

Enhanced Stability of Hydrogen Silsesquioxane (HSQ) through Stabilizer-Incorporated Variant

Harry Biller^a, Dr. Mandy Sendel^a, Dr. Maik Gerngroß^a, Frank Heyroth^b, Matthias Schirmer^a

^a Allresist GmbH, Strausberg, 15344 Germany, harry.biller@allresist.de

^b Interdisciplinary Center of Materials Science (CMAT), Martin-Luther-University, Halle-Wittenberg, 06120 Germany



MARTIN-LUTHER-UNIVERSITÄT HALLE-WITTENBERG



Introduction

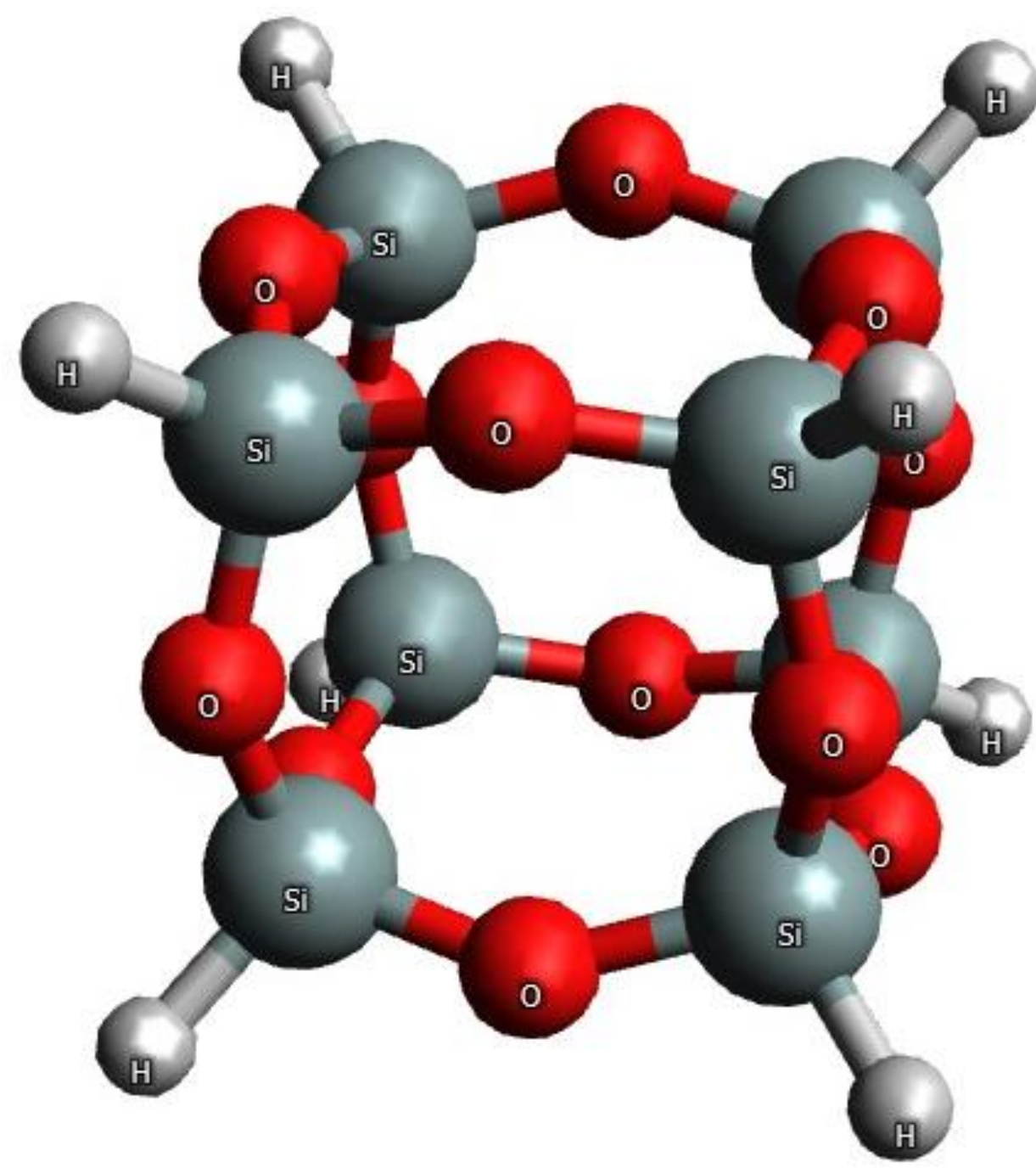


Figure 1: Schematic illustration of a HSQ molecule [H₈Si₈O₁₂] in a cage configuration.

- Hydrogen Silsesquioxane (HSQ) is a negative-tone electron beam resist widely used in nanofabrication due to its excellent resolution and etch stability.
- HSQ's limited shelf life is addressed by the introduction of butyl acetate as solvent which reduces gelation and particle formation.
- The addition of stabilizer molecules ensures improved stability during processing.
- 3 days between coating and e-beam writing and another 3 days until development showed significantly less degradation.
- The new HSQ alternative Medusa 84 SiH produced by Allresist GmbH was tested with several academic partners with different applications shown below.

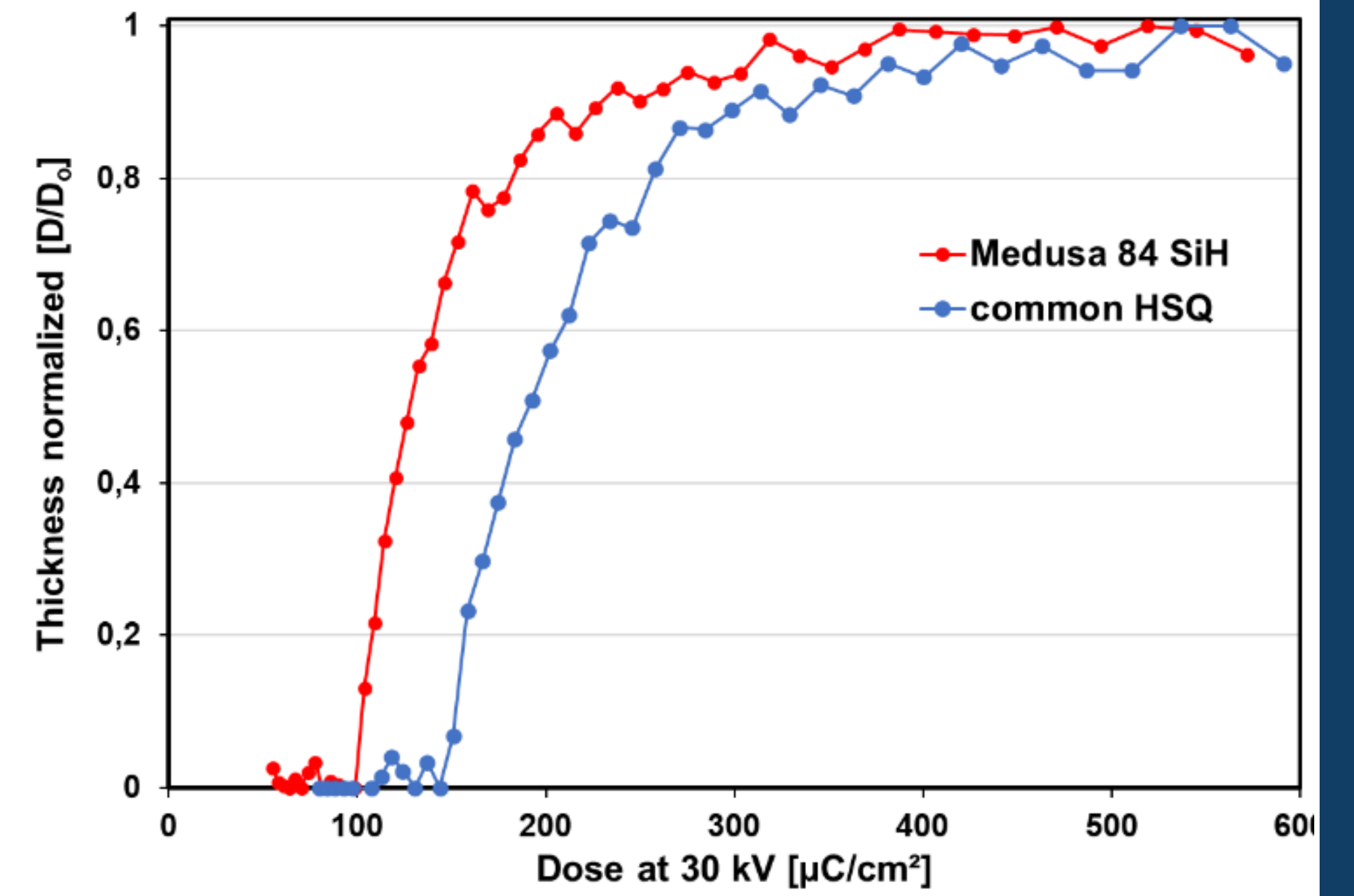


Figure 2: Contrast curves of Medusa 84 SiH compared with common HSQ. Medusa 84 SiH was processed with 3 days dwell time between writing and developing with 6.5% TMAH.

Medusa 84 SiH on GaAs

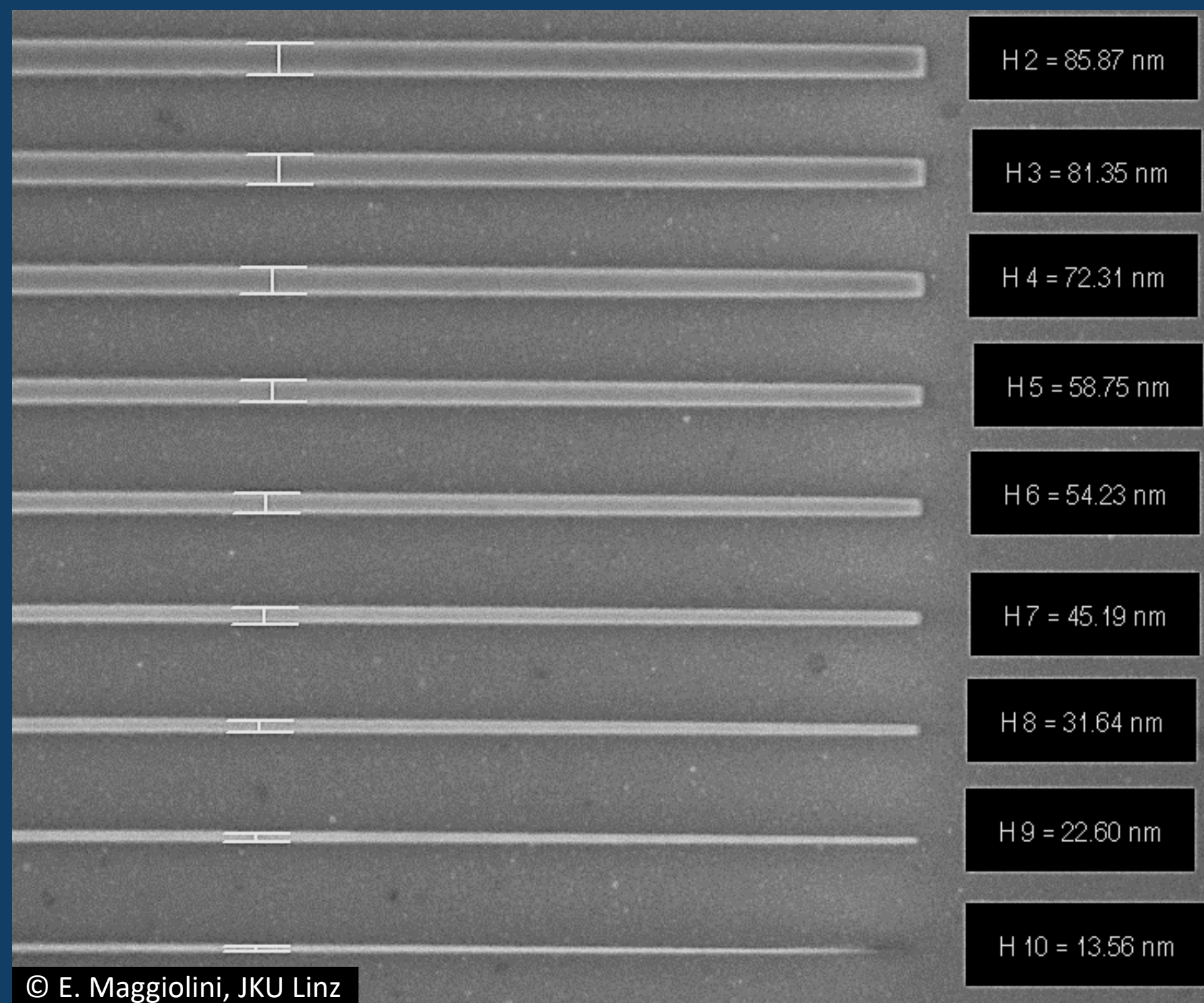


Figure 3: Single line structures of Medusa 84 SiH on GaAs written with 30 kV. An experimental TMAH-NaCl developer was used for enhanced contrast while maintaining good adhesion.

Medusa 84 SiH on Quartz + Electra 92

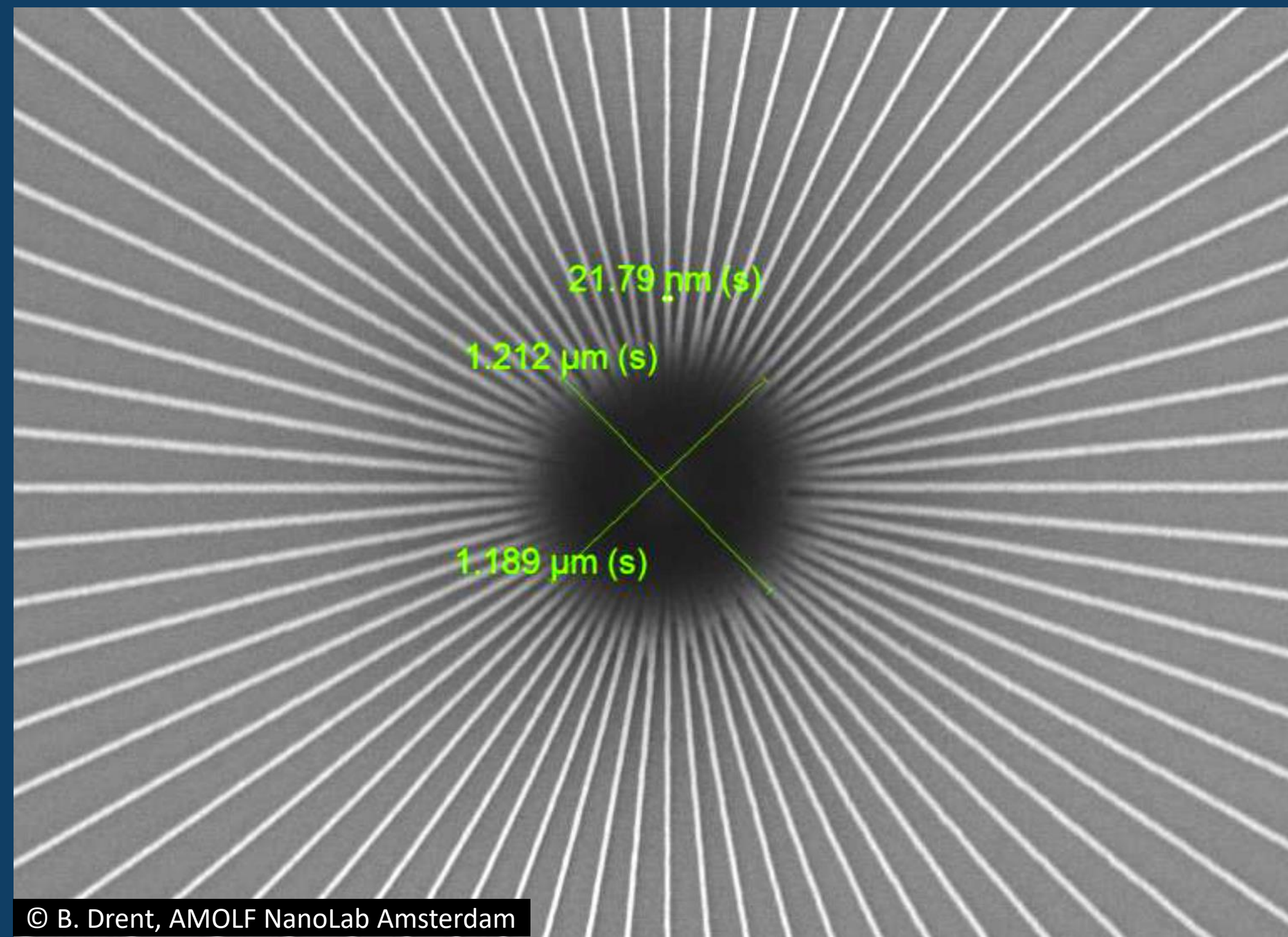


Figure 4: Siemens star written on quartz with the new conductive layer Electra 92 (AR-PC 5092.02/1) spun on top to prevent charge buildup. This variant of Electra 92, developed specifically for HSQ, shows excellent coating and adhesion properties.

Medusa 84 SiH 100 nm line/space

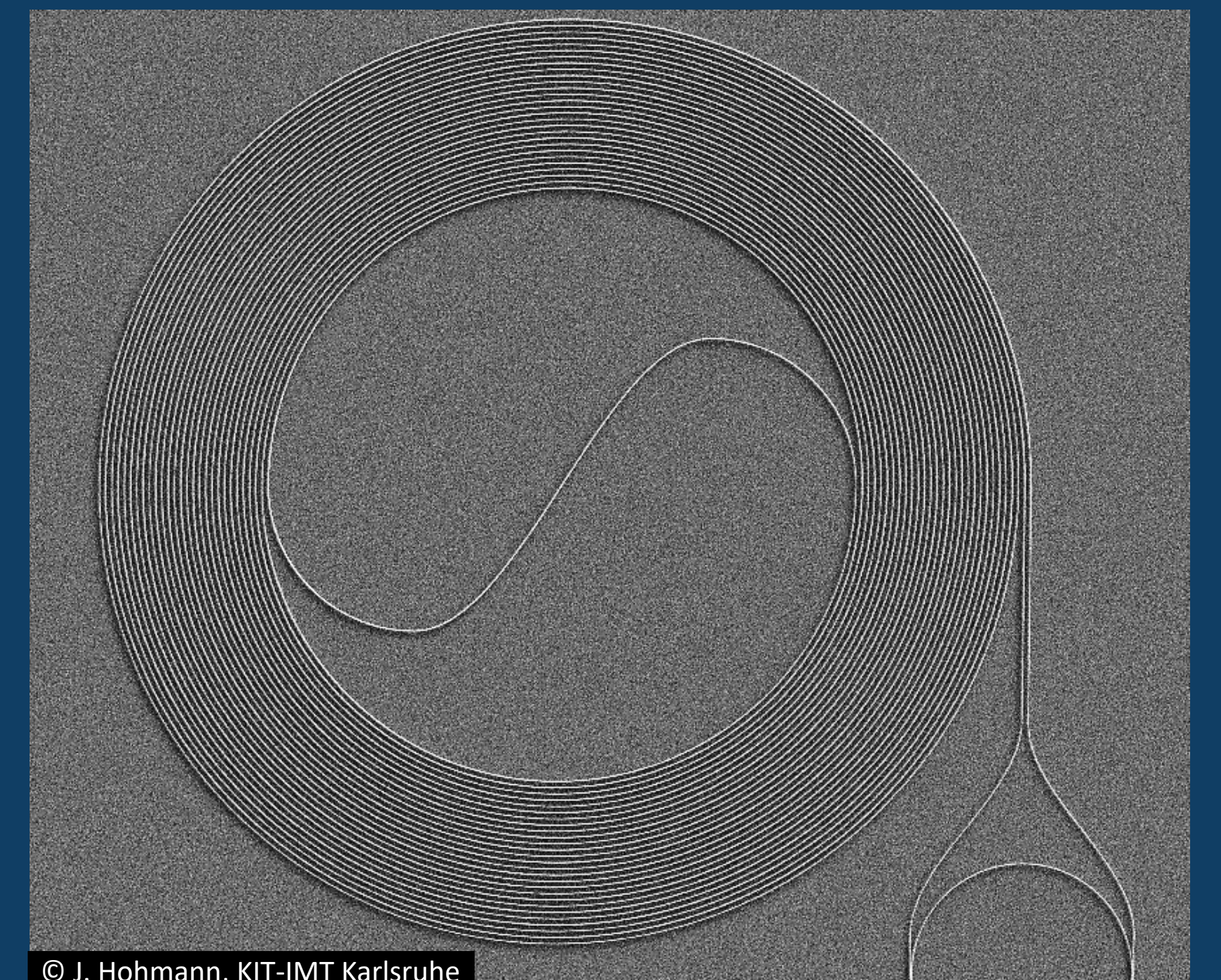


Figure 5: Circular 100 nm line/space structures written on silicon at 1000 µC/cm² @ 100 kV and developed with AR 300-73 (6.5% TMAH solution).

Medusa 84 SiH for Grayscale-Applications

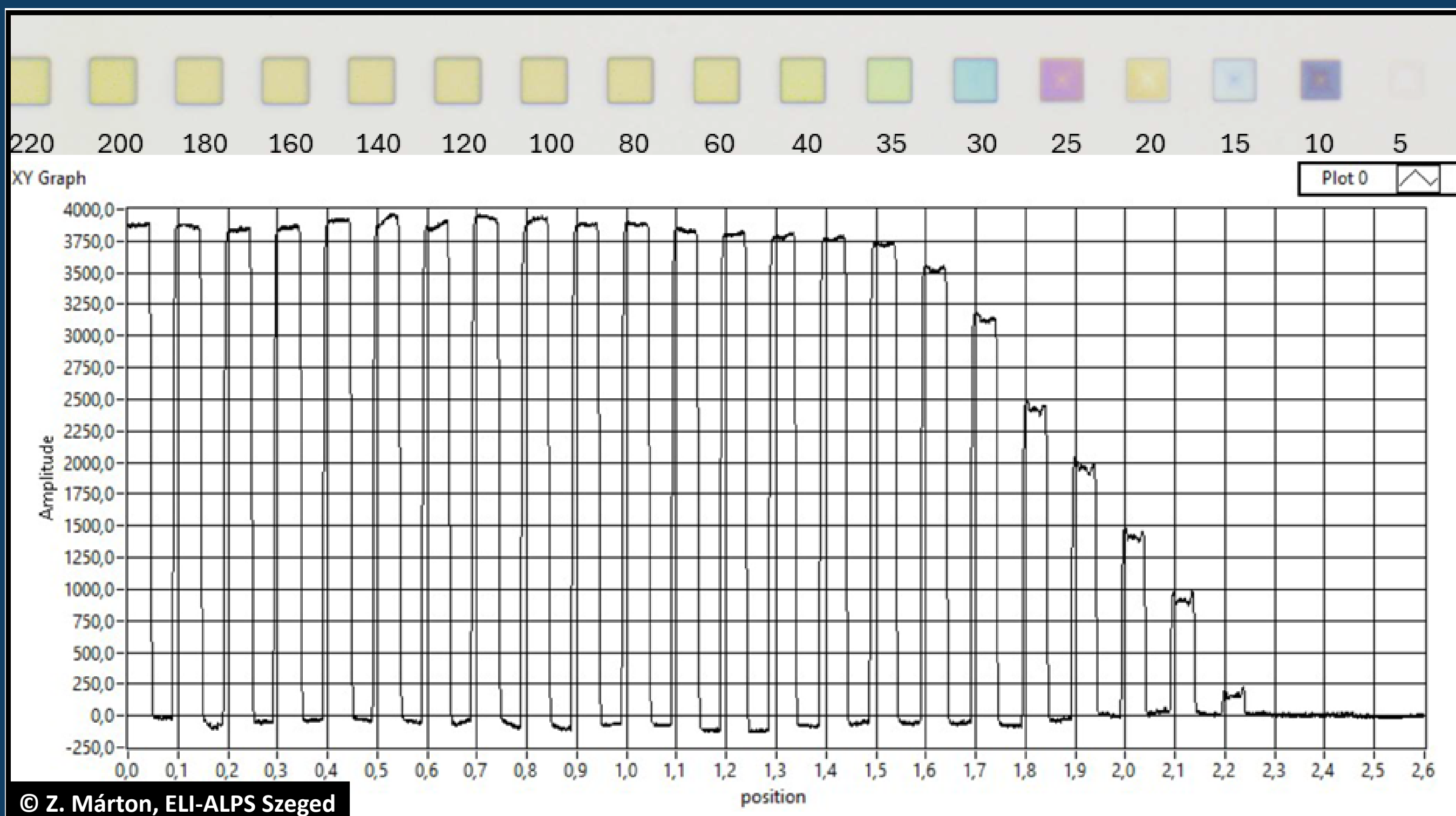


Figure 6: Grayscale structures written with 30 kV on silicon. Top row shows the squares with the dosage used in µC/cm². Stylus profilometer shows the remaining height in Å after developing with 2.38% TMAH.

Outlook & Acknowledgements

Allresist GmbH offers the new Medusa 84 SiH and Electra 92 products directly and through sales partners to interested users in the academic and industrial sectors. The improved shelf life guarantees consistent quality even during prolonged transportation.

We would like to thank our academic partners for testing several prototypes and supporting us in optimizing the Medusa 84 SiH to market readiness.

Medusa 84 SiH for metasurface fabrication

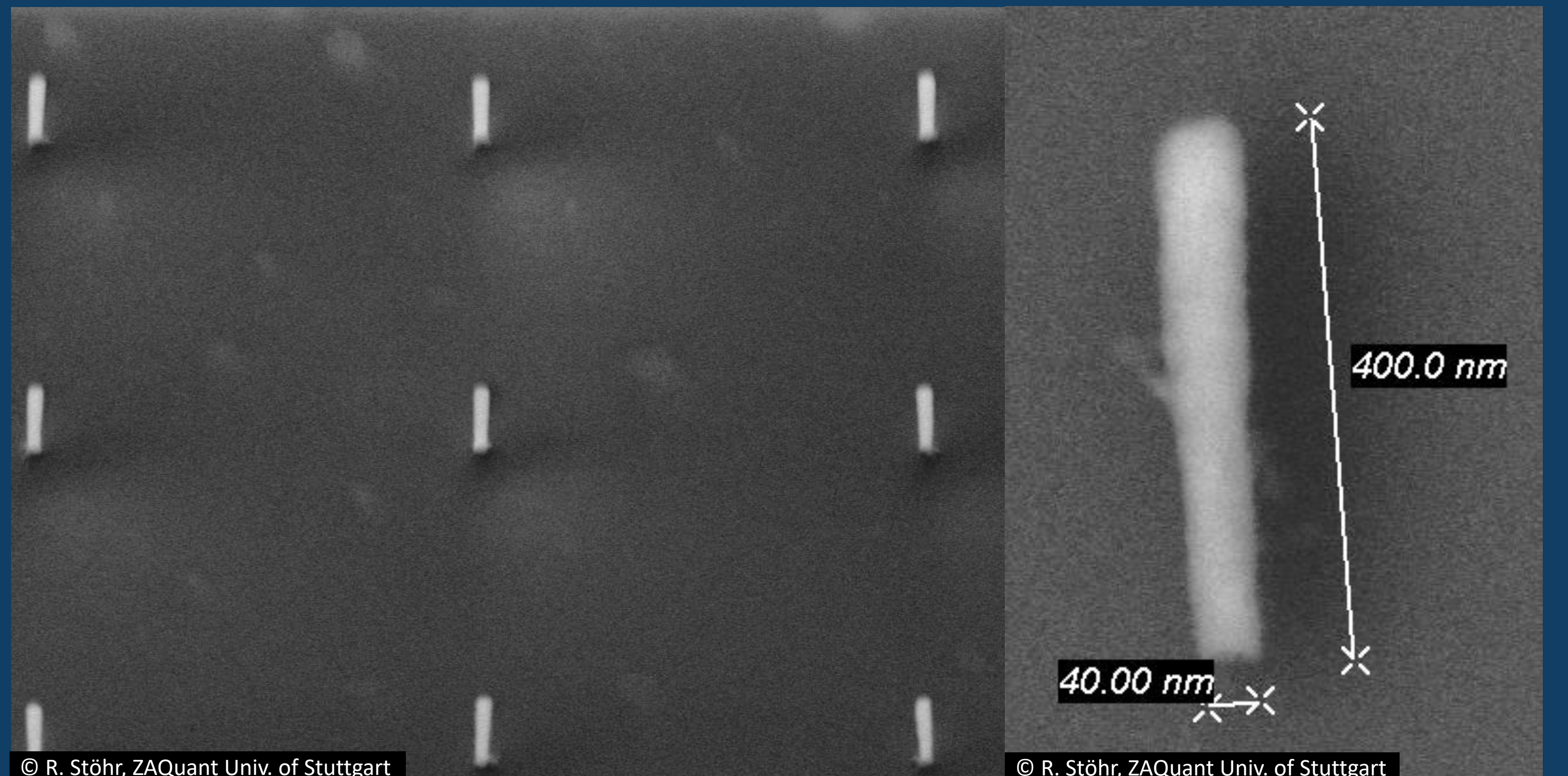


Figure 7, top left & right: Nanorods with a space of 1 µm written on silicon with 2000 µC/cm² @ 50kV and developed with AR 300-44 (2.38% TMAH). Aspect ratios of up to 10 have been achieved.

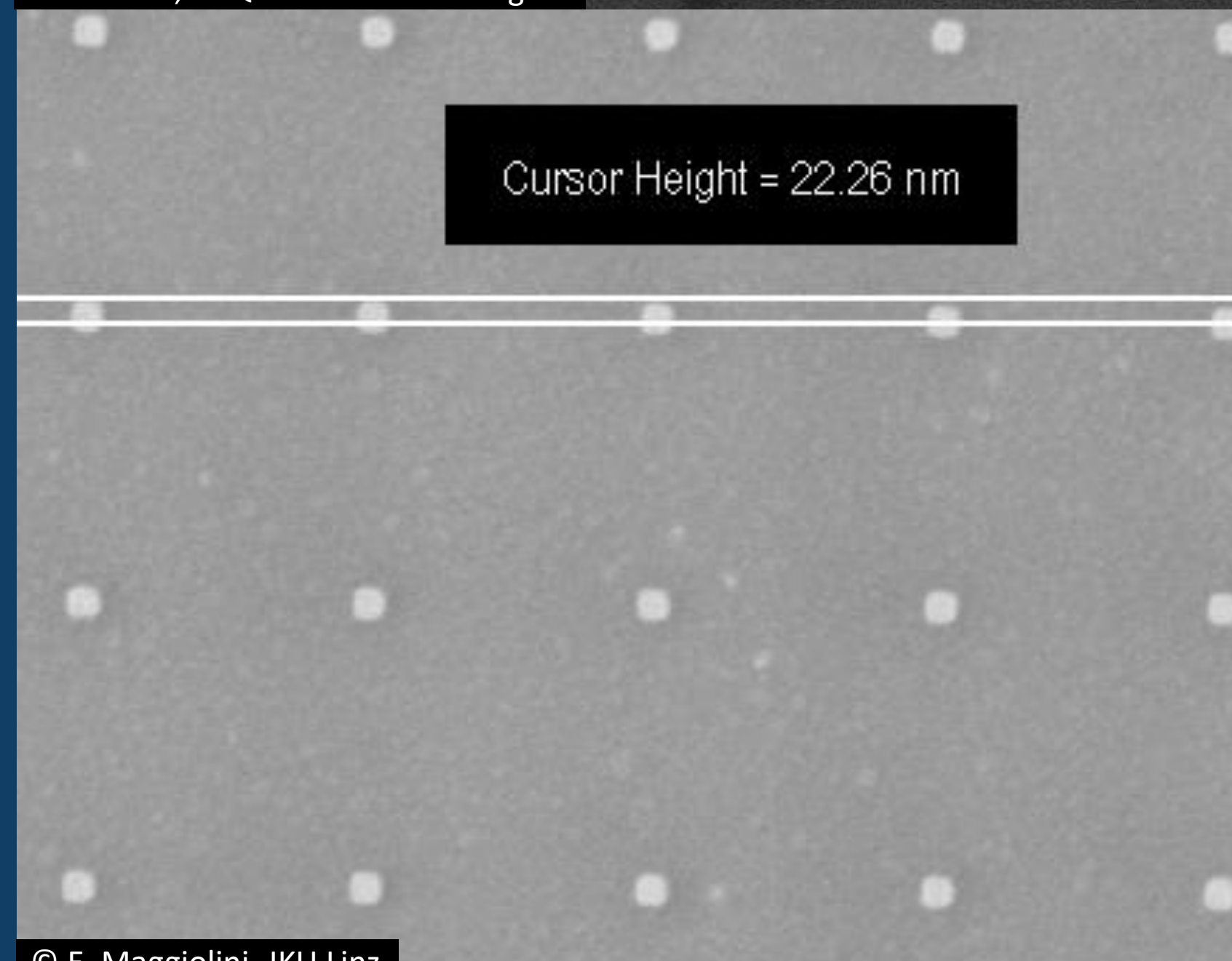


Figure 8, bottom left: Square pillars with 22 nm in diameter and 50 nm in height on GaAs written at 30 kV and developed with AR 300-44 (2.38% TMAH).