Local gradients of microstructure and residual stresses in Si device sidewalls separated by laser dicing

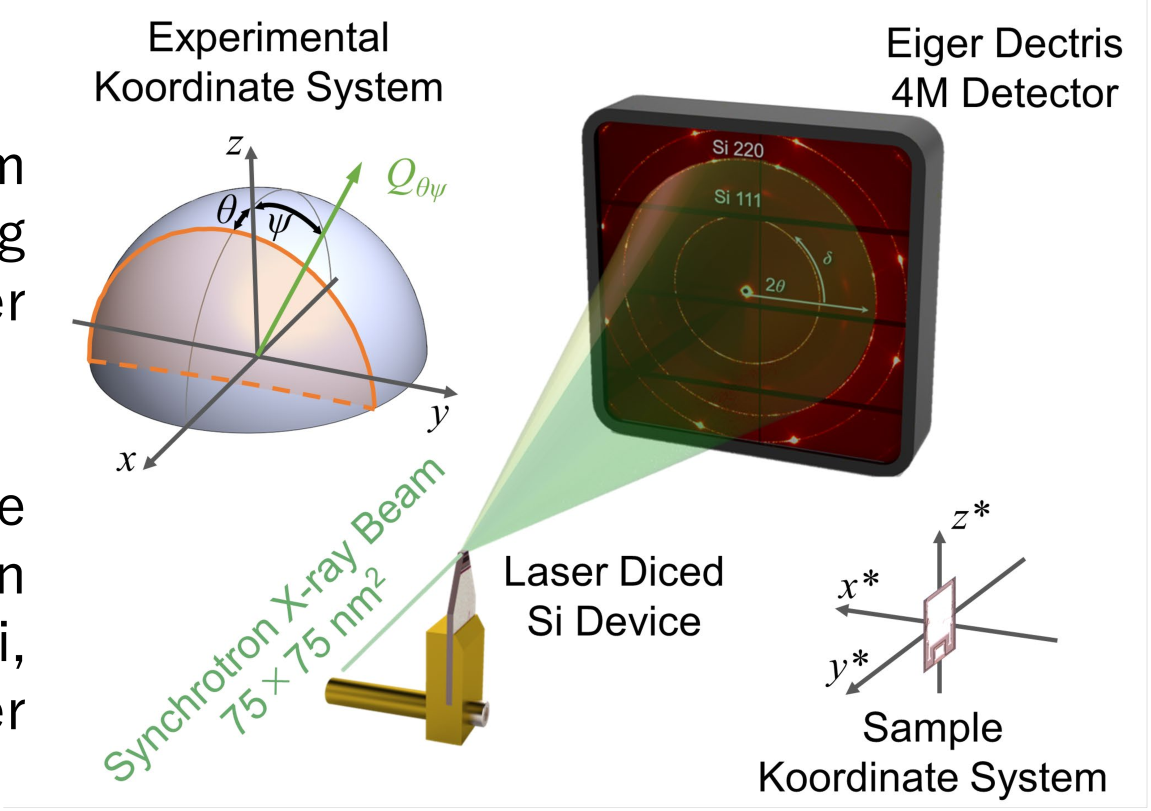
T. Ziegelwanger[a]*, M. Reisinger[b], K. Matoy[c], J. Todt[a], M. Meindlhumer[a], J. Keckes[a]

[a] Department Materials Physics, Montanuniversität Leoben, Leoben, Austria
[b] KAI – Kompetenzzentrum Automobil- und Industrieelektronik GmbH, Villach, Austria
[c] Infineon Technologies AG. Villach, Austria
*Correspondence E-mail: tobias.ziegelwanger@unileoben.ac.at

Introduction & Experimental

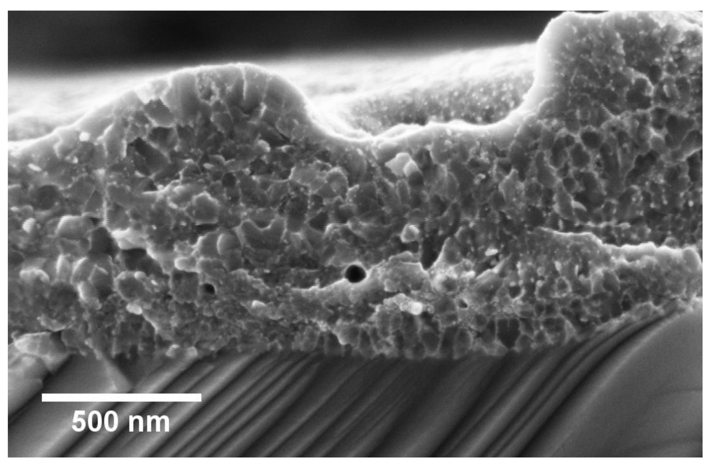
Laser Dicing is the established process for separation of wafers thinner than 100 µm thickness. One of the process characteristics is the redeposition of ablated material along the final device sidewall. The role of the deposited layer is still under debate. This poster sheds some light on intrinsic stress and microstructure of the recast layer.

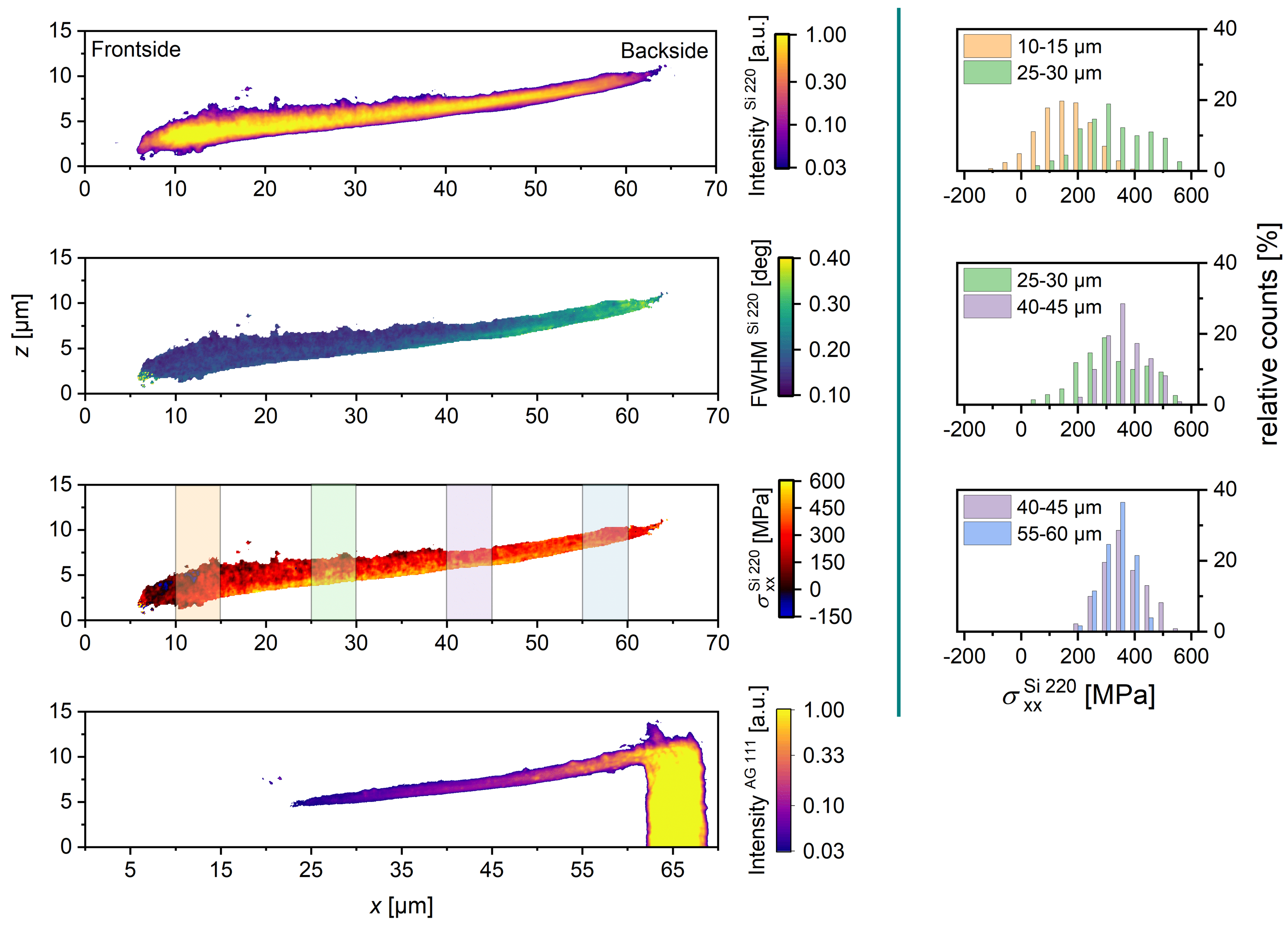
In this contribution local tensile residual stresses within the redeposition layer were quantified with **CSnanoXRD** at the beamline ID13 at the ESRF synchrotron light source in Grenoble. Two devices one with and one without a backside metallization consisting of Ti, Ni, Ag and V were characterized. The results were interpreted based on the layer microstructure characterized in the **SEM**, as well as **TEM**.



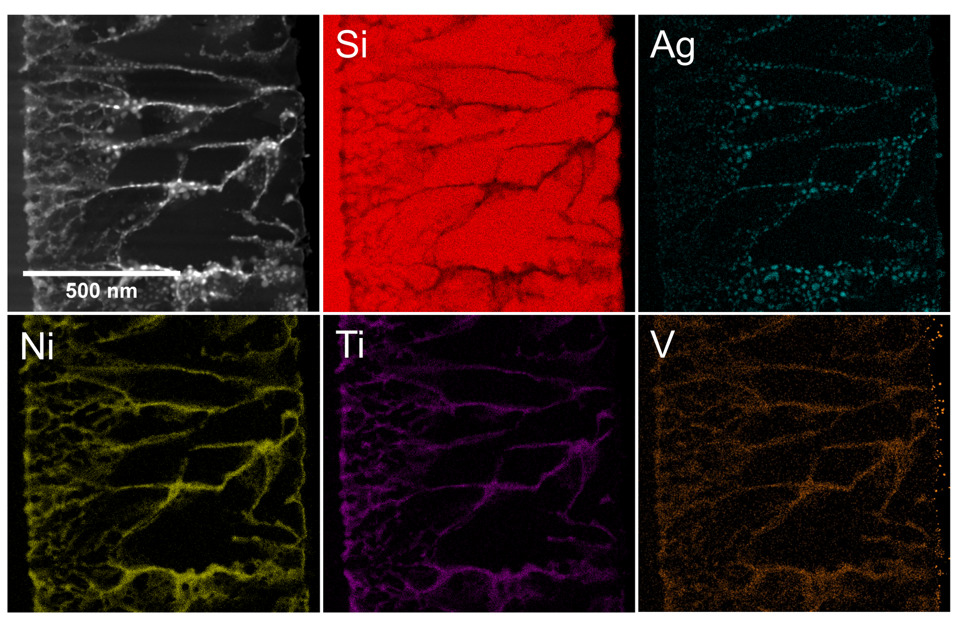
Recast from metallized Die

The redeposition layer of the metallized device is inhomogeneous in thickness and ranges from 500 nm to 1 µm. The ultrafine-grained microstructure exhibits pores and precipitates along the grain boundaries.





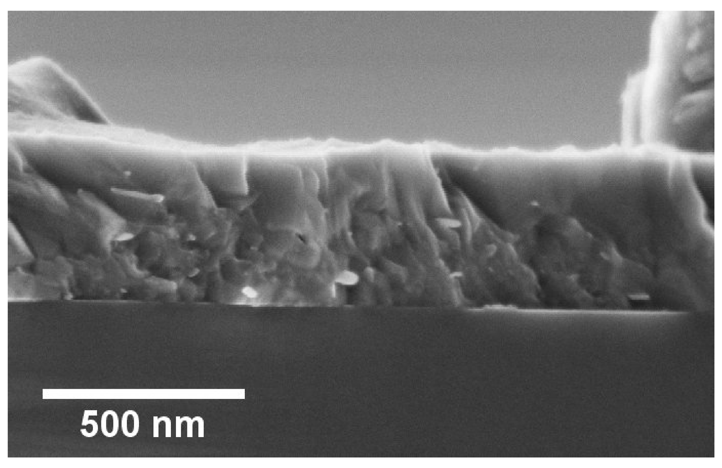
The Si 220 diffraction peak reveals a gradient from front- to backside in **FWHM** and tensile residual stress. First, this indicates a decreasing grain size with increasing number of defects and second that there is an according increase of an average residual stress from 150 MPa up to 350 MPa. This further aligns with the signal of the Ag 111 reflection peak.

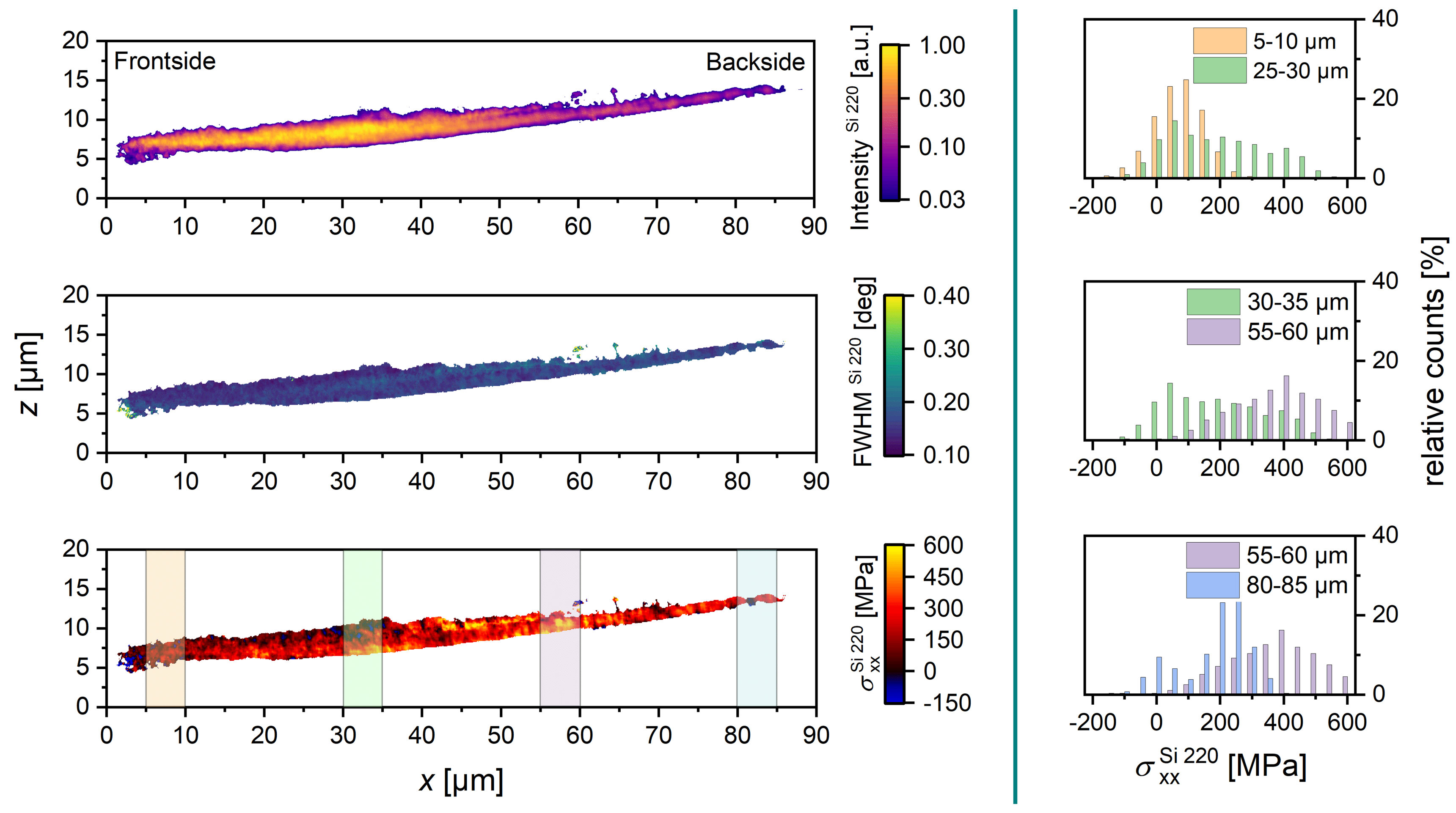


HAADF-TEM images reveal elements of the backside metallization incorporated into the redeposition layer. They gather at the grain boundaries, where Ti, Ni and V form a continuous phase and Ag forms separated particles.

Recast from bare Die

The redeposition layer of the bare device is of similar size to the metallized device and exhibits a coarse-grained microstructure. The grain size increases from the interface to the wafer upwards.





A streak of polycrystalline Si was measured by **CSnanoXRD**. The increased length of the redeposition layer is explained due to a sample misalignment. Gradients of **FWHM** and tensile residual stress observed within the metallized device are notably absent. However, a small gradient between interface to the wafer and top of the layer is visible.

Conclusions

- **TEM** images displayed metallic precipitates along the grain boundaries of the redeposition layer, originating from the backside metallization.
- Gradients of Increasing **FWHM** and residual stresses were measured for the metallized sample and align well with the intensity of the Ag 111 X-ray diffraction peak.
- A backside metallization influences the residual stress distribution after laser dicing

Abbreviations: **CSnanoXRD**: Cross-sectional X-ray nanodiffraction; **FWHM:** Full Width Half Maxima; **HAADF:** High-angle annular dark-field imaging; **SEM:** Scanning Electron Microscopy; **TEM:** Transmission Electron Microscopy