Enhanced laser annealing for ohmic contact formation for SiC power devices

3D MICROMAC

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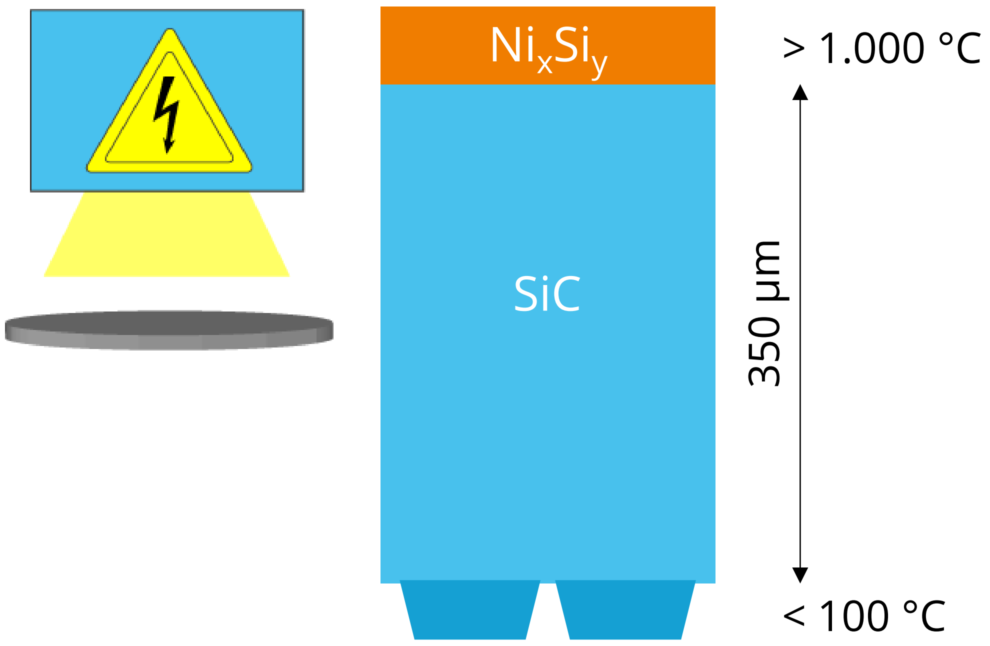
The Upcoming Challenge: Thin Wafer Formation

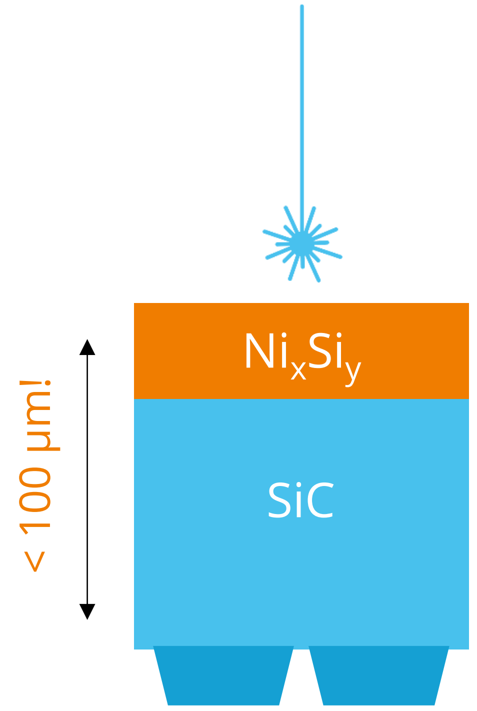
Traditional “thick” wafer

- RTP state of the art



Thin wafer

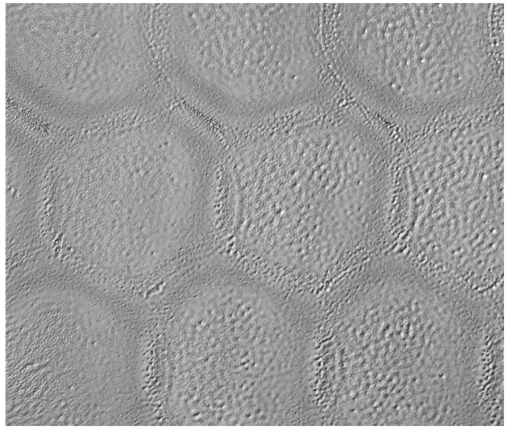
- Laser Annealing (UV ns-pulses)



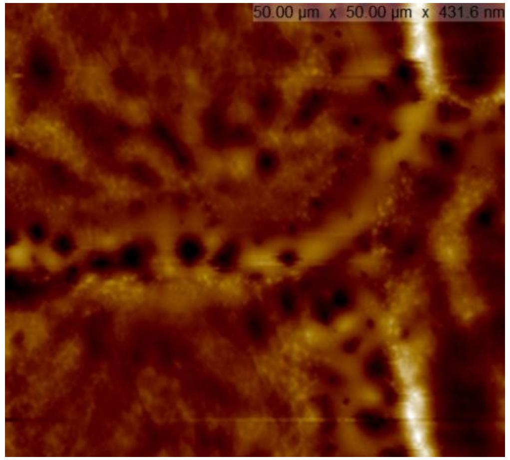
SiC devices getting thinner ➔ Laser OCF is the solution!

Methods of Material Analysis

Surface morphology

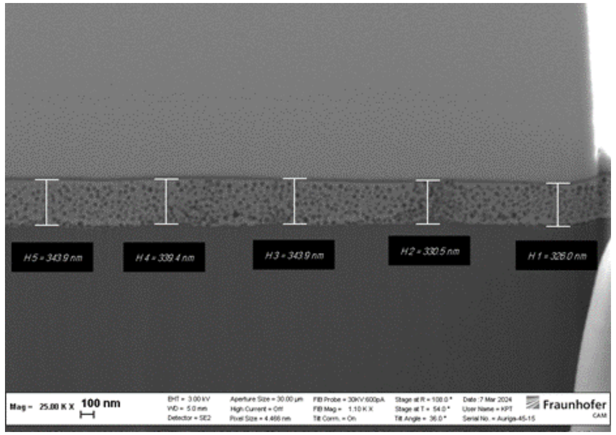


Optical / Laser scanning microscopy

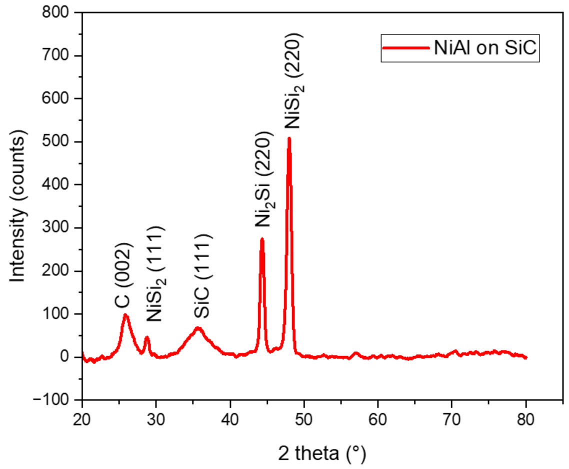


AFM surface roughness

Interface composition

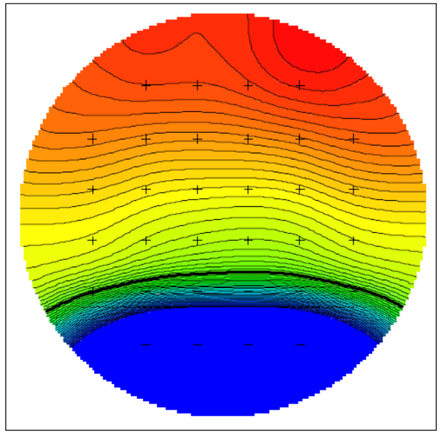


FIB cuts + SEM

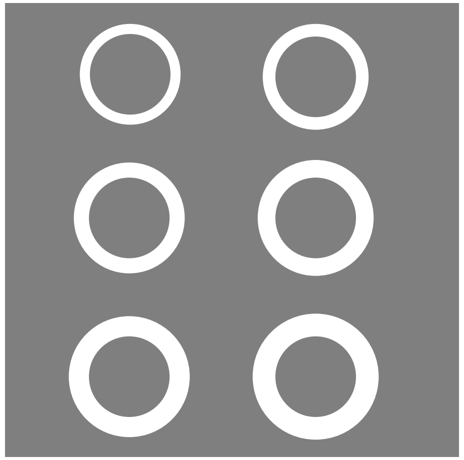


XRD-Spectroscopy

Electrical performance



Sheet resistance



Contact resistance (CTLM)

Application Results

Application results 60 nm Ni on 350 µm SiC Wafer

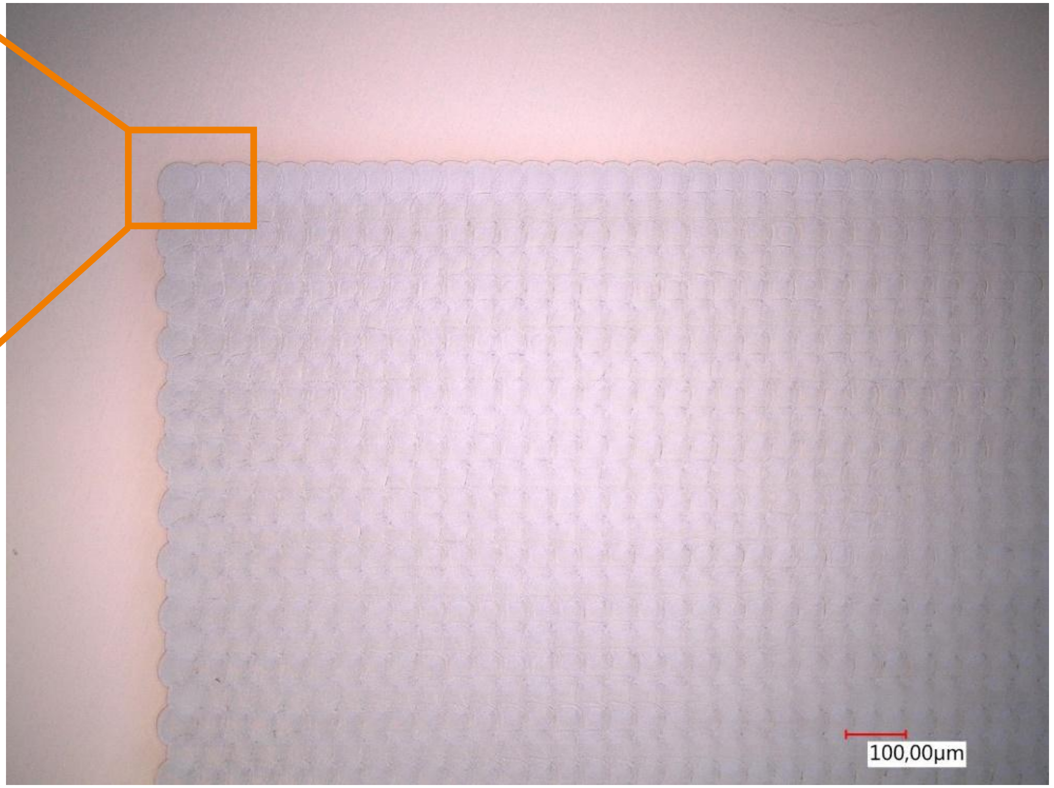
- 355 nm DPSS ns laser
- 100 µm top hat spot
- Adjustable pulse overlap
  (10%, 20%, 30%, 40%, 50%)

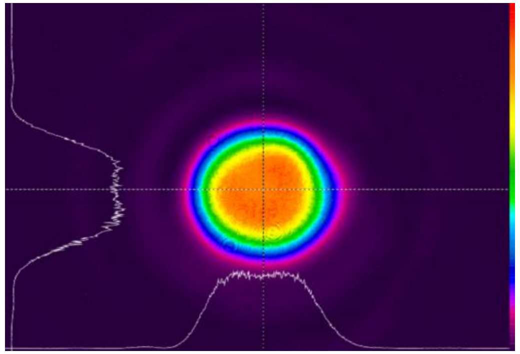
→ Significant higher throughput possible
up to 22 WPH

→ Typical surface roughness
~ 30 nm

→ Typical Sheet resistance
~ 0.5 Ohm/sq

→ Typical uniformity
< 1.1%



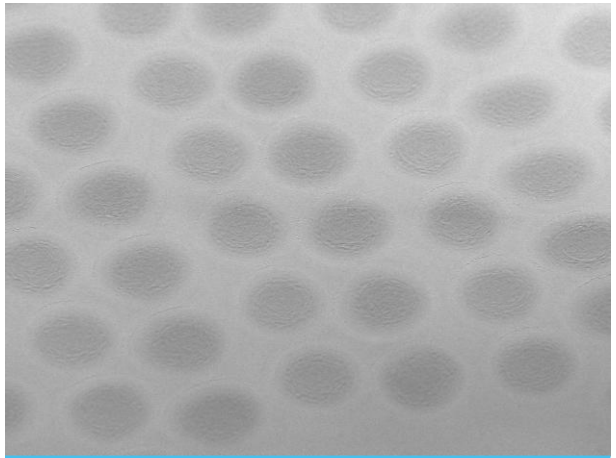


Beam Profile Comparison

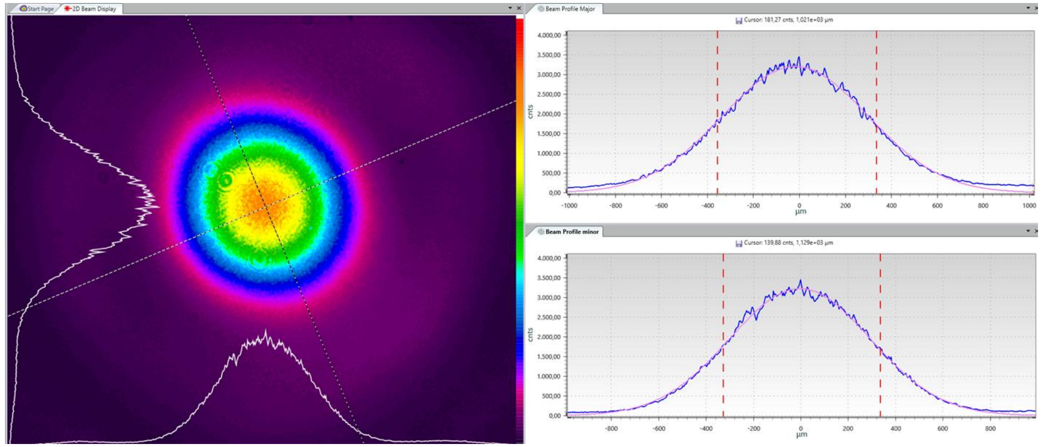
microPRO XS OCF offers

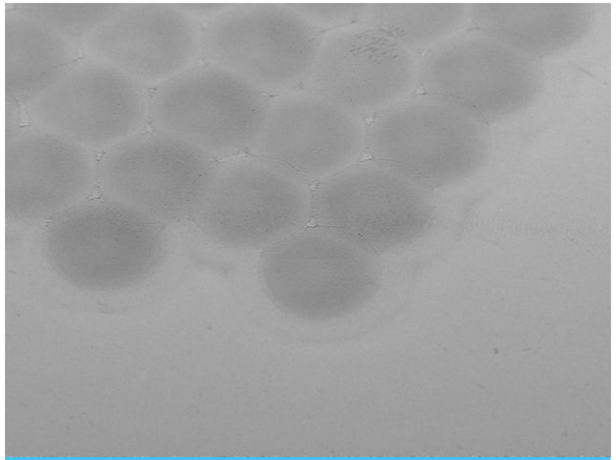
two beam profile modules:

- Gauss
- Flat-Top
    - Round
    - Square

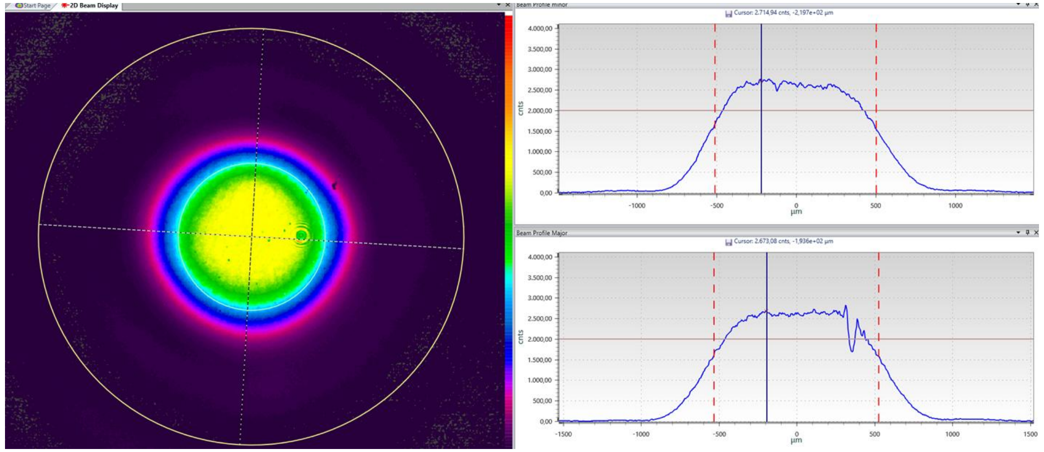


Gauss





Flat-Top



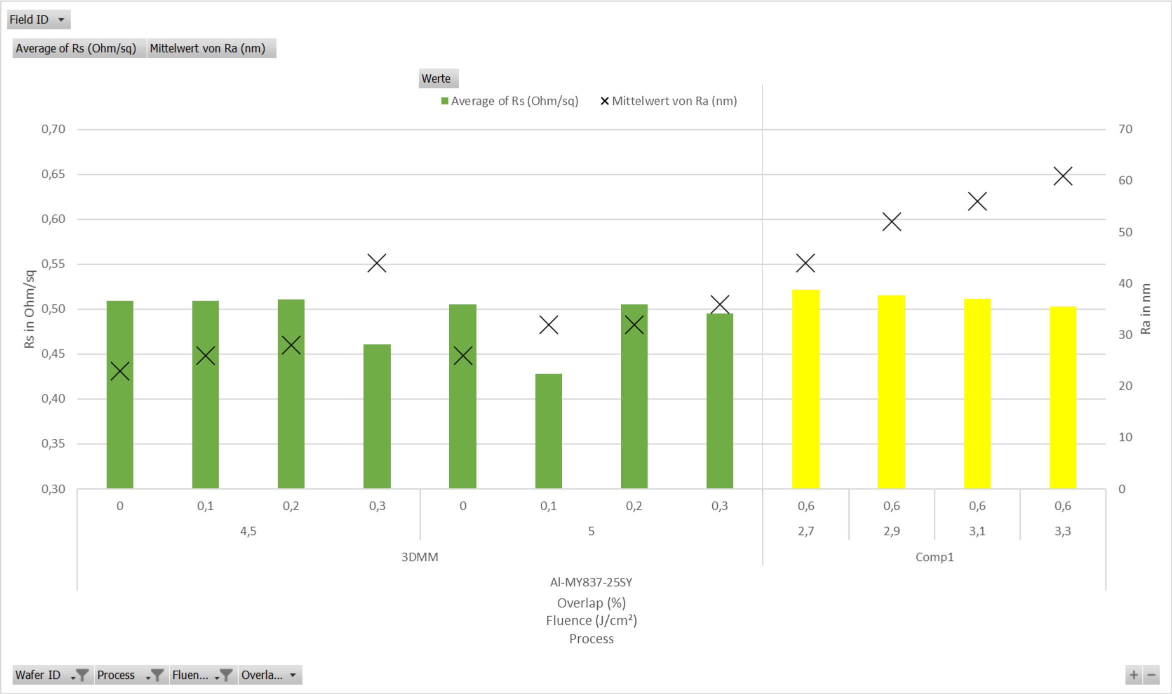
Flat-Top

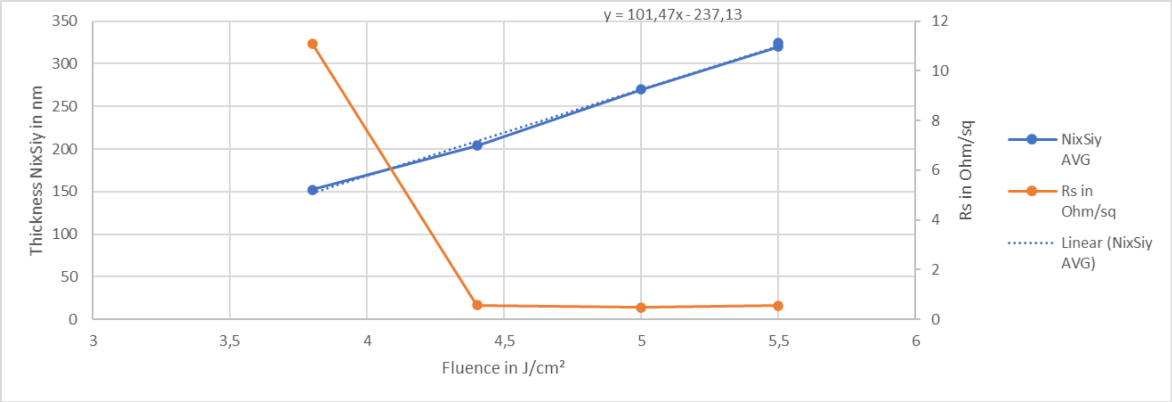
- 3D-Micromac laser process shows broad process window
- Overlap and fluence can be tuned for specific Ni_xSi_y phase and layer thickness
- Increasing fluence showing consistent surface roughness

- Imprint D ~ 100 µm (@Baseline 3D-Micromac)

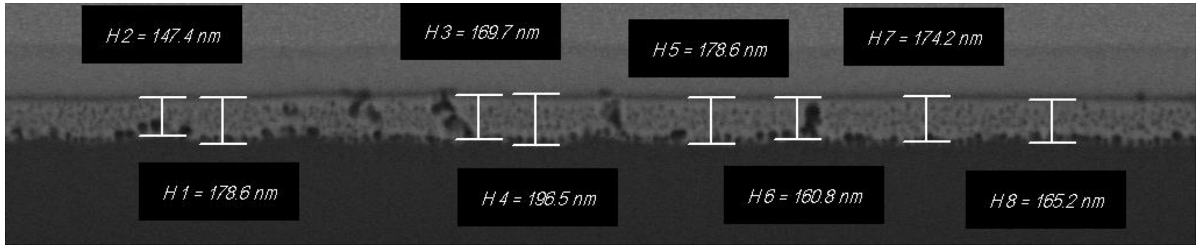
- Medium fluence / low overlap

  → Highest throughput achieveable
  - up to 22 WPH @ 6“
  - up to 18 WPH @ 8“

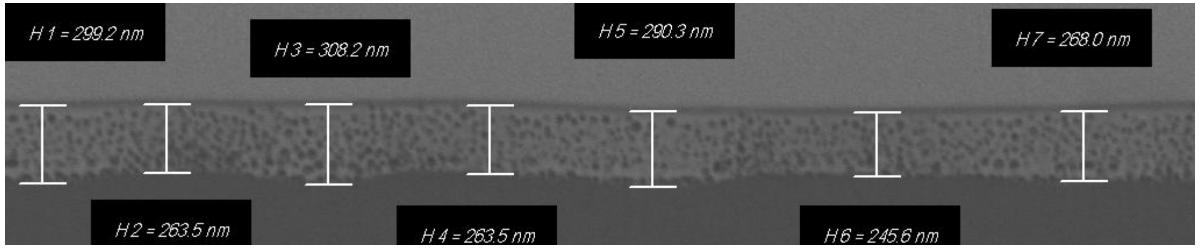




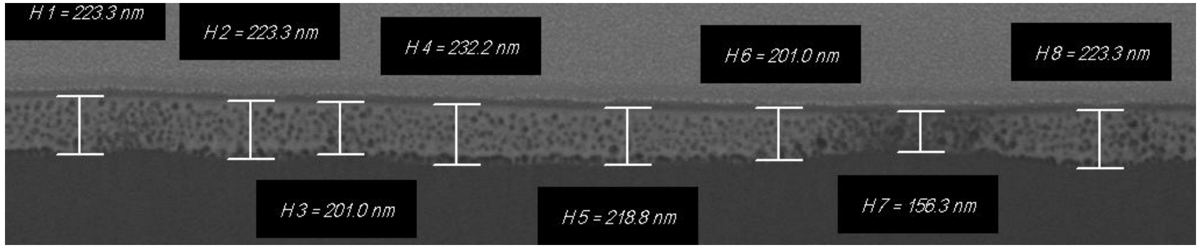
Comparision of Ni_xSi_y Interface with Flat-Top Spots - SEM



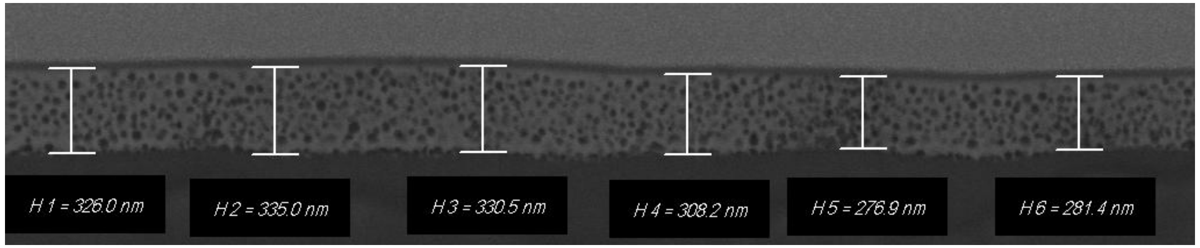
3.8 J/cm^2 20% 11.1 Ohm/sq



5.0 J/cm^2 20% 0.48 Ohm/sq



4.4 J/cm^2 20% 0.58 Ohm/sq



5.5 J/cm^2 20% 0.55 Ohm/sq

- Homogenious distribution of C in Ni_xSi_y
- No barrier C layer is build during 3D-Micromac process

Comparision of Ni_xSi_y Interface with Flat-Top Spots – SEM / XRD

5.5 J/cm² / 20%

0.55 Ohm/sq

5.0 J/cm² / 20%

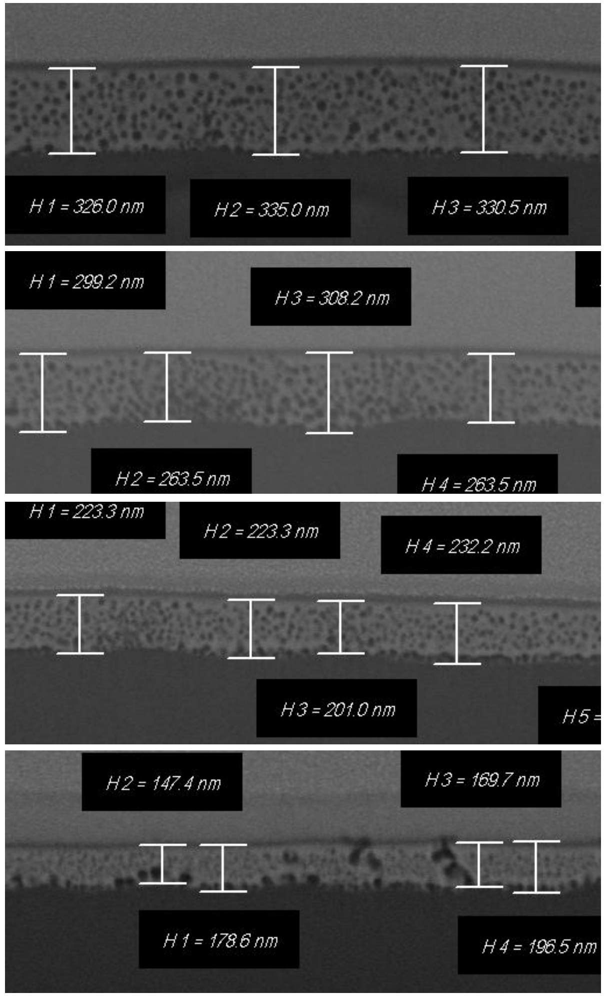
0.48 Ohm/sq

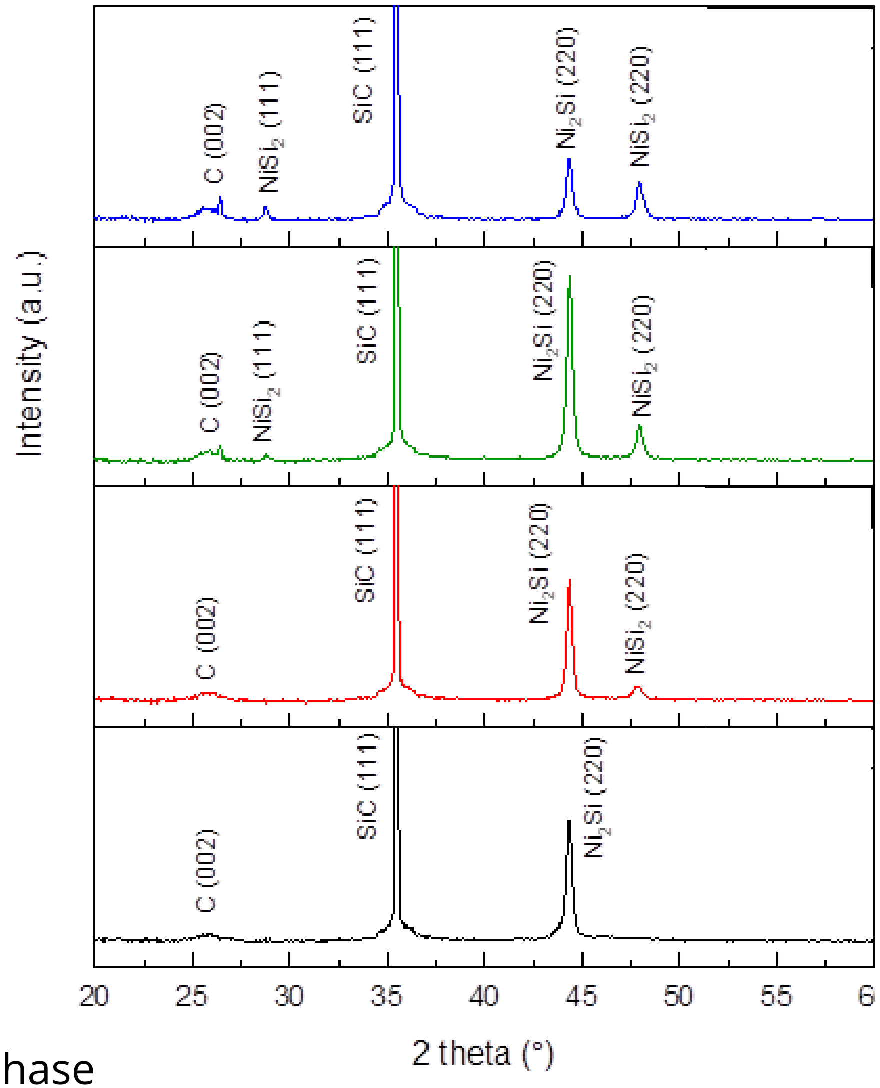
4.4 J/cm² / 20%

0.58 Ohm/sq

3.8 J/cm² / 20%

11.1 Ohm/sq





Increase of fluence results in increase of $NiSi_2$ phase

Highlights and Benefits of microPRO™ XS for OCF

Highlights

- Best-in-class throughput (up to 22 WPH / 6“ wafers)
- Excellent R_s homogeneity ($\delta < 1.1\%$)
- 6“ and 8“ wafer can be processed without stitching and tool adaption
- Ultra-thin wafer handling available
- Small footprint (TPFP)
- Fully automated beam stabilization

Benefits

- Freely programmable geometry for test patterns
- Wide and stable process window
- Semiconductor mass production proven
- Variable laser spot profile enables processing of different material compositions
- Full range of services available, including feasibility studies, recipe development, contract manufacturing, pilot production and global customer support

microPRO™ XS OCF – Huge Process and Technology Knowledge

Collected jointly by renowned industry partners and European research institutes

- Joined process optimization possible
- Tool adaption to customer needs
- Characteristics of results
- Contract manufacturing for bridging the lead time
- Remote support for optimizing the process possible (beam setting, log file including sensor data analysis)

Thank you for your attention!

Maximilian Genz
genz@3d-micromac.com
+49 371 40043 18

+49 371 400 43 0
info@3d-micromac.com
www.3d-micromac.com

Headquarters 3D-Micromac AG
Technologie-Campus 8
09126 Chemnitz
Germany