

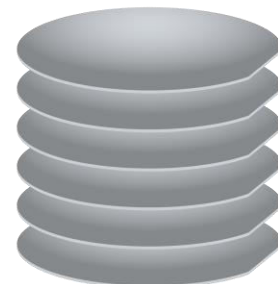
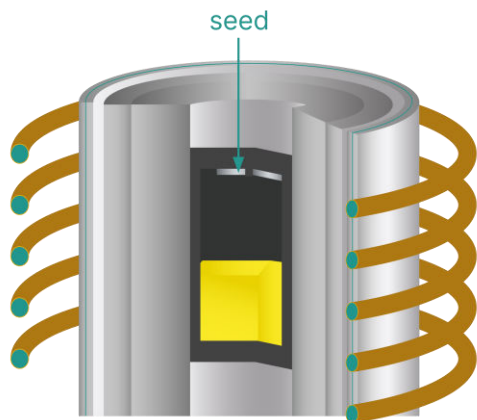


Sharpening SiC Wafer Specs and Frontend Performance by Crystal Orientation Metrology

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Motivation

Crystal orientation is critical in various steps in SiC

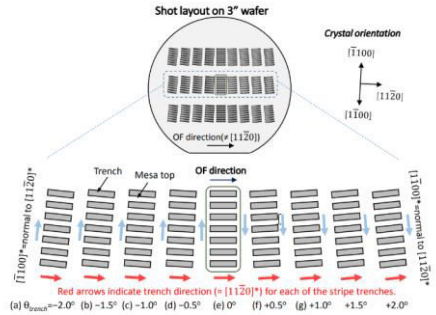
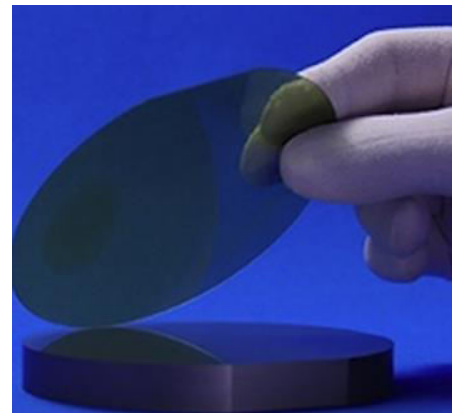
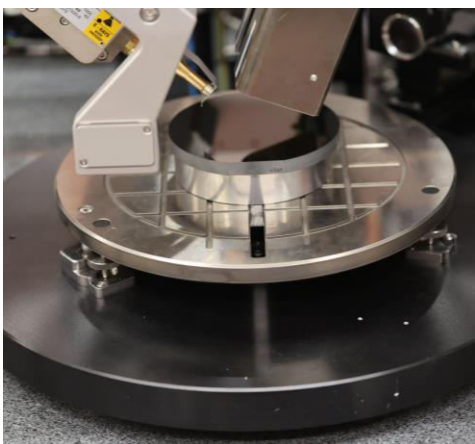
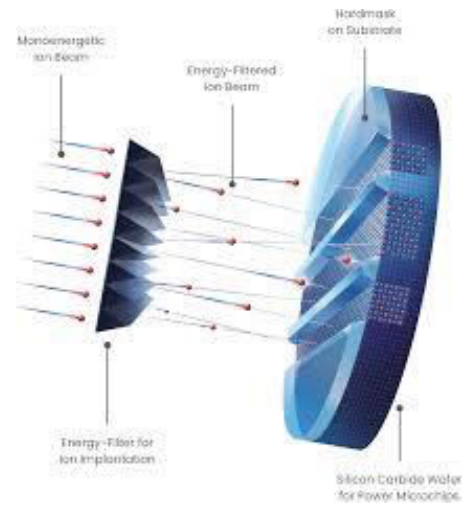


Fig. 1. (Color online) Shot layout on 3-in. wafer with schematic of nine intentionally-tilted stripe trenches on a photo mask. The direction at (e), where $\theta_{\text{trench}} = 0^\circ$, corresponds to the OF, which is not exactly the same as the $[11\bar{2}0]$ crystal orientation. $[11\bar{2}0]^*$ indicates the trench directions on each



- Our technology is sold to almost all major SiC players who do
 - Growth
 - Grinding
 - Splitting
 - Slicing
 - Lithography
 - Ion Implantation
- ...to align the crystal with their process.

New Product line

In a nutshell

SDCOM



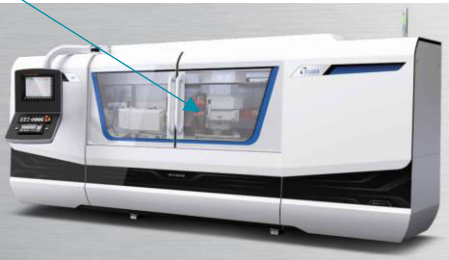
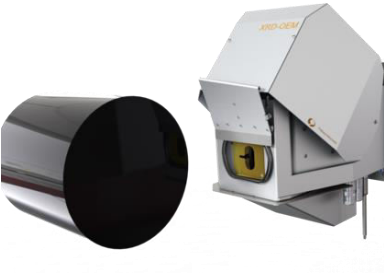
DDCOM



Wafer XRD 200, Wafer XRD 300



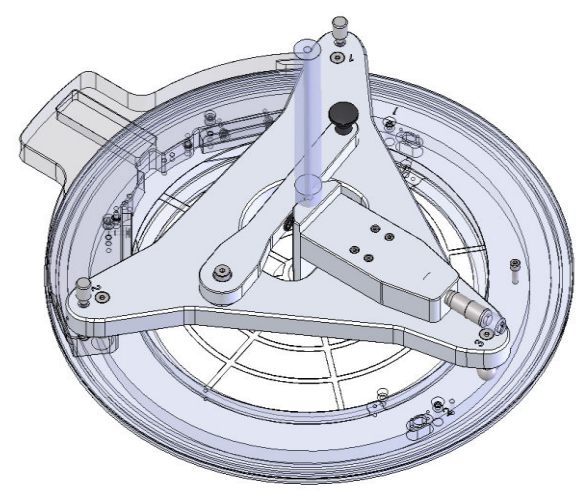
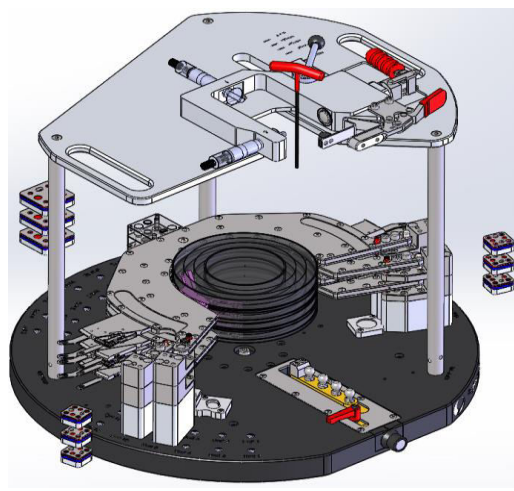
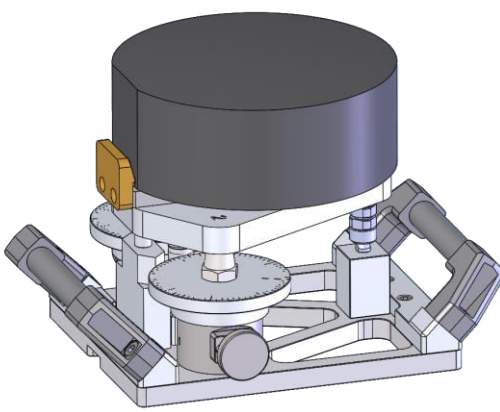
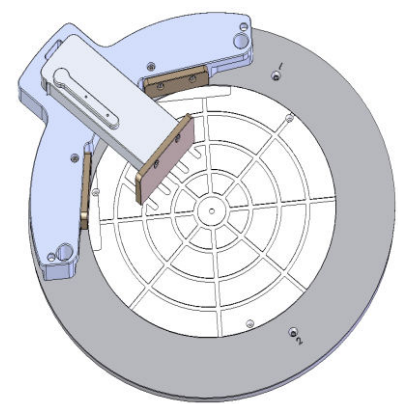
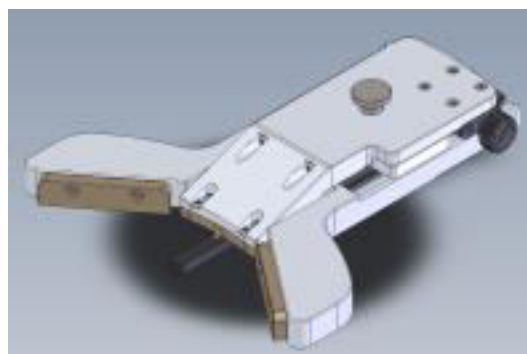
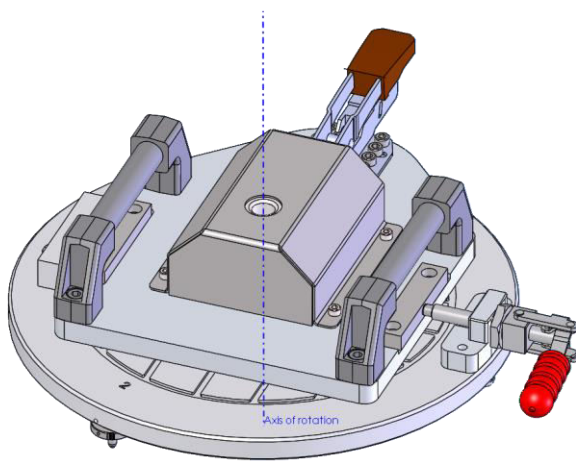
XRD OEM



Omega/Theta

Accessories

Small things enabling big improvements!

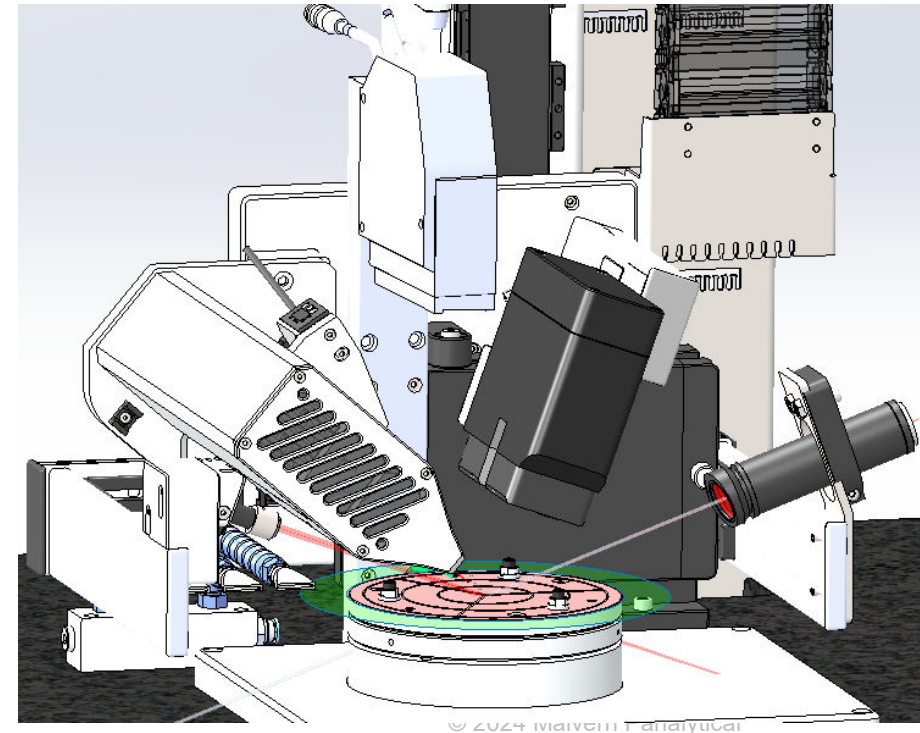
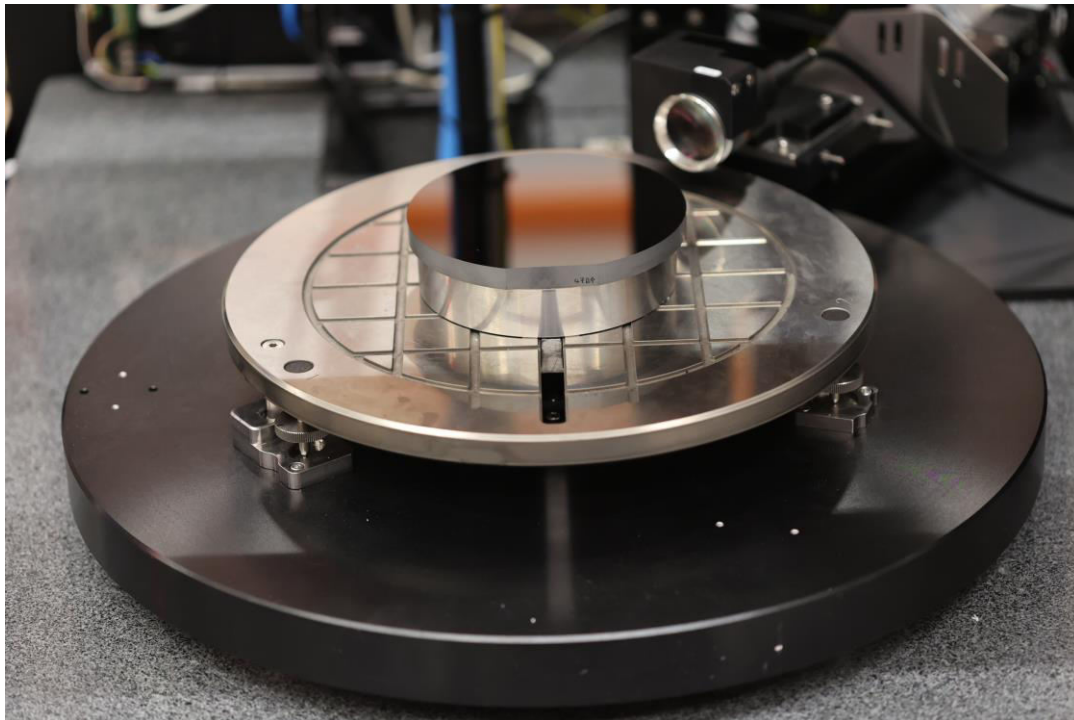


Multi Sensor Integration

Optical recognition of notch or flat



- Measures ingot diameter to micrometer precision.
- Recognizes notch/flat for positioning in respect to crystal directions.



Crystal orientation

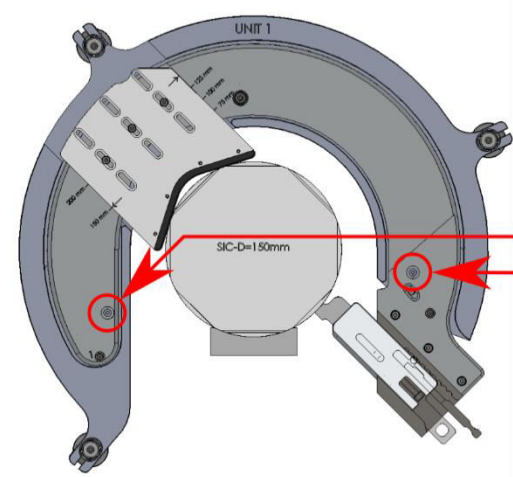
Classical solutions in comparison



	Laue	Rocking curves	Azimuthal Method
Measurement speed	5-30 s	180 -1000 s	5-30 s
Lateral directions	all	one	all
Std. dev. Tilt magnitude	0.1°	0.001°	0.003°

Ingots stacking

Cut many ingots at once



Current measurement Results list / Statistics Mapping view Options

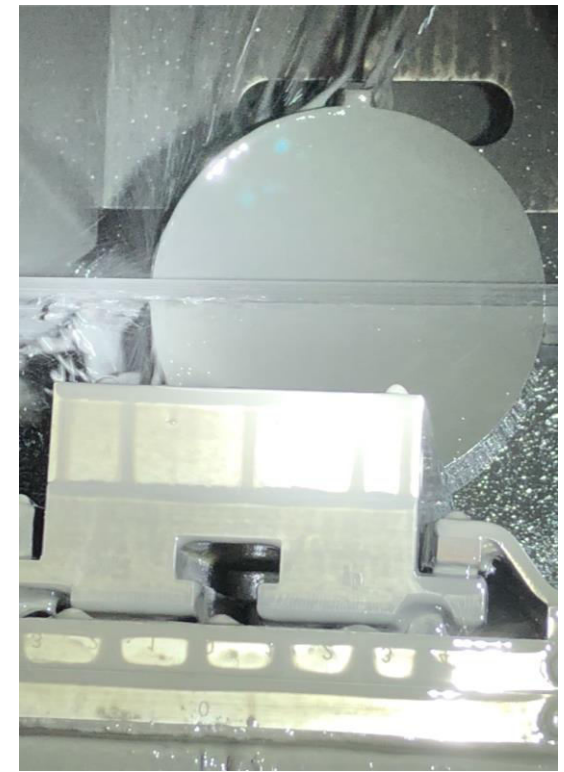
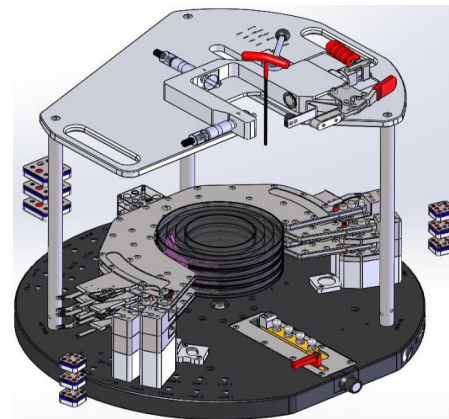
Tilt adjustment

Tilt unit type Target 0 Target 90

Stacking-Stage 0.0 0.0

Screw 1 -486.2 Degrees turn left

Screw 2 904.5 Degrees turn right

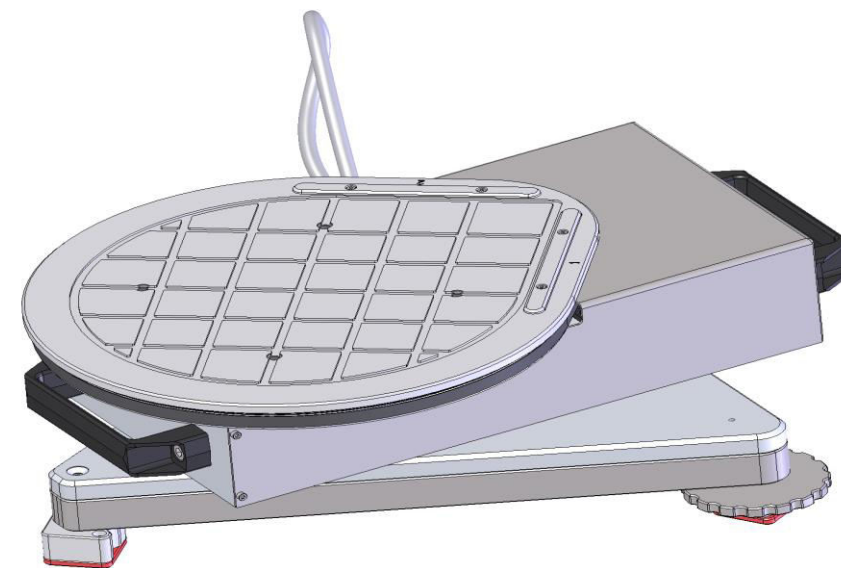
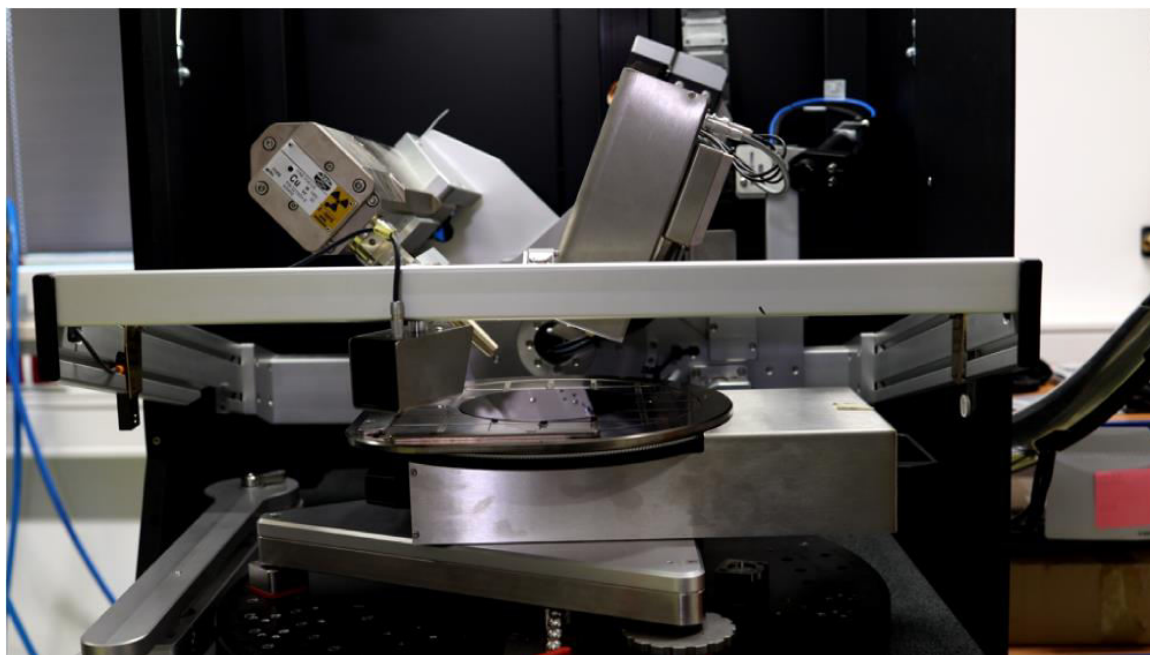


Wafer mapping

Control across the entire wafer

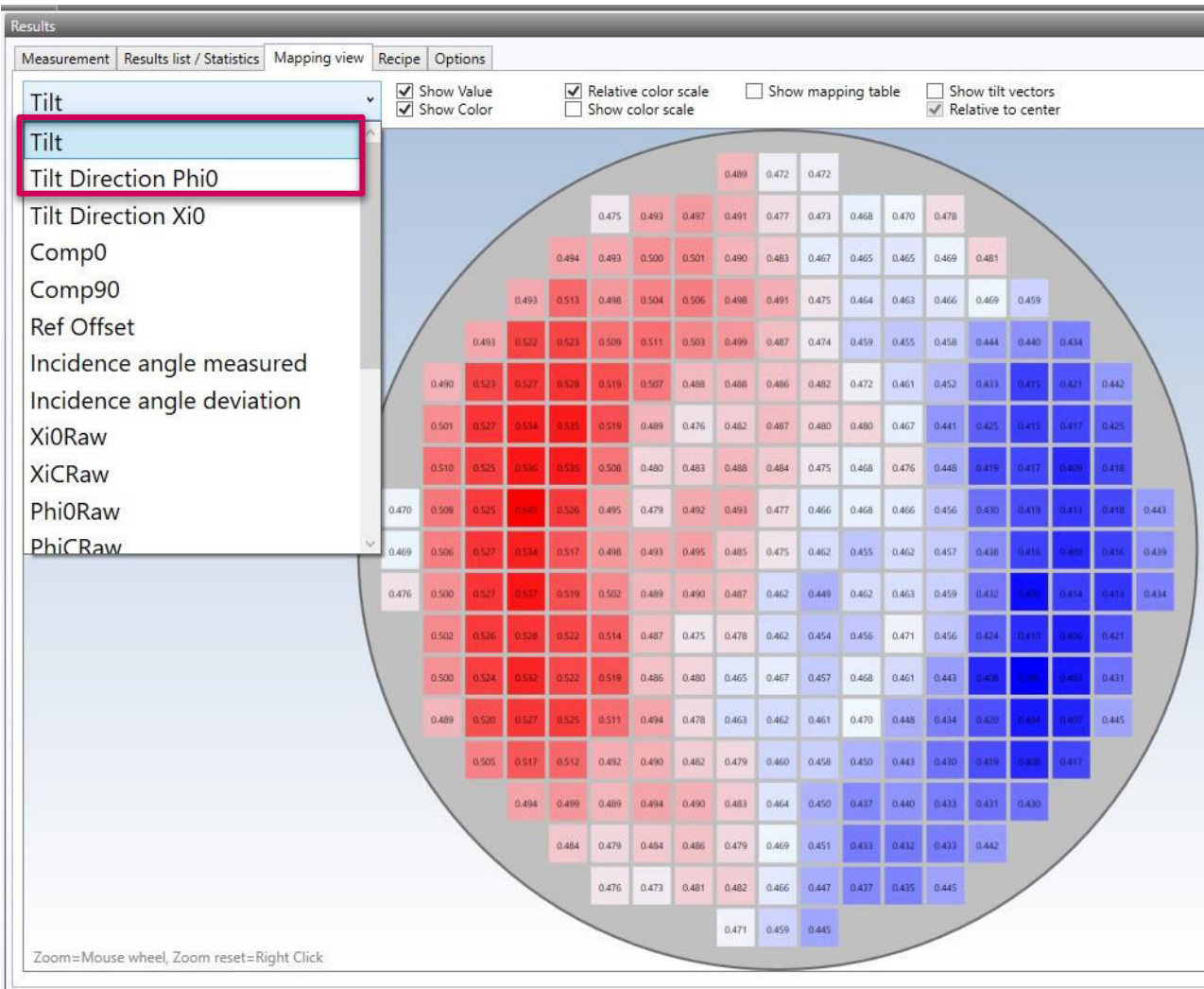
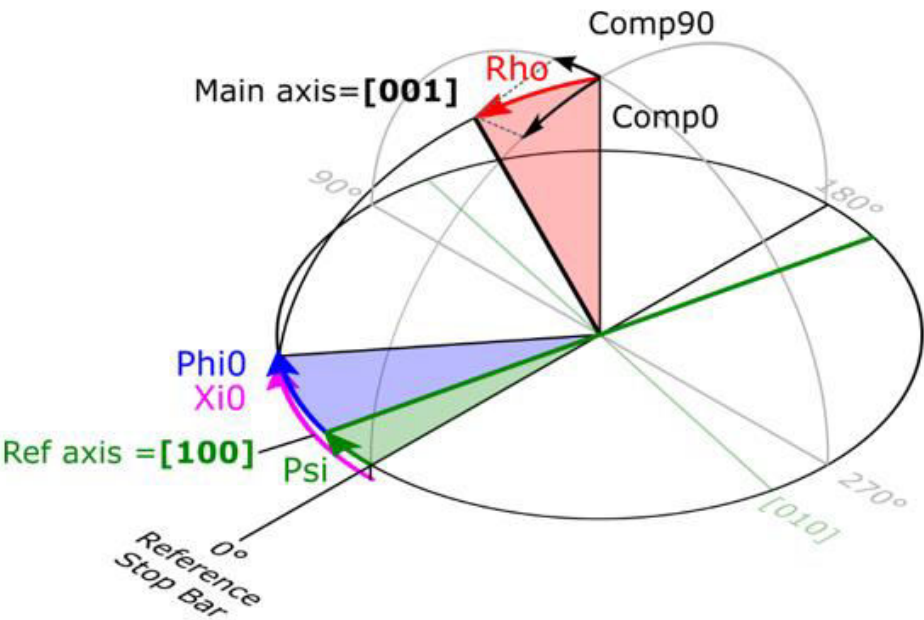


- Automatic 285 mm diameter stage
- Azimuthal-, Theta-Scan or rocking curve mapping

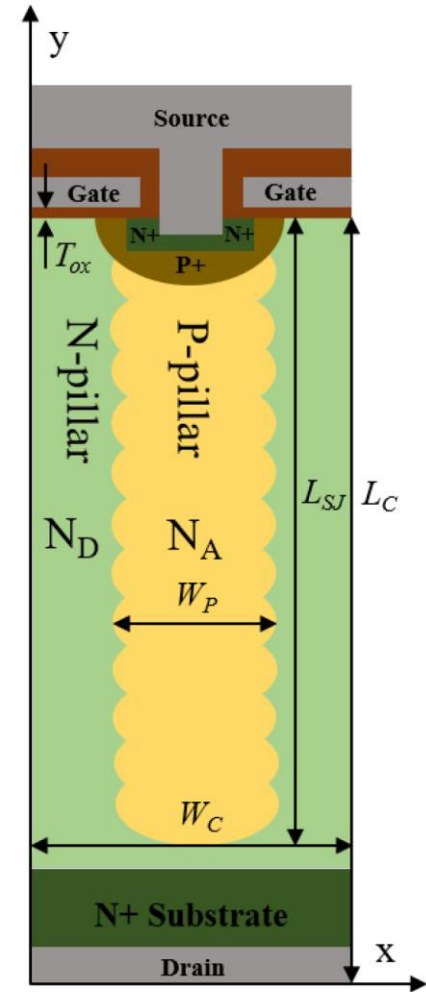


Offcut mapping

- 5 to 20 sec/point
- Tilt, tilt direction etc. for each point
- 261 points in about 1h



Why talking about crystal orientation here?

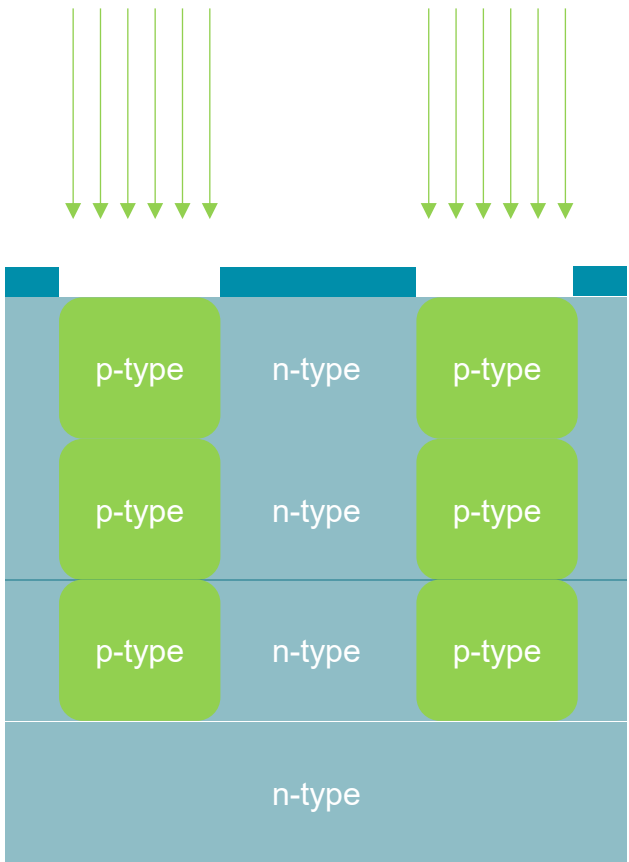
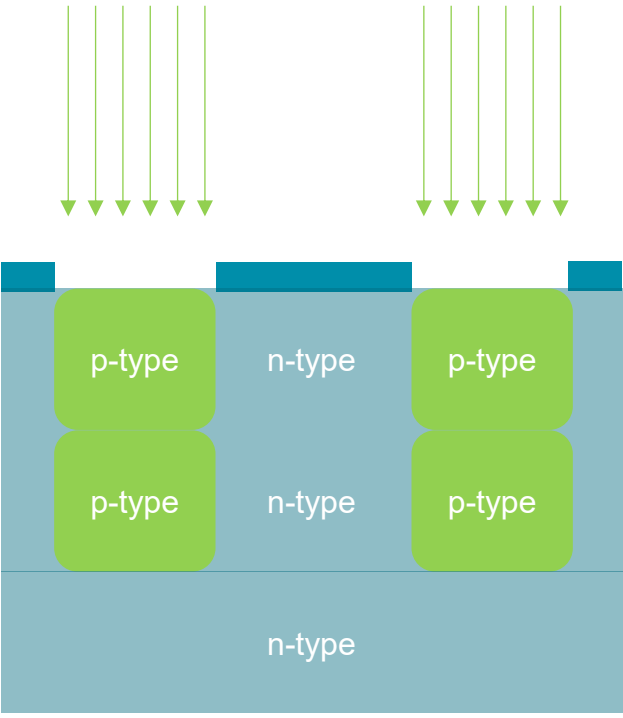
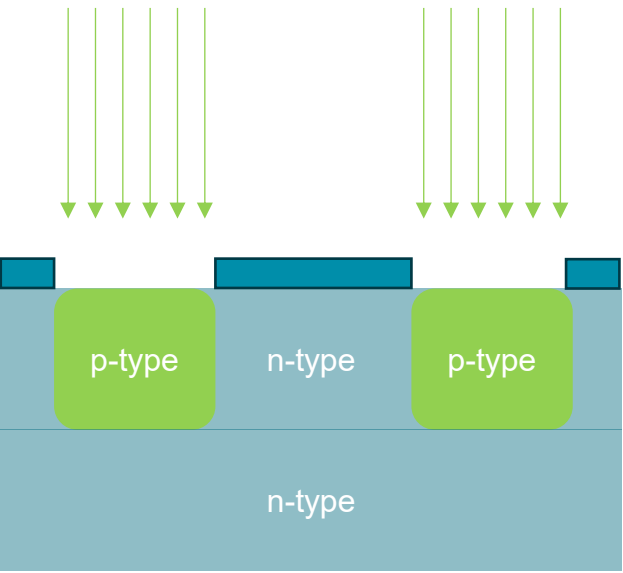




Conventional Multistep Workflow

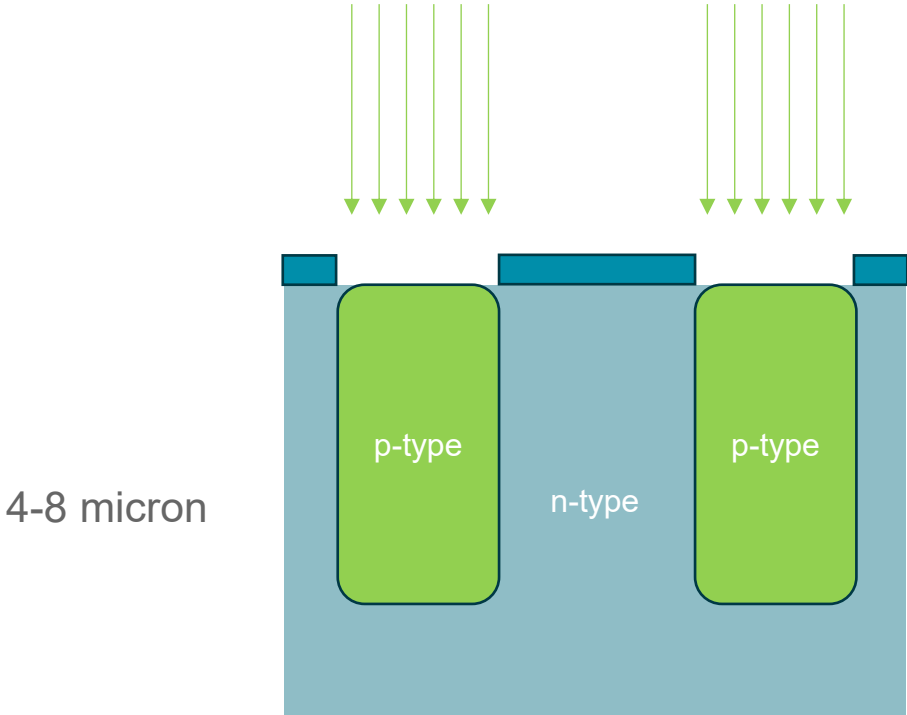
Epitaxy, Lithography, Implan

1 micron

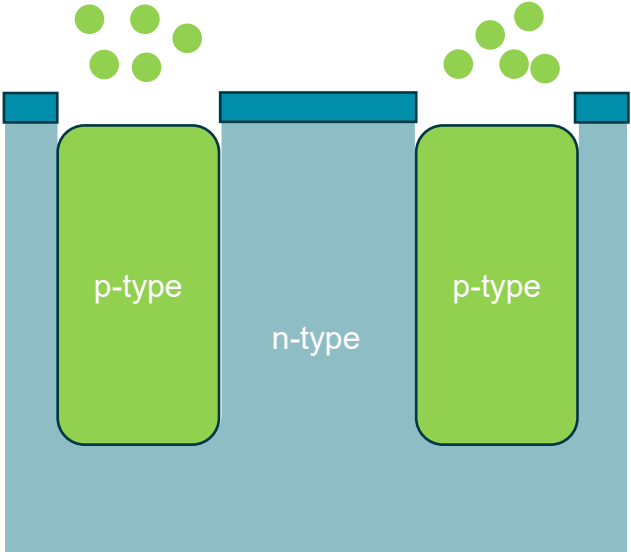


Aspired Workflow Options

Epitaxy, Lithography, Implant



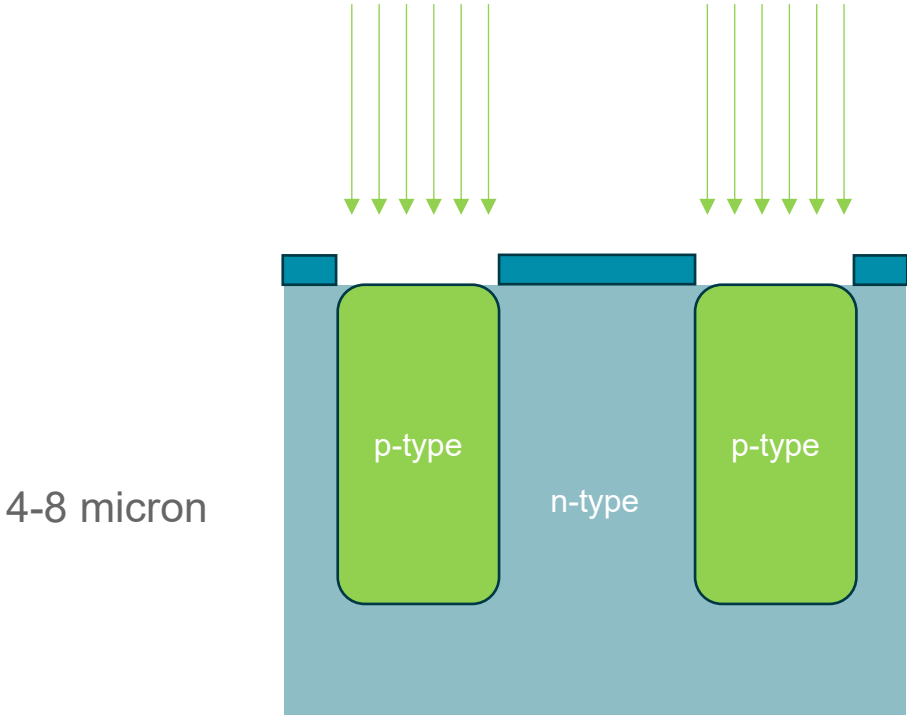
Deep Ion Implantation



MOCVD Trench Fill

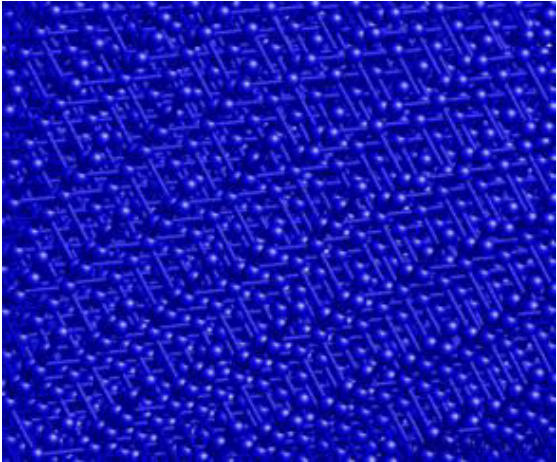
Channeling for Ion Implantation

Epitaxy, Lithography, Implant

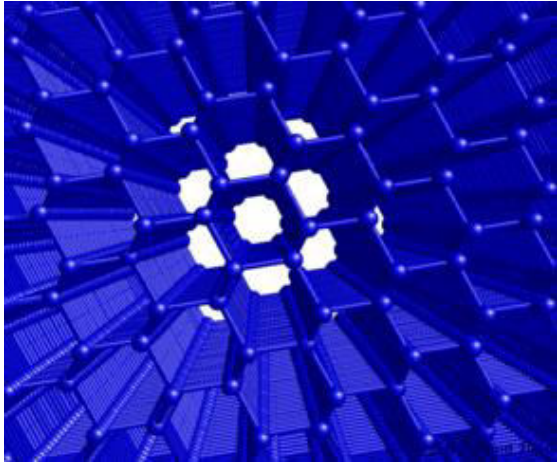


Deep Ion Implantation

Off-axis oriented
lattice



On-axis oriented
lattice



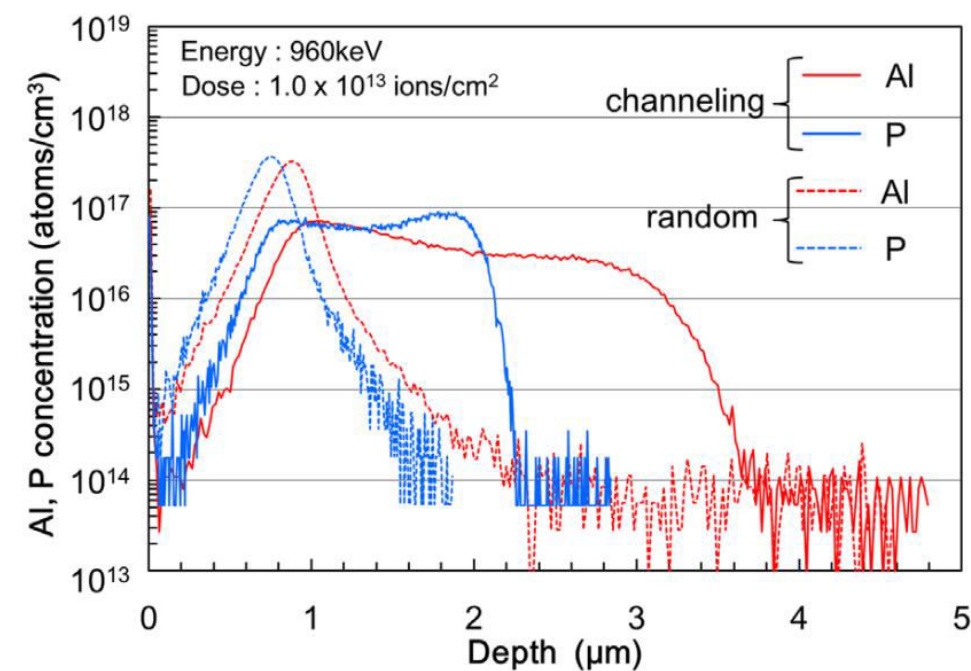
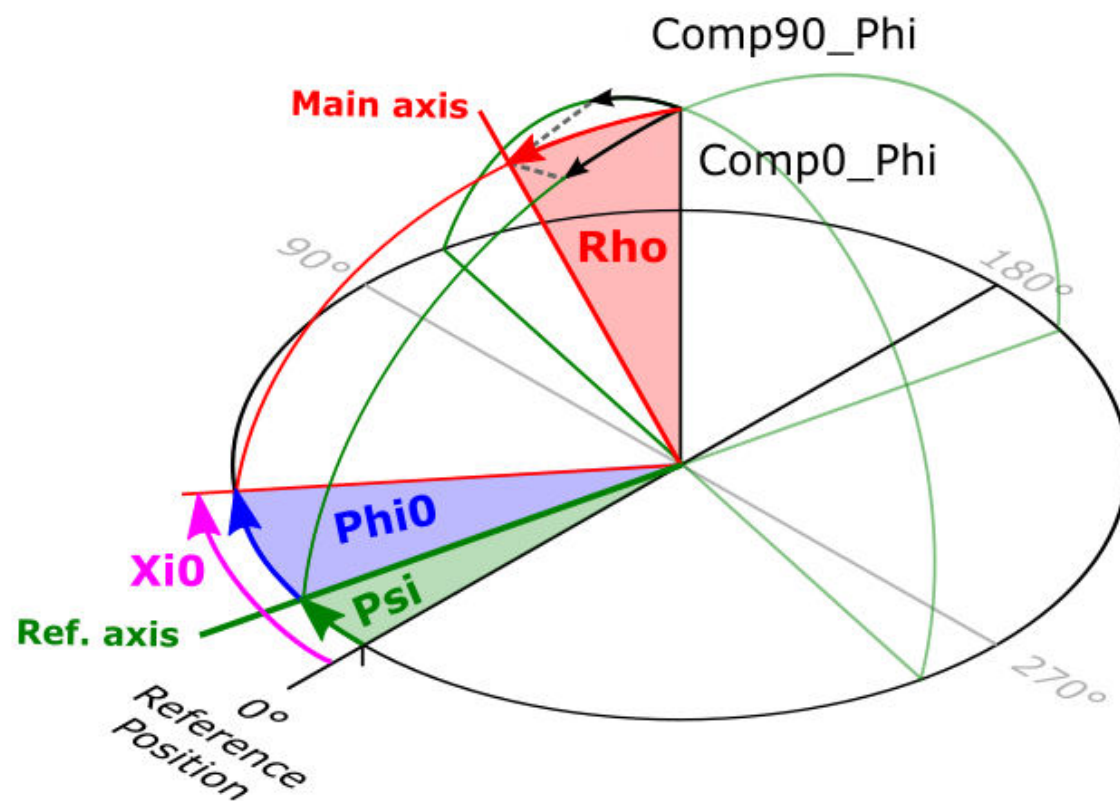
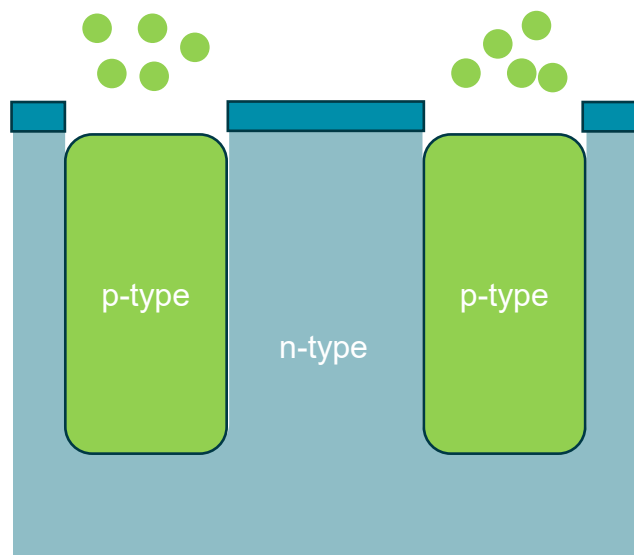


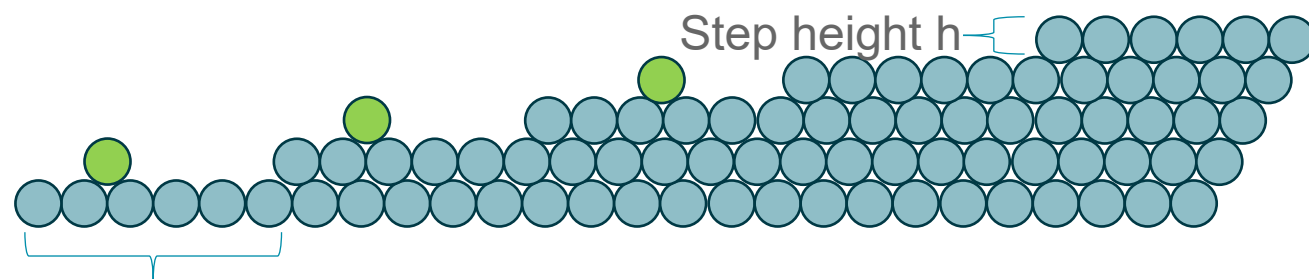
Fig. 1. (Color online) SIMS depth profile of Al and P for channeling and random implantation.

Ryota Wada et al 2022 Jpn. J. Appl. Phys. 61 SC1033



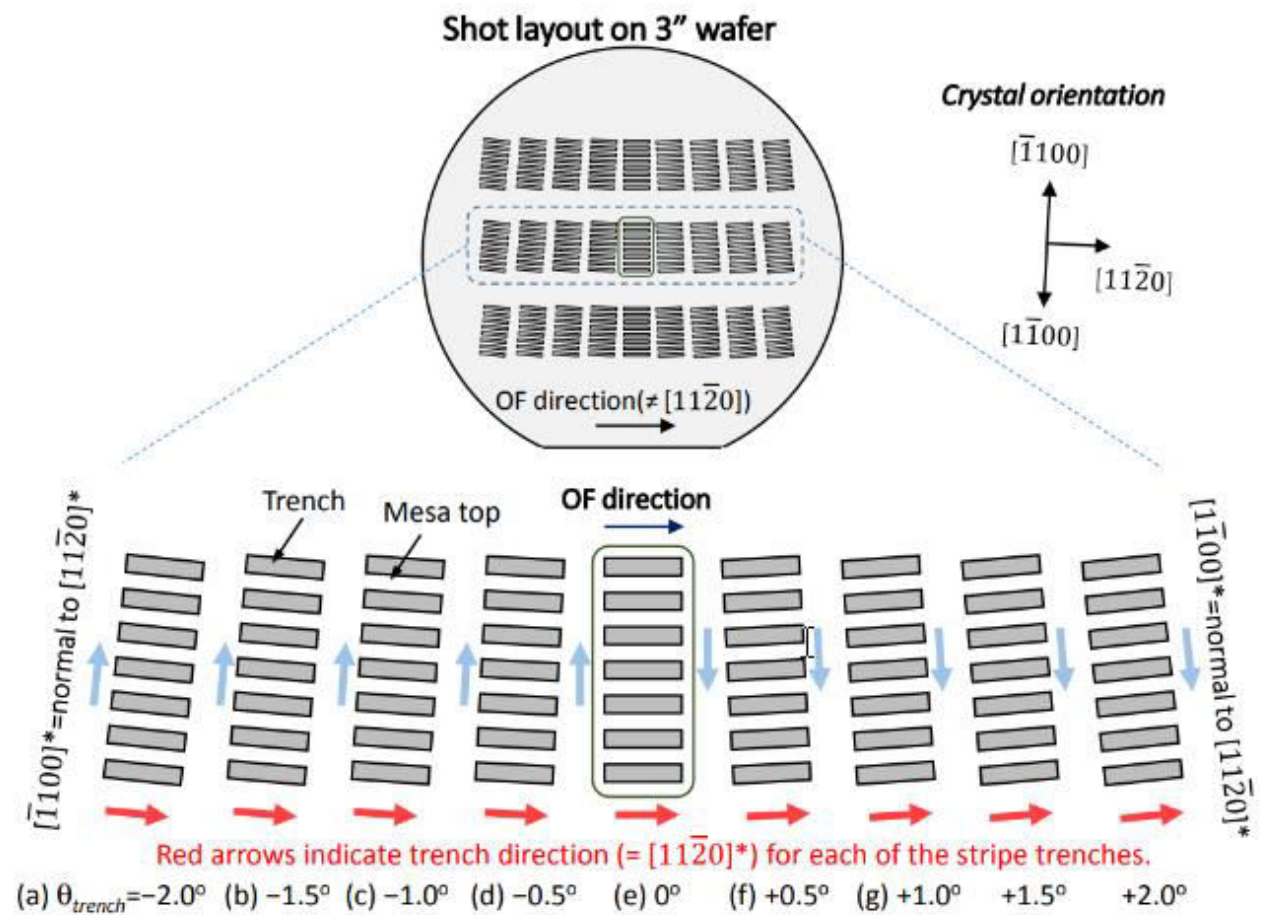
The diagram shows a circular arc with several key features:

- Main axis:** A red arrow pointing towards the center of the arc.
- Comp90_Phi:** A green arc segment labeled at the top right.
- Comp0_Phi:** A green arc segment labeled at the top right, below Comp90_Phi.
- Rho:** A red shaded sector labeled in the center.
- Phi0:** A blue shaded sector labeled in the center.
- Psi:** A green shaded sector labeled in the center.
- Xi0:** A magenta arc segment labeled on the left.
- Ref. axis:** A green arrow pointing towards the center of the arc, labeled at the bottom left.
- 0°:** A label at the bottom left indicating a reference position.
- 90°:** A label on the left indicating a reference position.
- 180°:** A label on the right indicating a reference position.
- 270°:** A label at the bottom right indicating a reference position.

Terrace width w

Crystal Orientation Effects – Trench Fill

Trench orientation vs. Growth rate



Crystal Orientation Effects

Orientation affects growth

- The deviation of the trench filling growth rate varies strongly with the offset.
- Also, the mesa starts tilting with increasing offset.

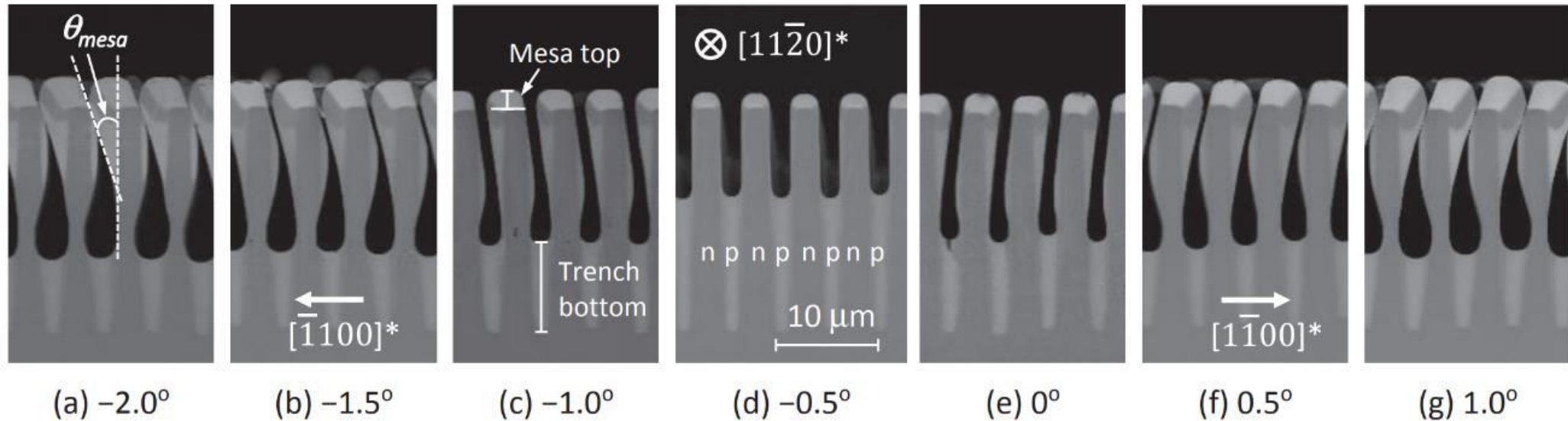


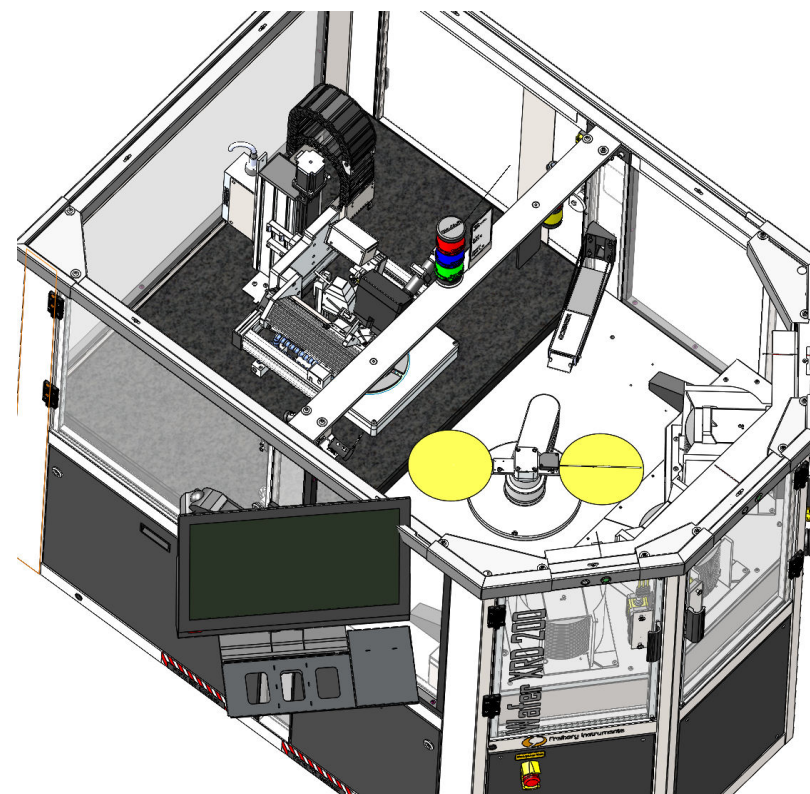
Fig. 3. Cross-sectional SEM images after 3 h of backfilling epi-growth on the seven intentionally-tilted stripe trenches that were formed on the same wafer. The notations of (a) to (g) and the definitions of the $[\bar{1}100]^*$, $[1\bar{1}00]^*$, and $[11\bar{2}0]^*$ directions on each mask pattern are the same as those used in Fig. 1. Each sample was individually cut to be perpendicular to $[11\bar{2}0]^*$.

Frontend Solution

Creating millions of USD value for you per year!



- Up to 1 000 samples per day (fixed arrangement)
- 70-200mm wafer handling with vacuum
- Optical notch/flat recognition available for 100mm-150mm-200mm wafers
- 3 cassette stations (optional 5)
- Supports for single wafers available
- Tilt/Azimuth std. dev. $< 0.003^\circ / 0.03^\circ$ (on-axis wafers)
- MES System SECS/GEM or similar
- Air cooled tube



Invest for Cost Down

Crystal orientation opens new process windows

- Ingot grinding precision increased
- Sawing process spec tightened
- 100 % wafer check possible
- Implantation depth controlled
- Lithography steps reduced
- MOCVD trench filling improved



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Our International Team

Booth close to entrance next to cloakroom



Severine Michel
Marketing Specialist



Dr. Kristin Gratz
Product Manager Semi



Luc Harding
Benelux Business Manager

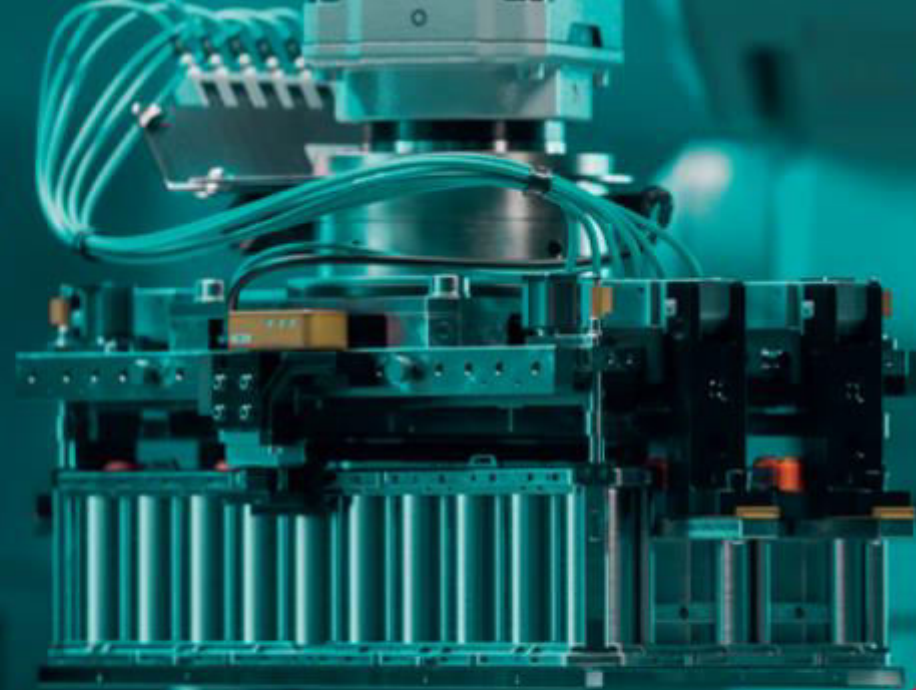


Dr. Alexey Pustovarenko
Application Specialist XRD



Future Days

a Malvern Panalytical event



Register now!

Discover the future of crystal engineering

Gather insights from leading industry figures into the latest innovations in processing, simulation, and metrology

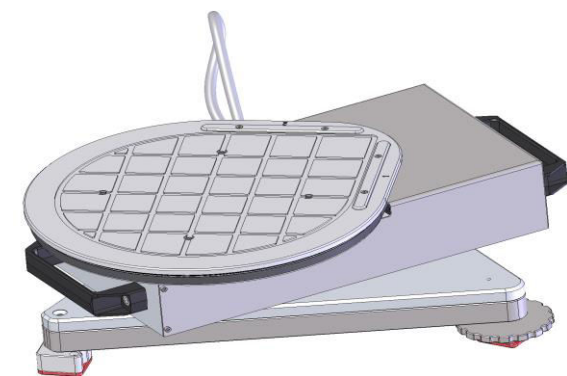
Online broadcast: May 15, 14:00 CET





Questions?

Versatile use in your lab!



Crystal Orientation Effects

Orientation affects etching and growth

