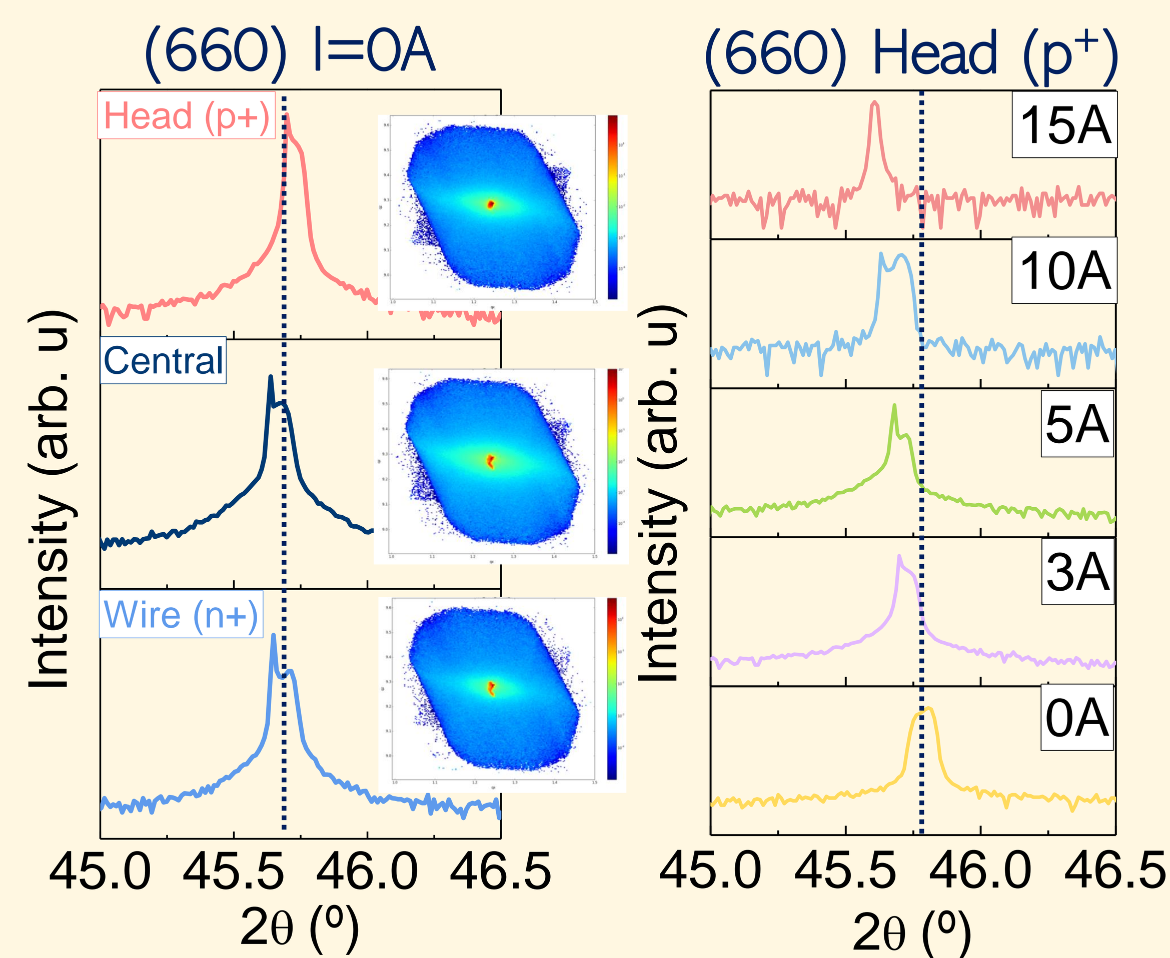
GRAZING INCIDENCE X-RAY DIFFRACTION (GIXRD)

SpLine Spanish CRG Beamline

In situ GIXRD experiments were carried out on the 3 doped regions of Si wafer.

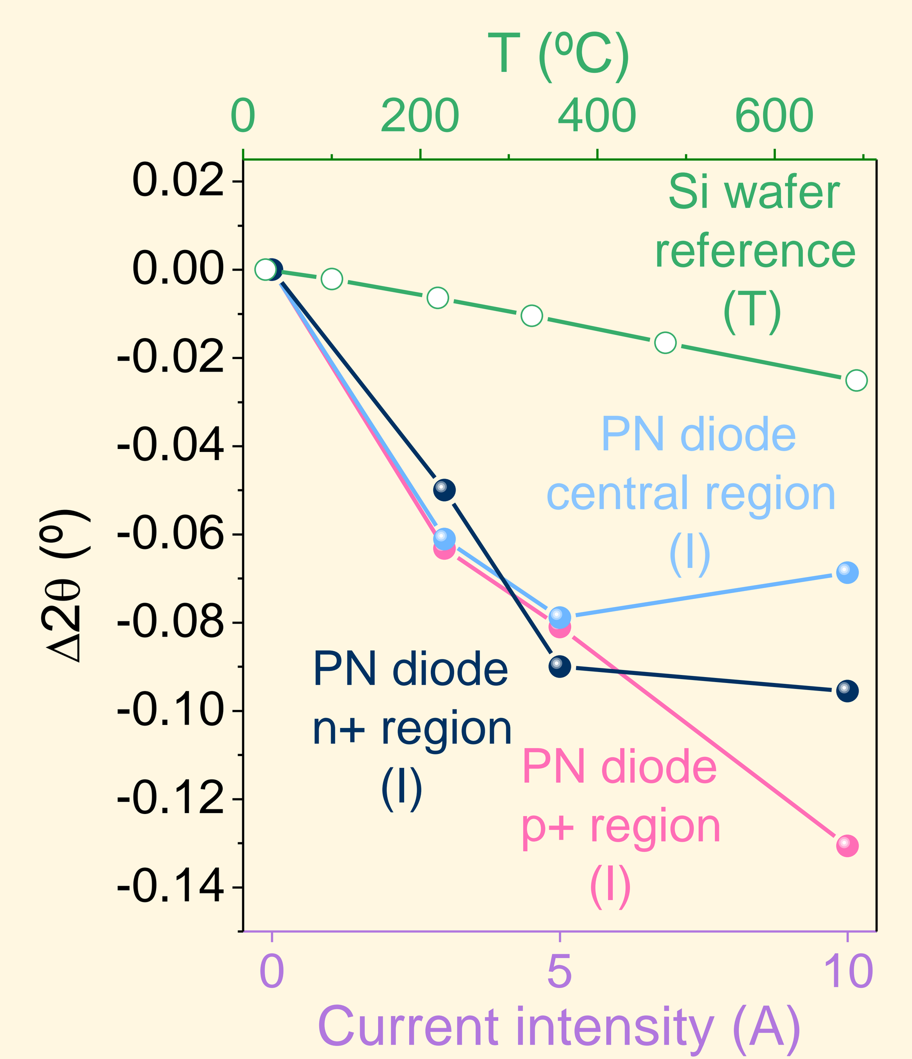


E= 24.77 keV
l= 0.5 Å
Ø= 40 µm



p-dopants induce changes in the Si lattice, leading to a shift towards higher 2θ values.

As the electric current increases, 2θ decreases in all regions, which means thermal dilatation of the structure.



At high currents, differences between the three regions of Si embedded in the diode and with the Si wafer reference are revealed. These findings are related to dopants, stress or other phenomena.

CONCLUSIONS

- *In situ* structural studies of a forward-biased PN diode were performed by **CRM** and **GIXRD** using a **specifically designed setup**.
- **3 different regions** corresponding to the doping scheme of a PN diode are identified in the Si wafer.
- An **evolution with the current** in all regions **reveals differences between pure and non-purely thermal effects**.

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