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FNSNF

Strain free GaAs grown on Si by MOVPE

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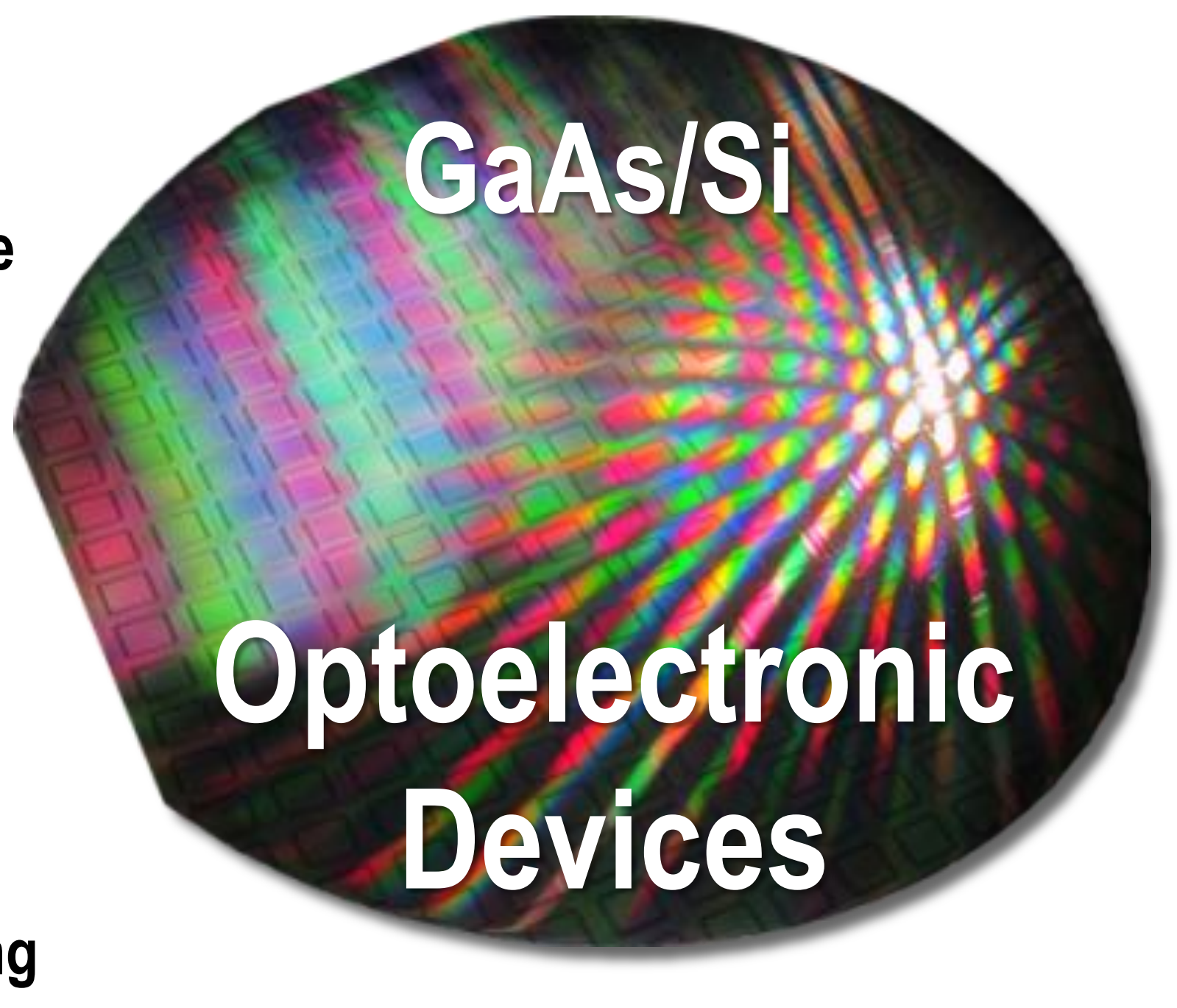
Motivation: III-V integration on Si

Si

Standard in production
Abundant and inexpensive
Available in large size

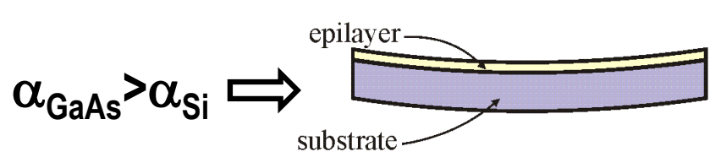
III-V

Larger electron mobility
Direct bandgap
Flexible bandgap engineering

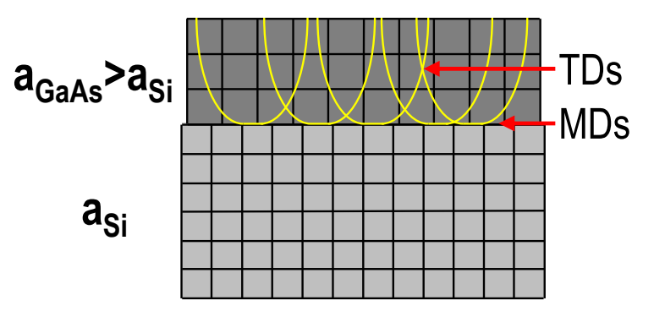


Challenges

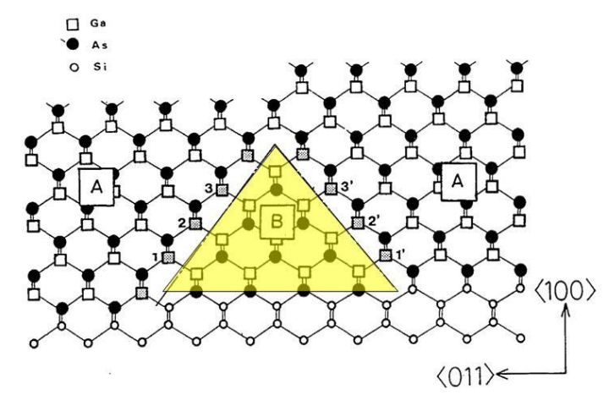
Thermal expansion mismatch
(wafer bowing & cracks)



Lattice mismatch (high TDD)



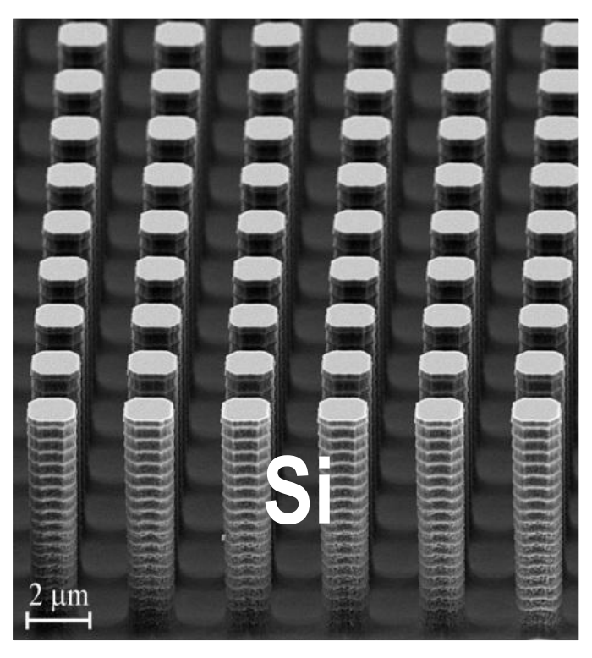
Anti Phase domains

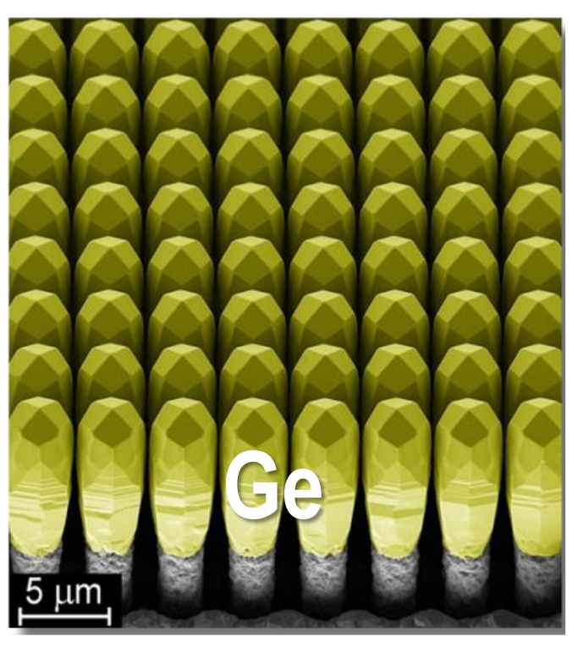


Background: 3D epitaxy

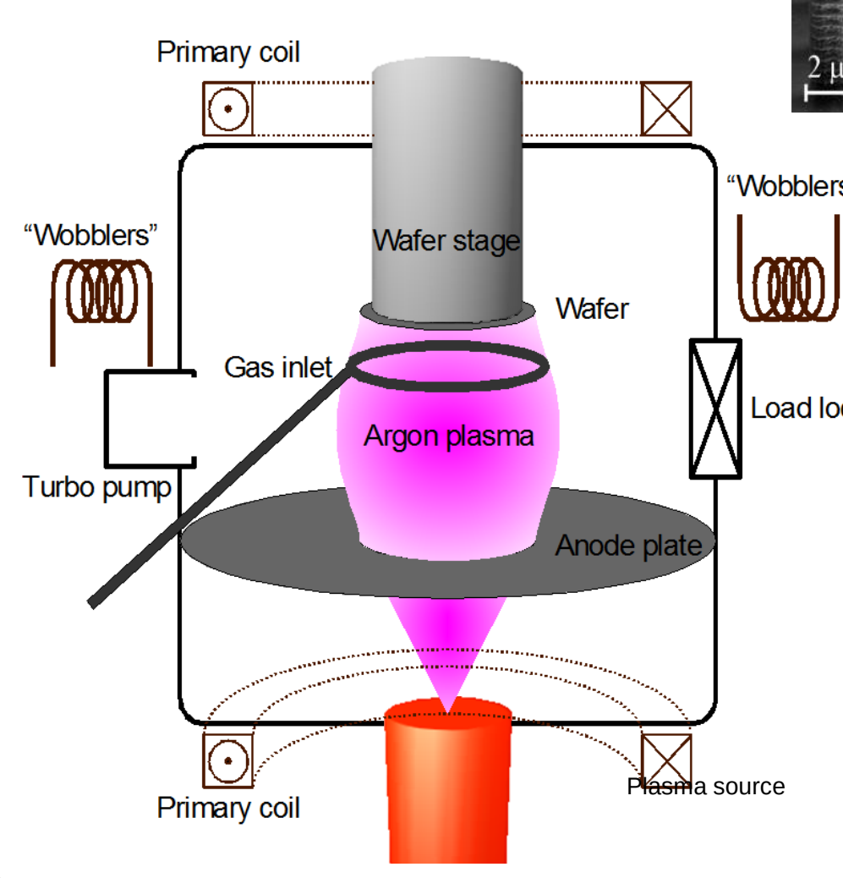
LEPECVD

Low substrate temperature ~500°C
High growth rates (10 nm/s)

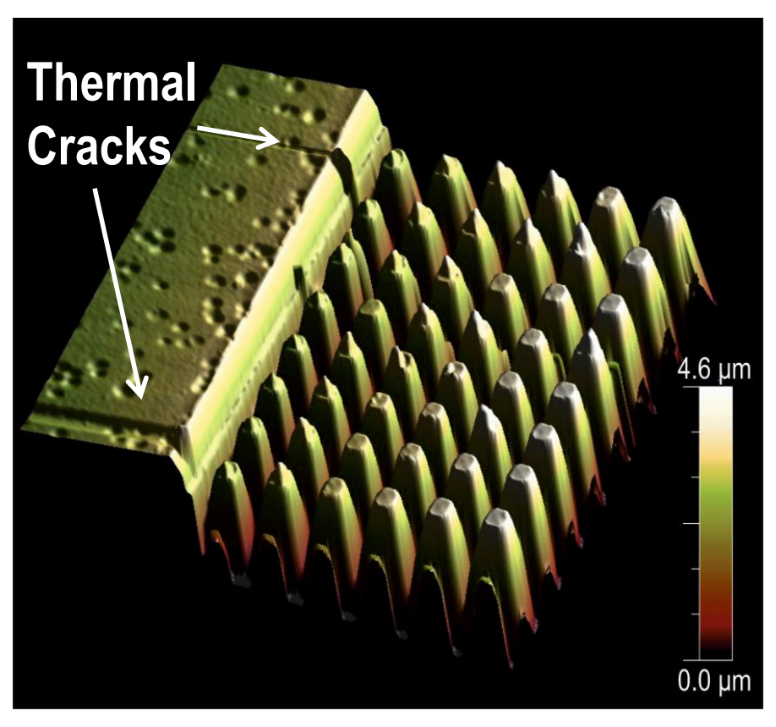




- ART + faceting:
- TDD zero on faceted material
- Self limited lateral growth: Full coverage of wafer surface (~ 98%)



Is it possible to extend this growth method to other materials/systems?

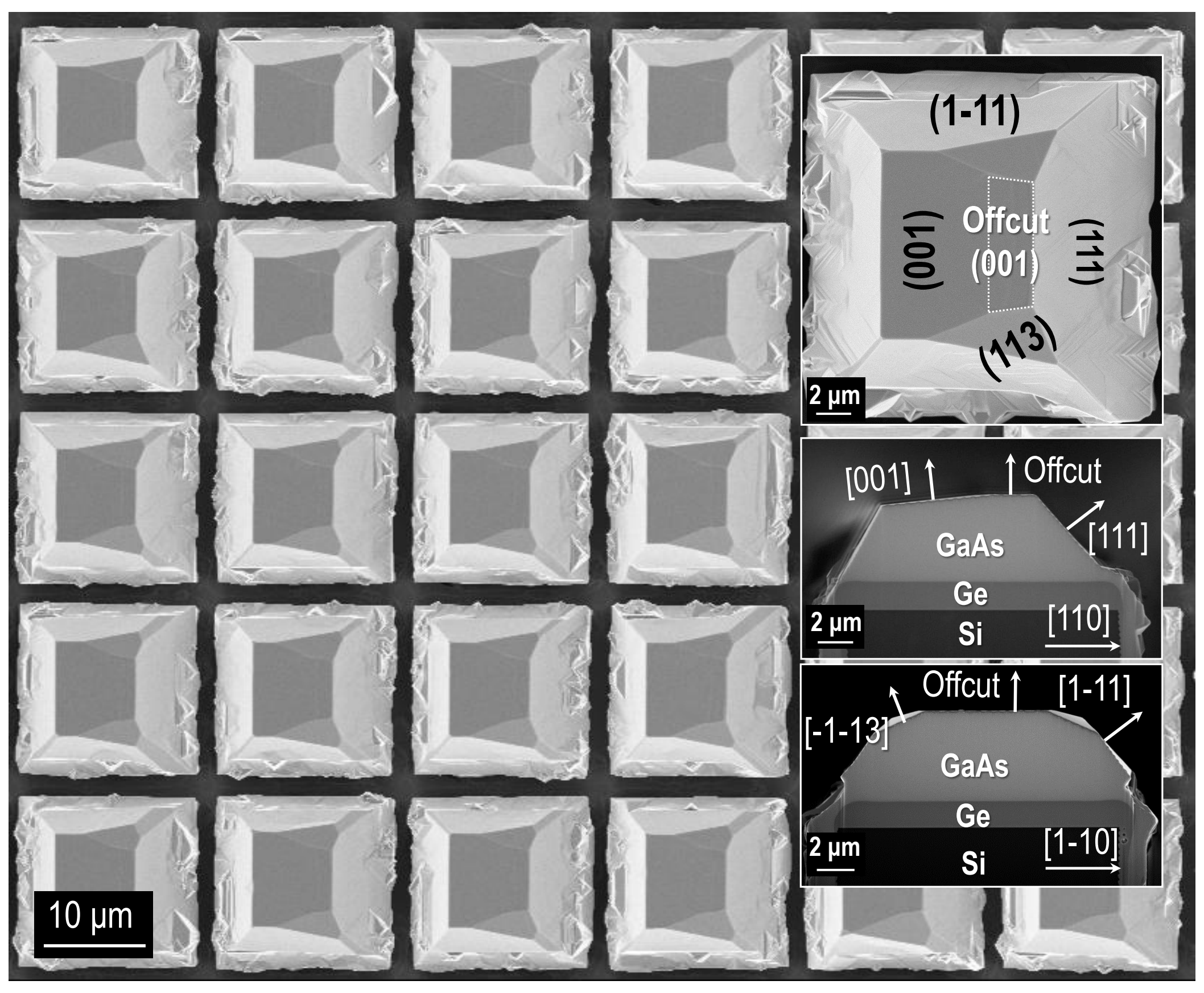


GaAs crystals grown by MOVPE on Ge/Si patterns

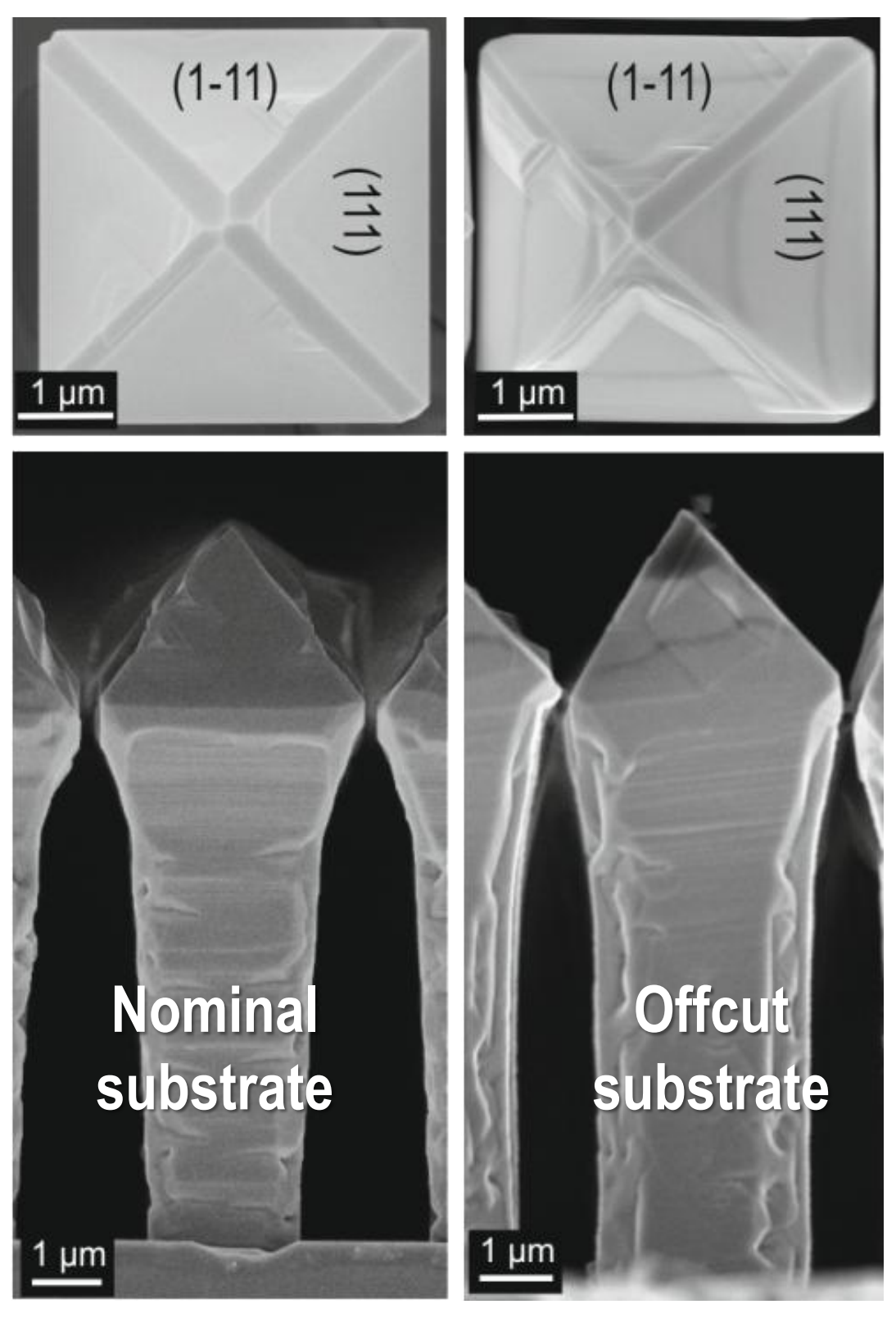
GaAs MOVPE growth on Ge/Si towers


MOVPE system at FIRST

Two temperature growth method
- Low Temperature nucleation (T=500° C)
- GaAs growth at T=680° C, V/III=50

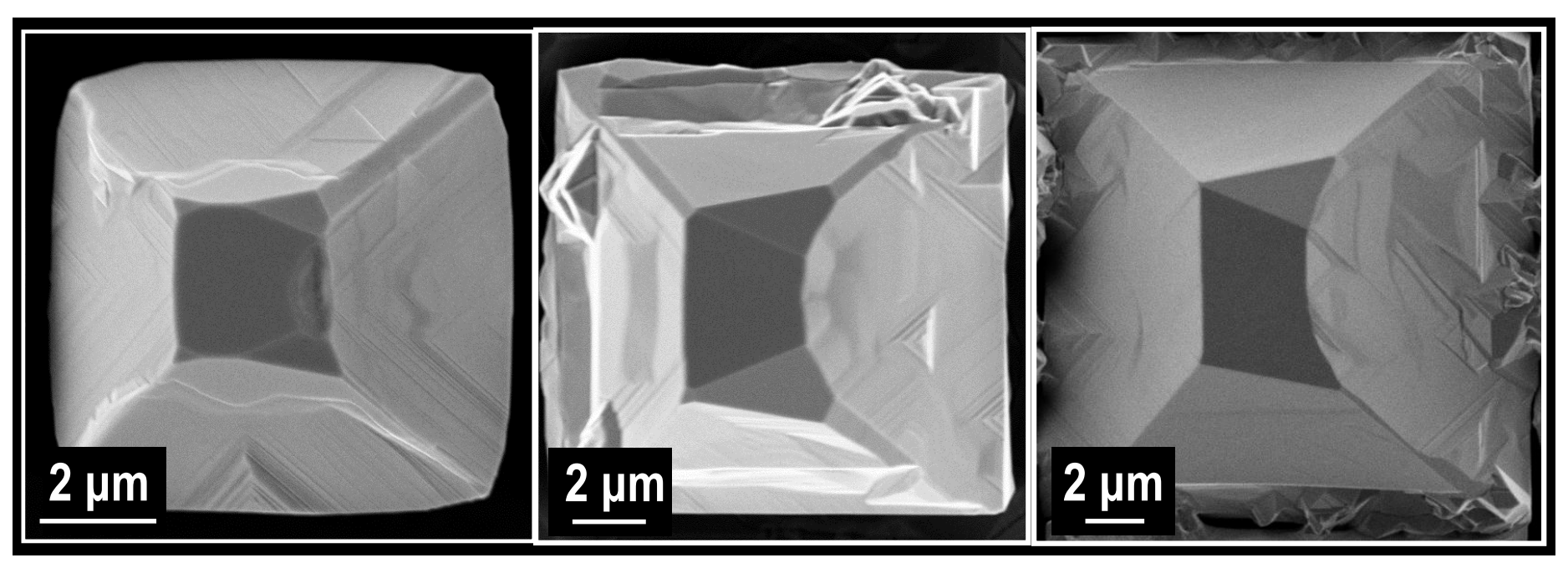


GaAs crystals morphology: **substrate orientation**



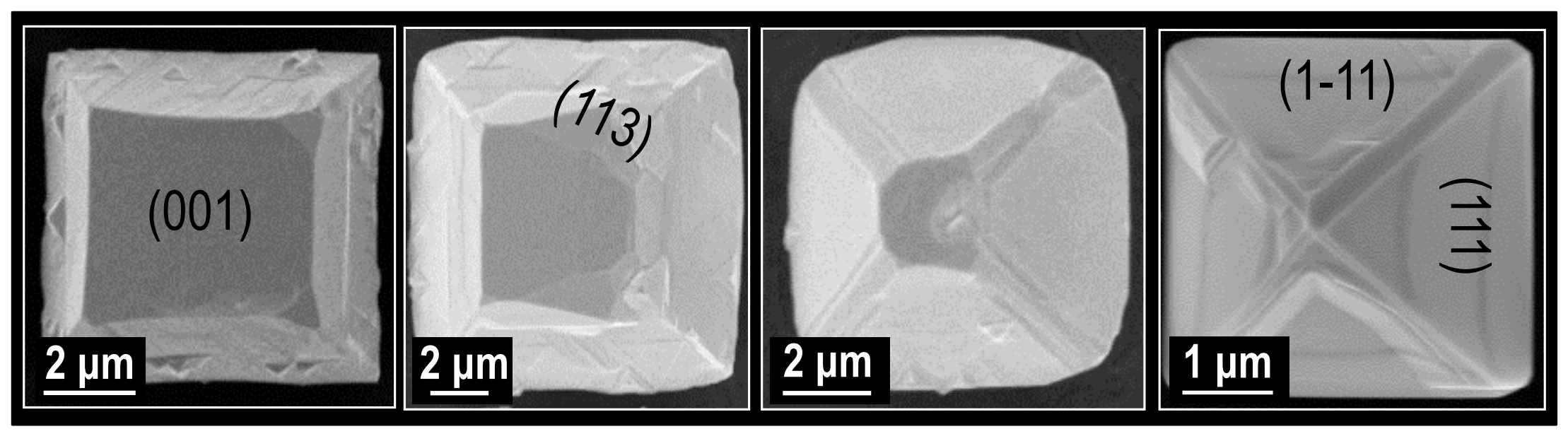
GaAs crystals morphology: **substrate *aspect ratio***

Constant aspect ratio (height/base)



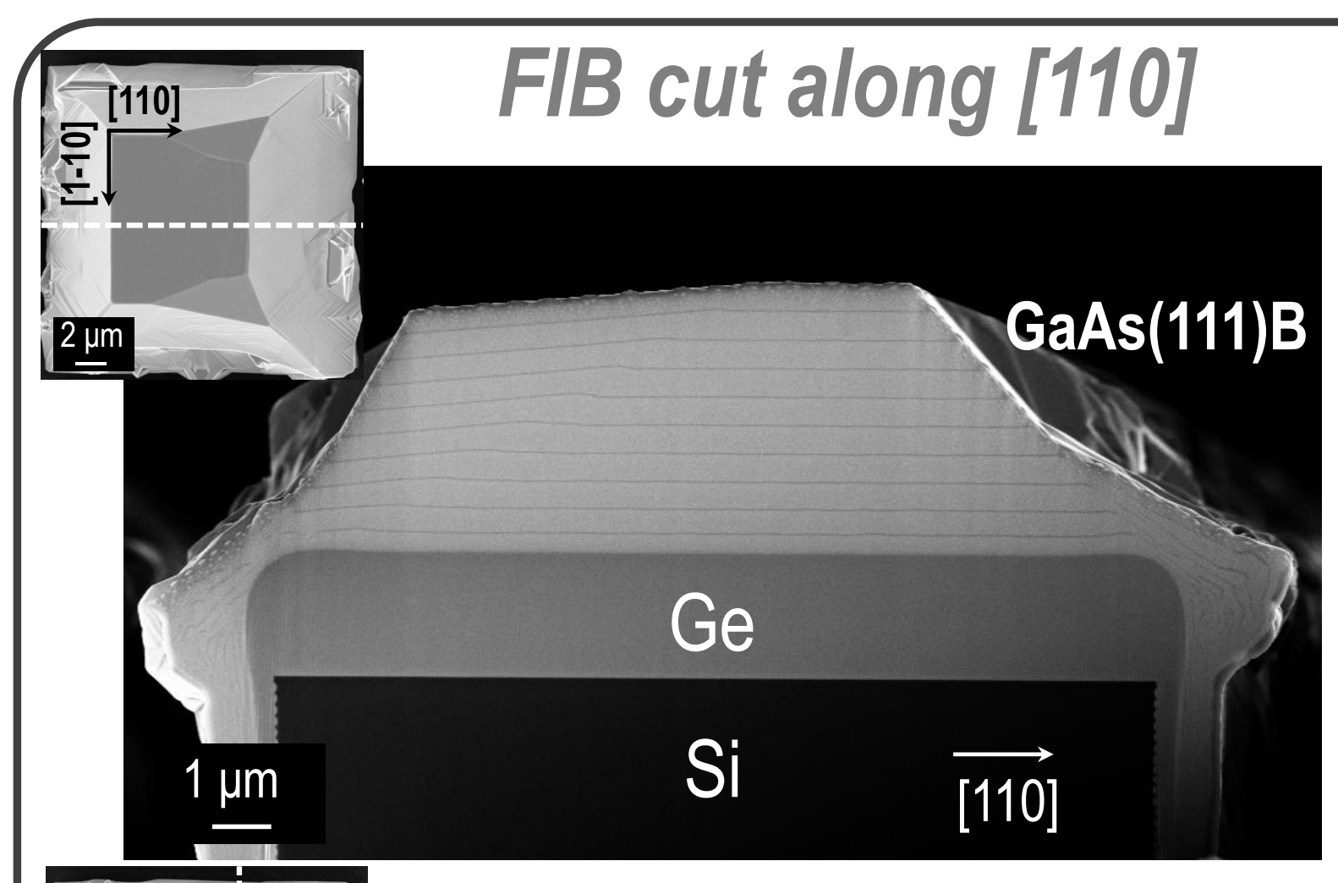
Constant GaAs thickness: 2 µm

15x15 µm^2 9x9 µm^2 5x5 µm^2 2x2 µm^2

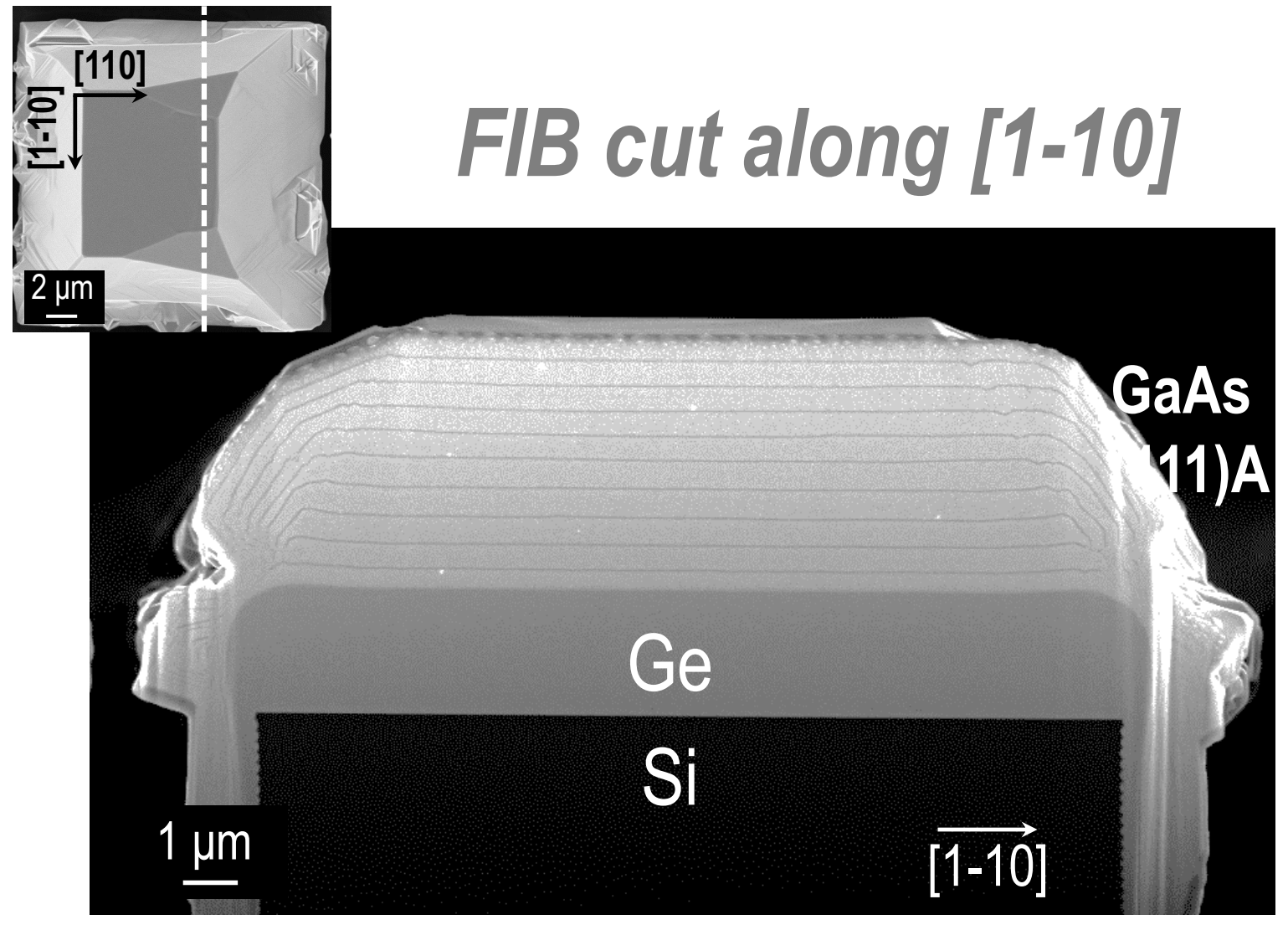


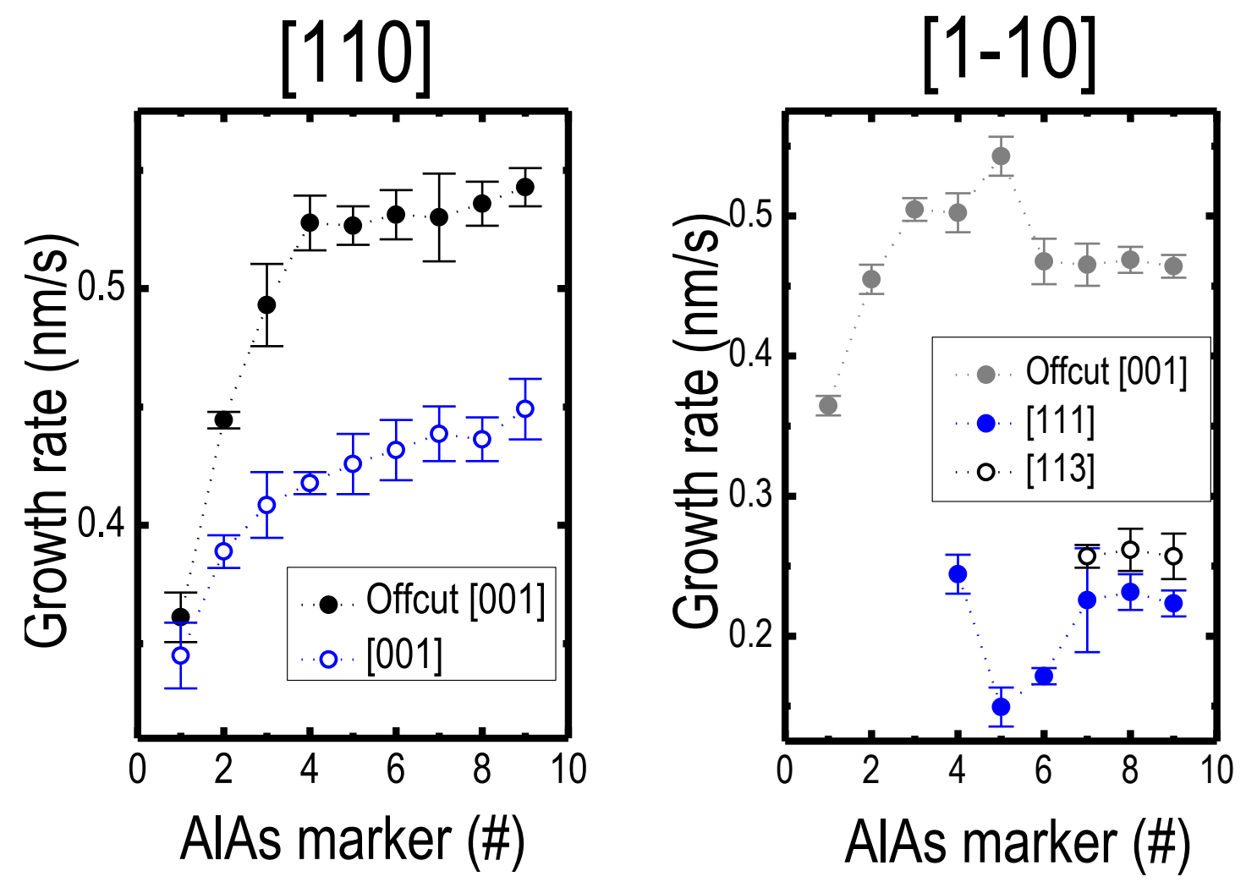
Growth kinetics

FIB cut along [110]



FIB cut along [1-10]

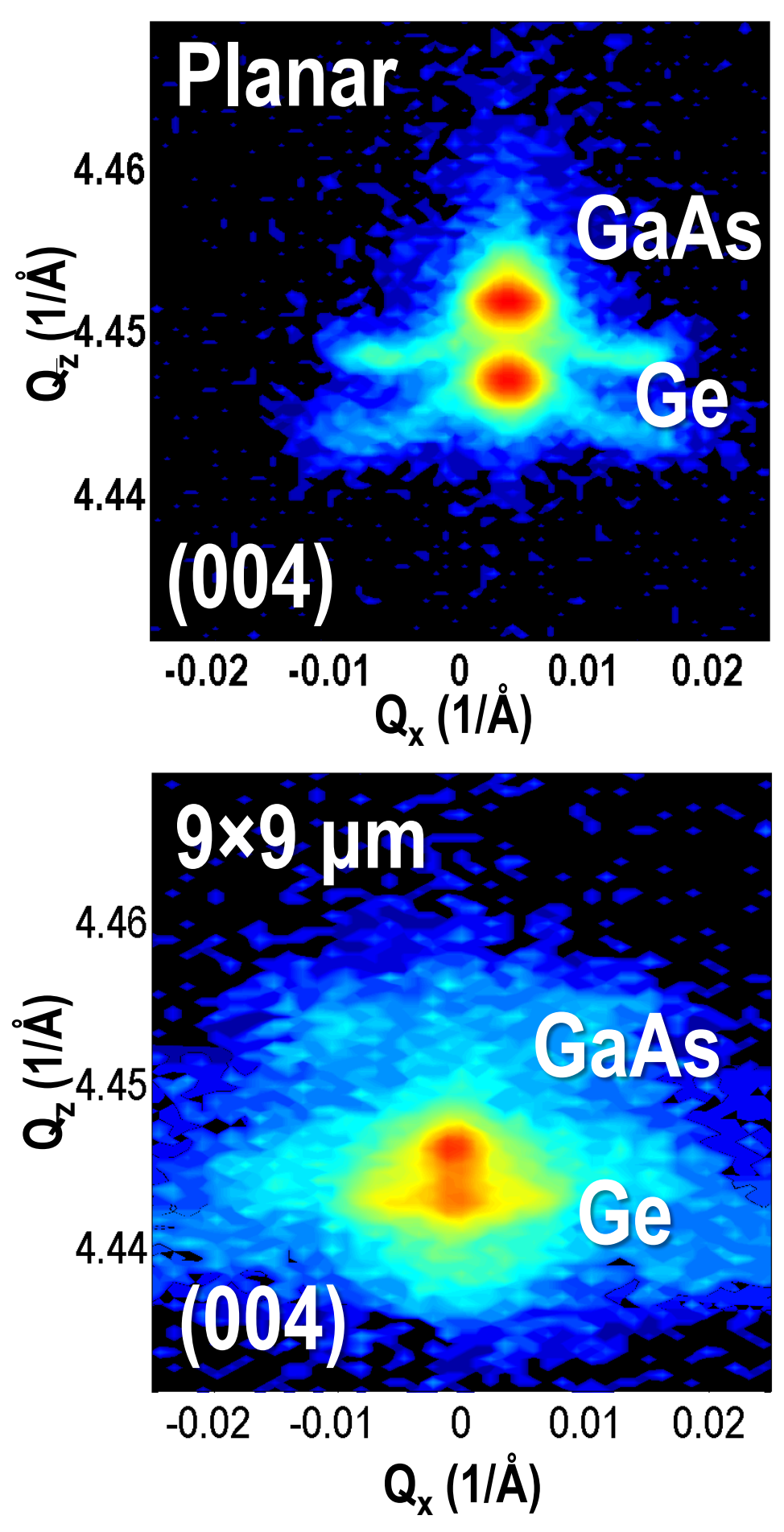


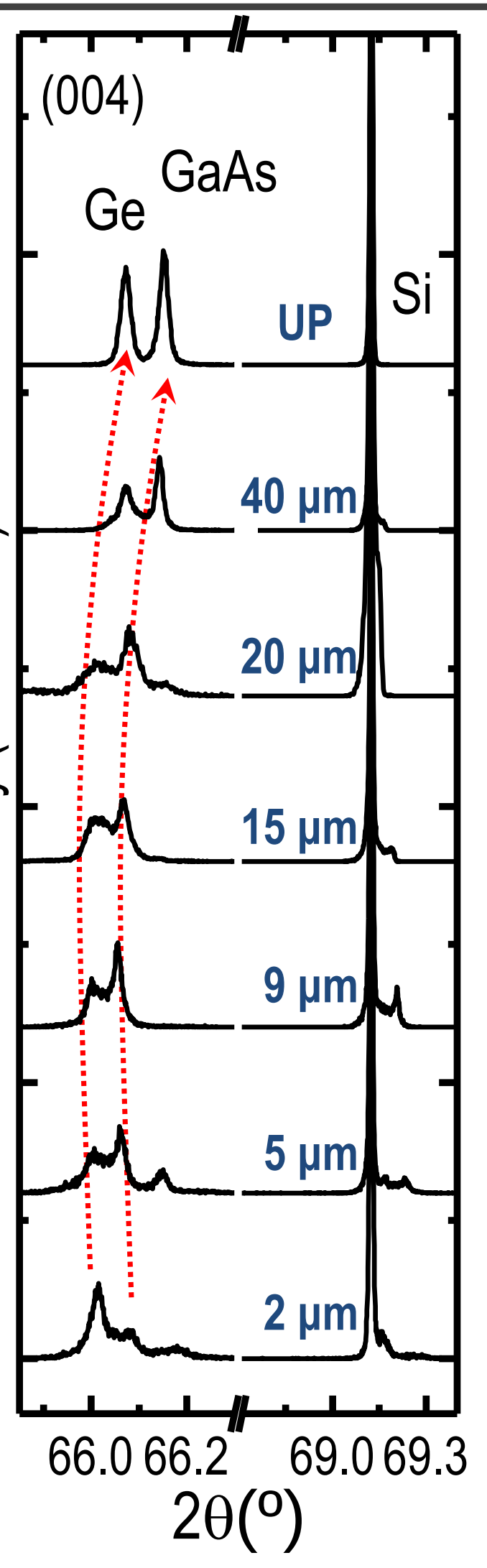


Growth rate of the different facets

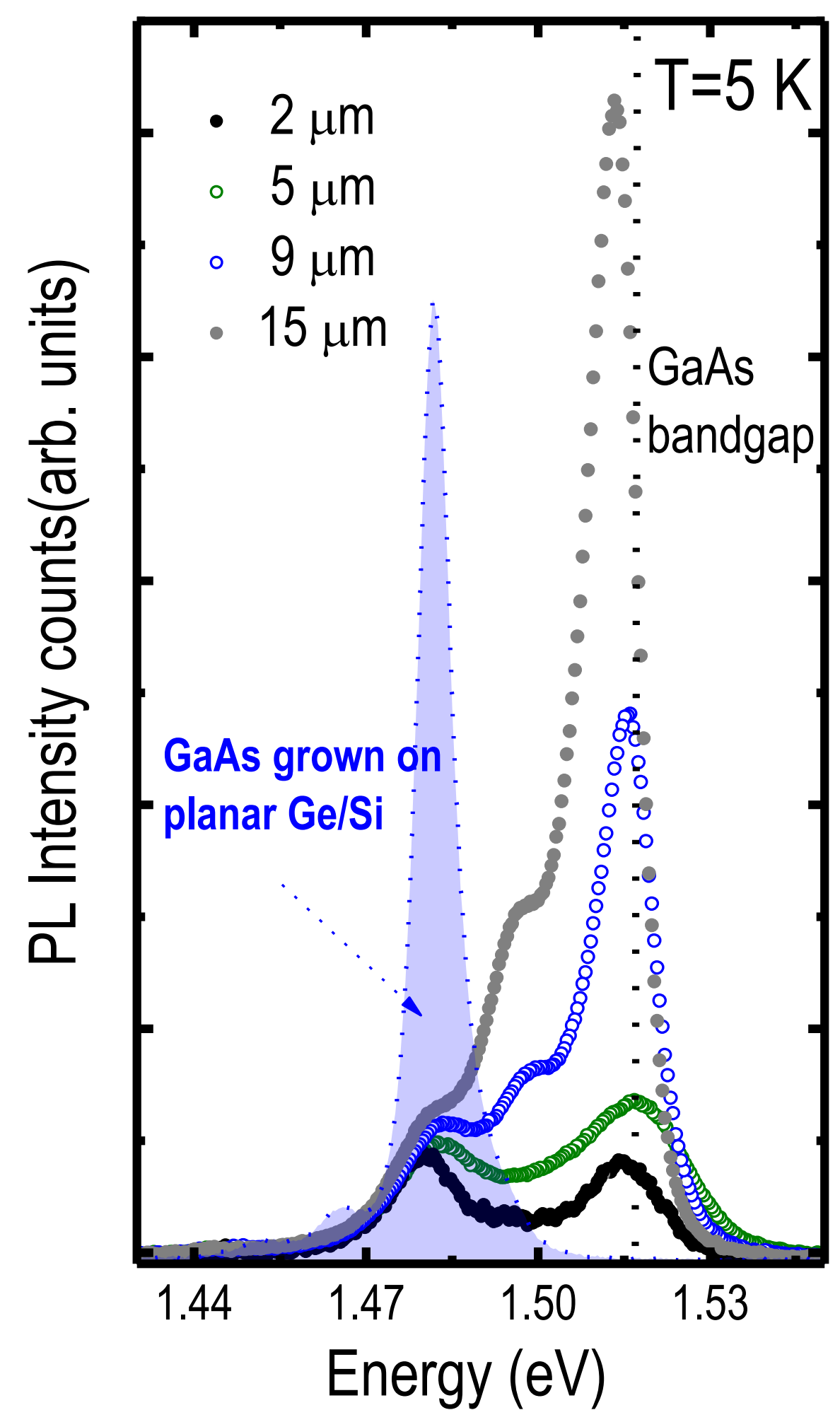
Strain free GaAs

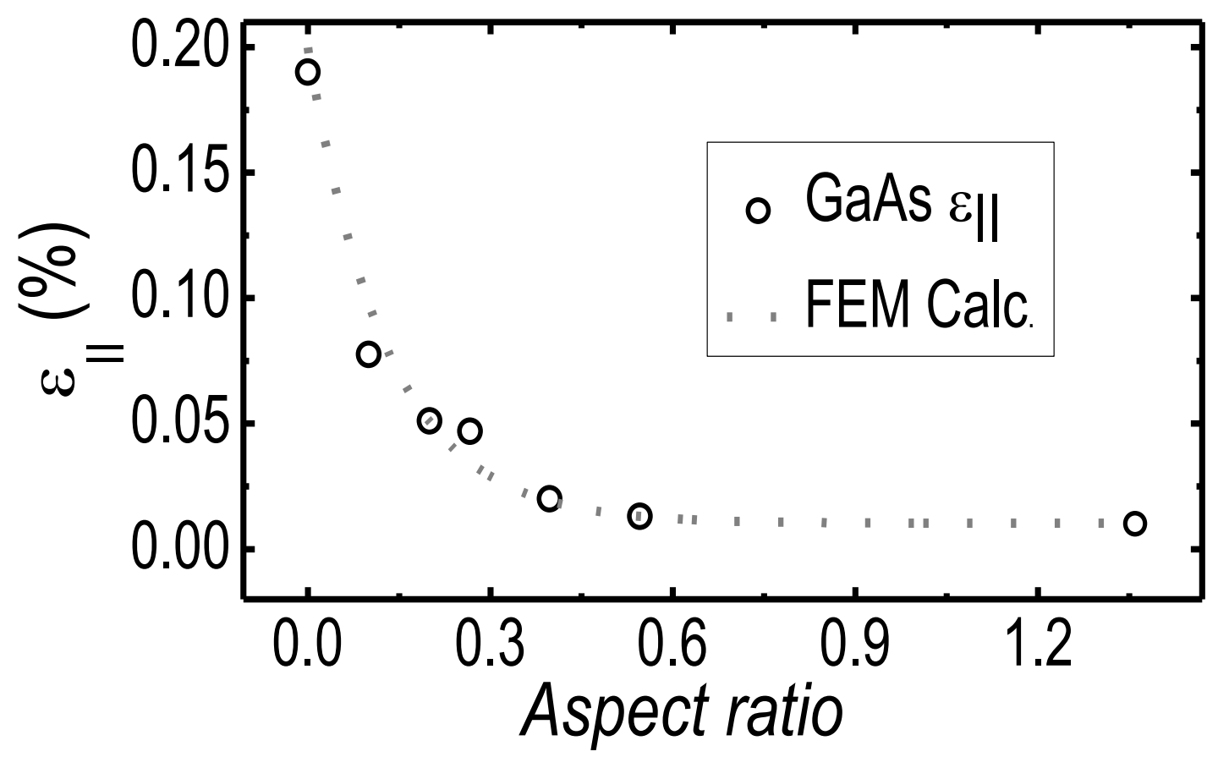
HR-XRD

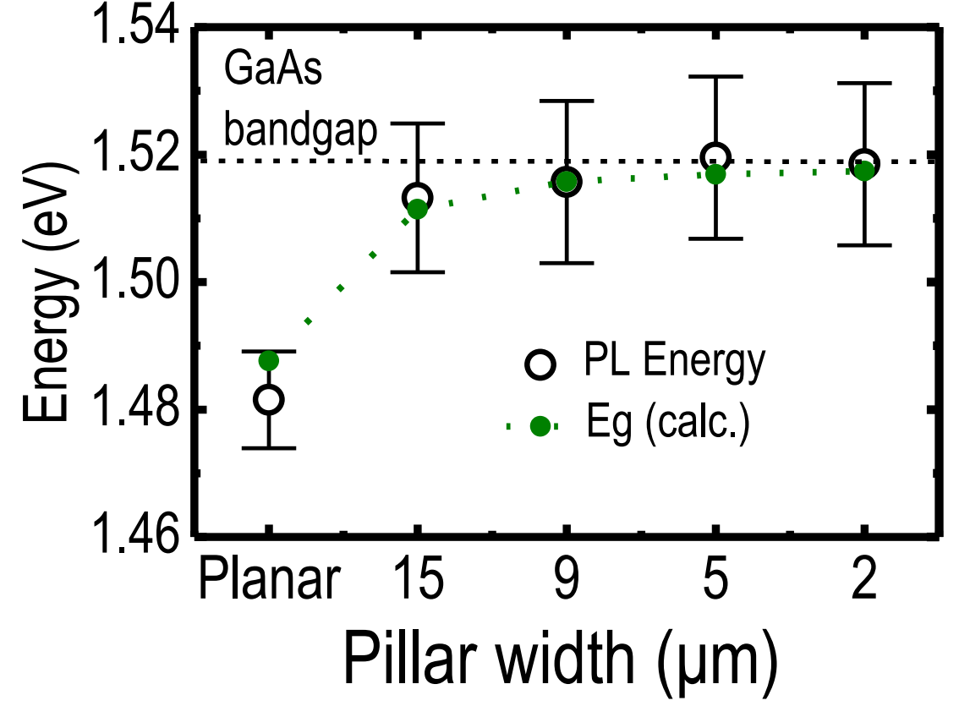




PL



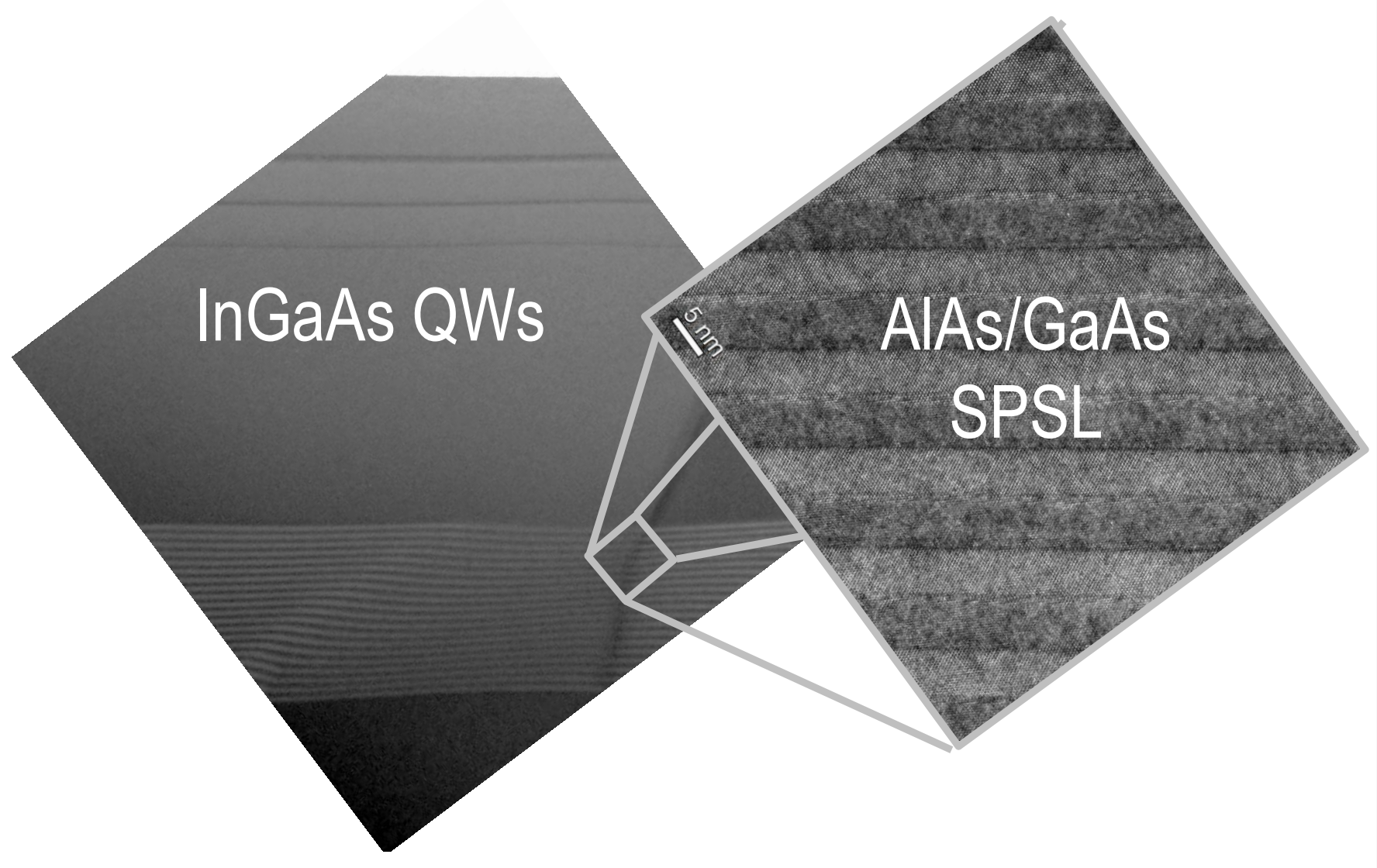


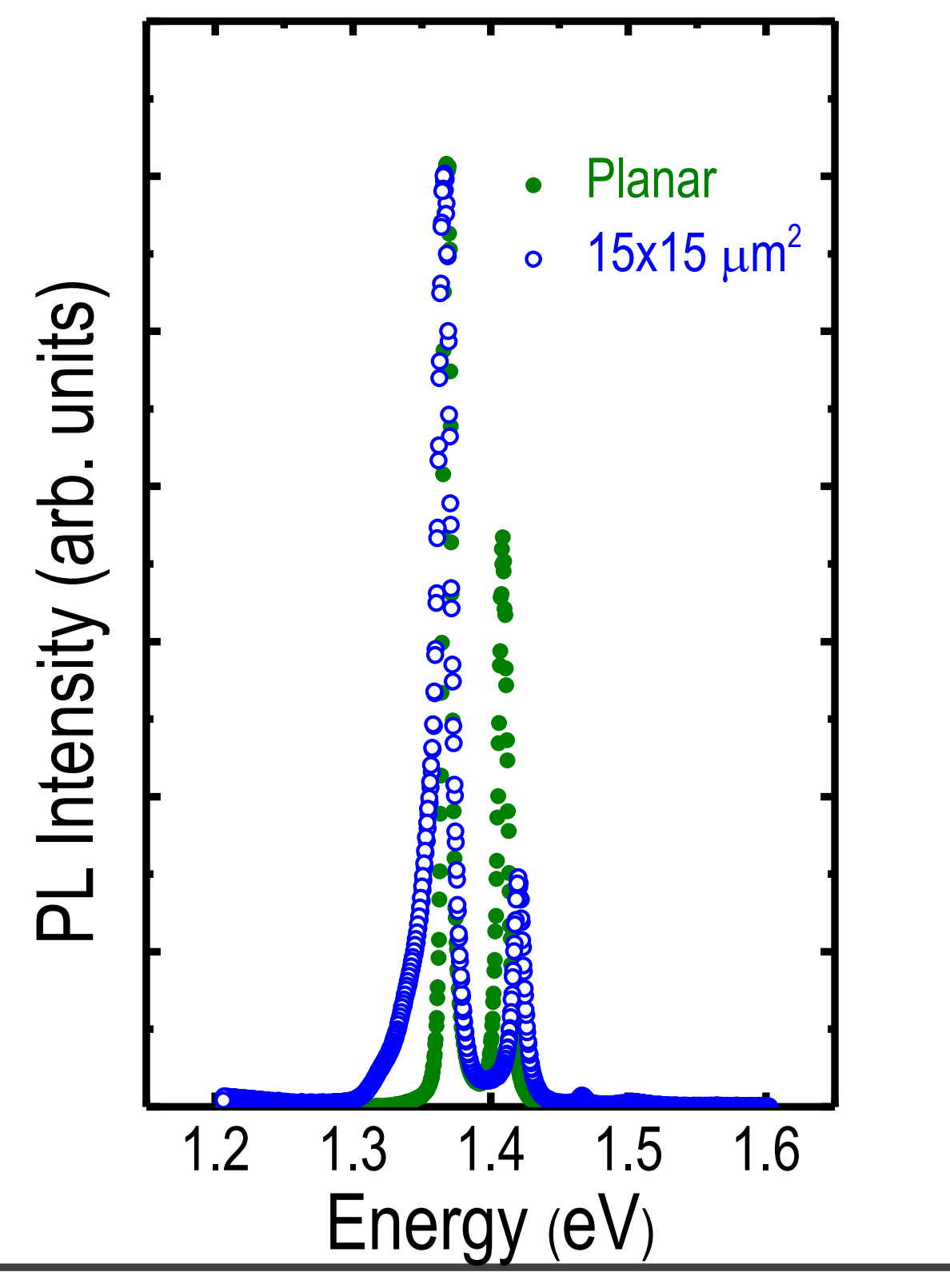


GaAs crystals grown on 15 µm wide Ge/Si pillars exhibit a **75% release of the strain** relative to GaAs layers grown on planar substrates

InGaAs/GaAs QWs on Si

Successful integration of optically active quantum structures on Si





Acknowledgements

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References

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- M. Richter, E. Uccelli, A.G. Taboada, D. Caimi, N. Daix, M. Sousa, C. Marchiori, H. Siegwart, C.V. Falub, H. von Känel, F. Isa, G. Isella, A. Pezous, A. Dommann, P. Niedermann, J. Fompeyrine,Journal of Crystal Growth *In press* (2013)