Nanofabrication - direct write and replication patterning technologies in EUMINAfab

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[14-09-2010, E-MRS Warszawa]

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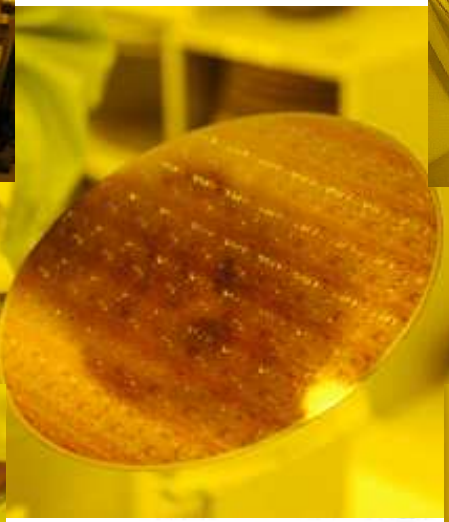
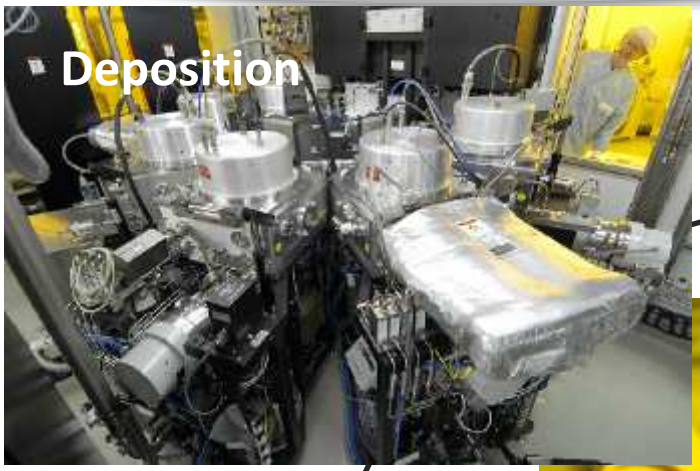
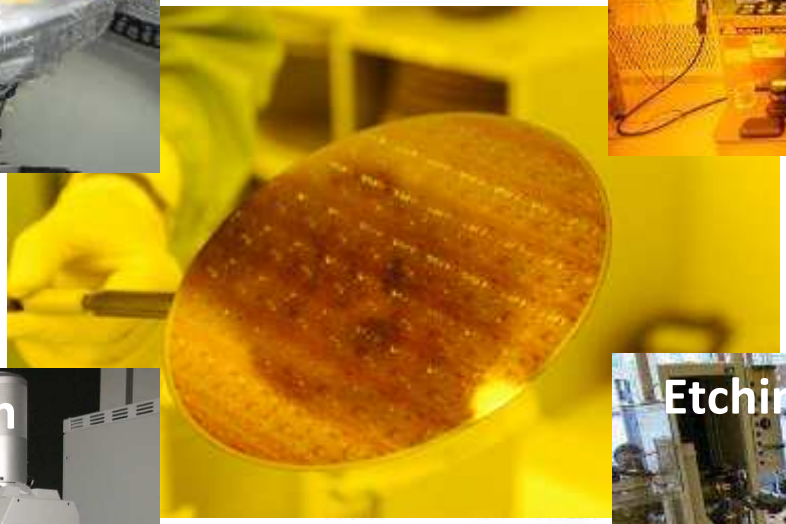
the Thin Film Tool Box



Equipment



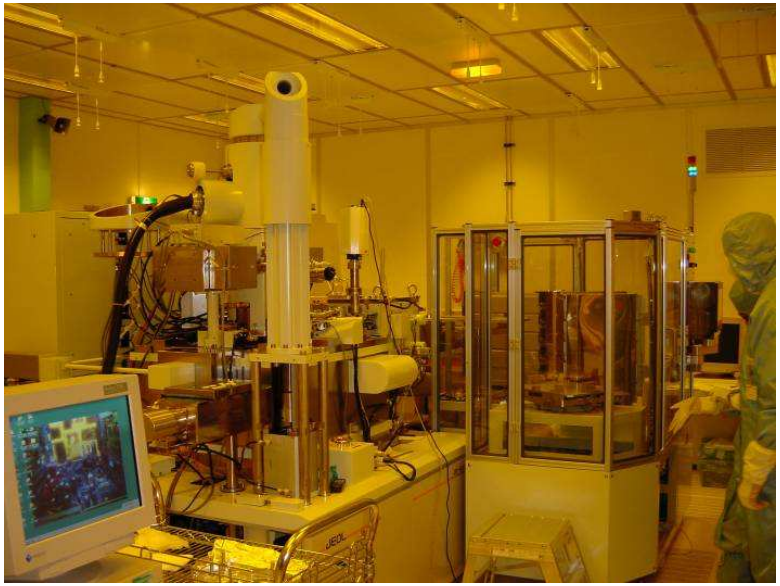


Lithography in EuminaFab

	optical **contact**	optical **stepper**	charged particle **e-beam**
Resolution	1 um	400 nm	10 nm
Ease of use	++	+	o
Flexibility	++	o	++
Through-put	o	++	--
Costs eqpt	low	high	very high
Cost per wafer	moderate	low	high

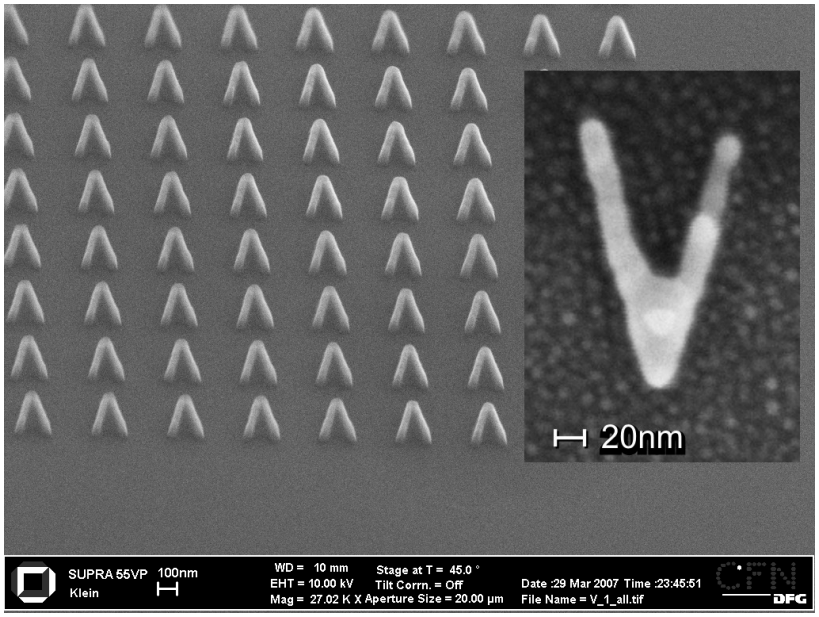
Ultra-High Resolution E-Beam Lithography

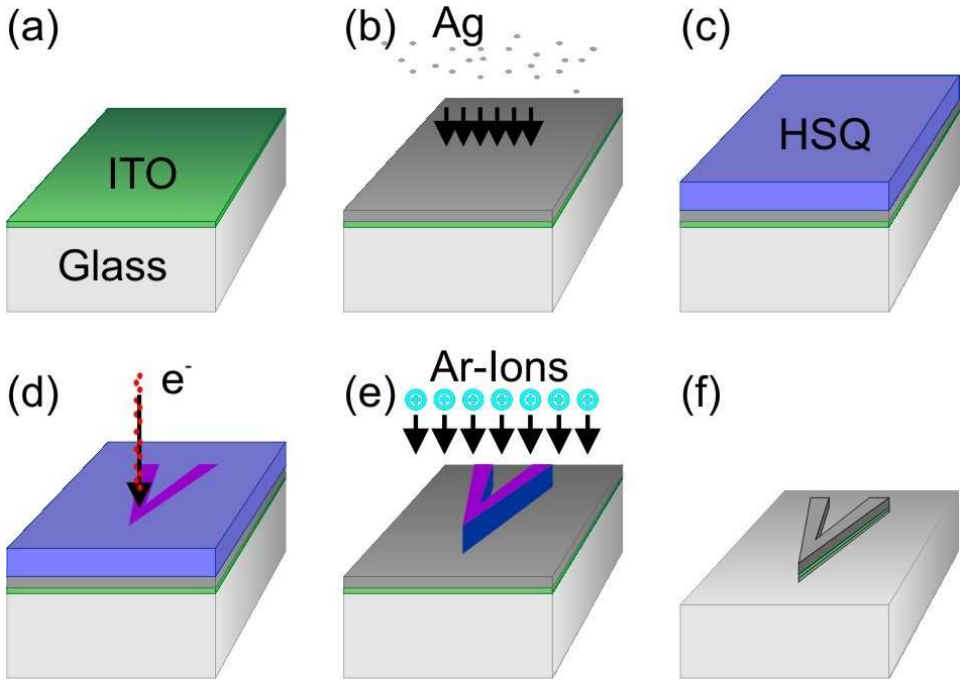
VB6 UHR EWF, Vistec @ KIT



Jeol JBX9300 @ MiPlaza

Ultra-High Resolution E-Beam Lithography



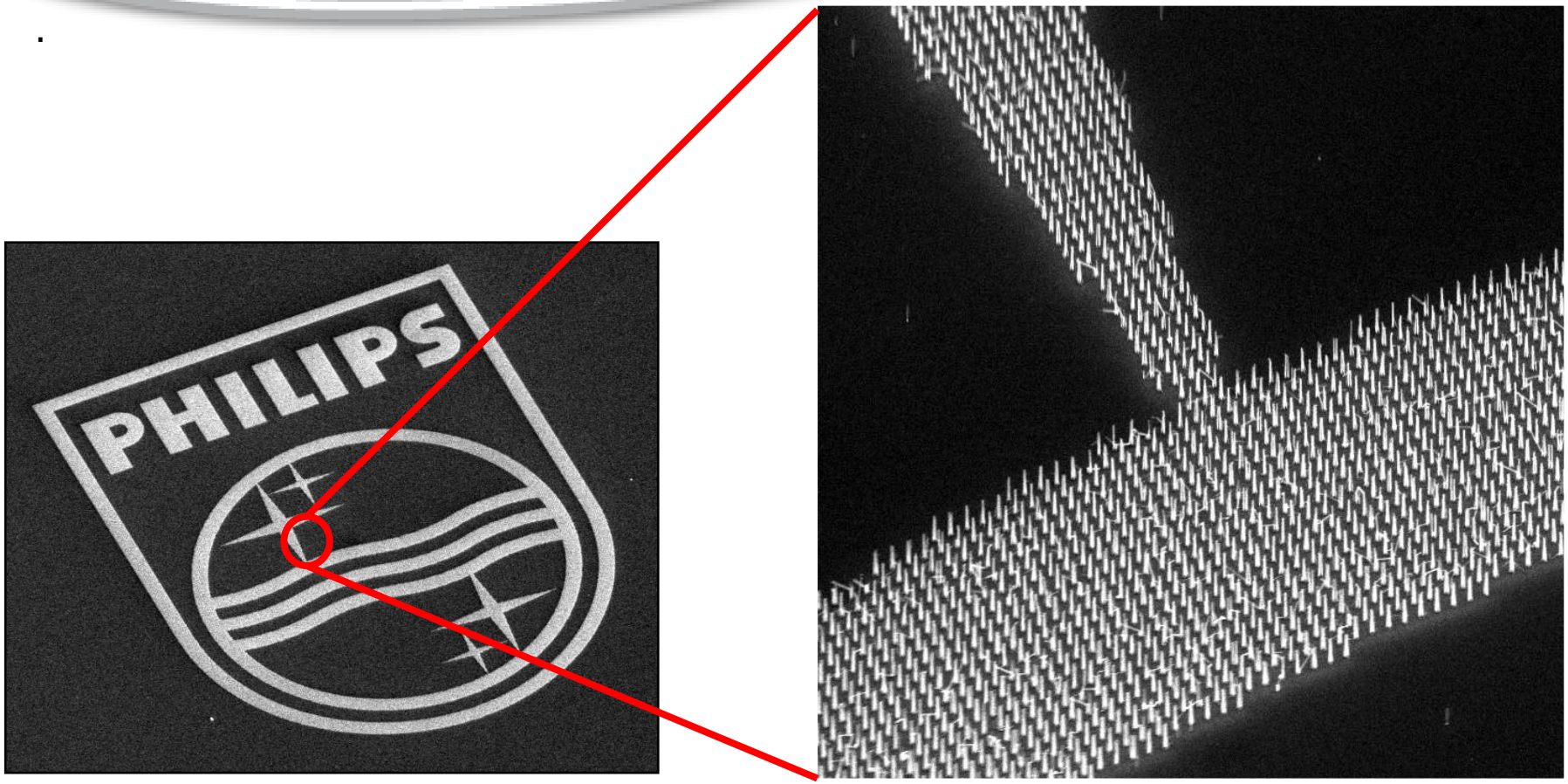


HSQ resist structures for fabrication of Ag nanoantennas (inset), CD: 15 nm

Fabrication scheme: e-beam + dry etching

Microelectronic Engineering 86 (2009) 1078-1080

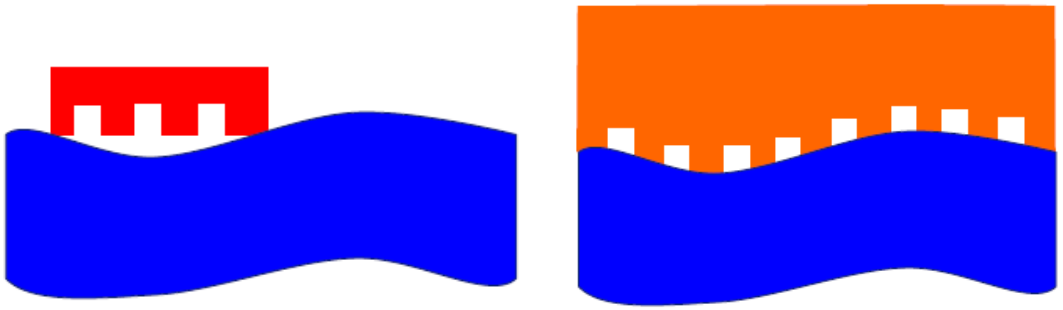
Ultra-High Resolution E-Beam Lithography



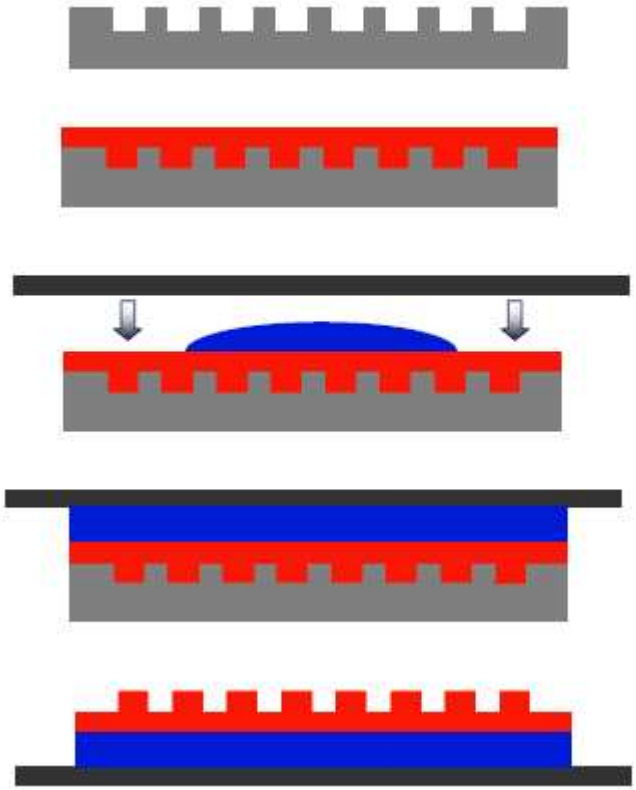
Lift-off process: 25 nm gold dots for nanowire growth.

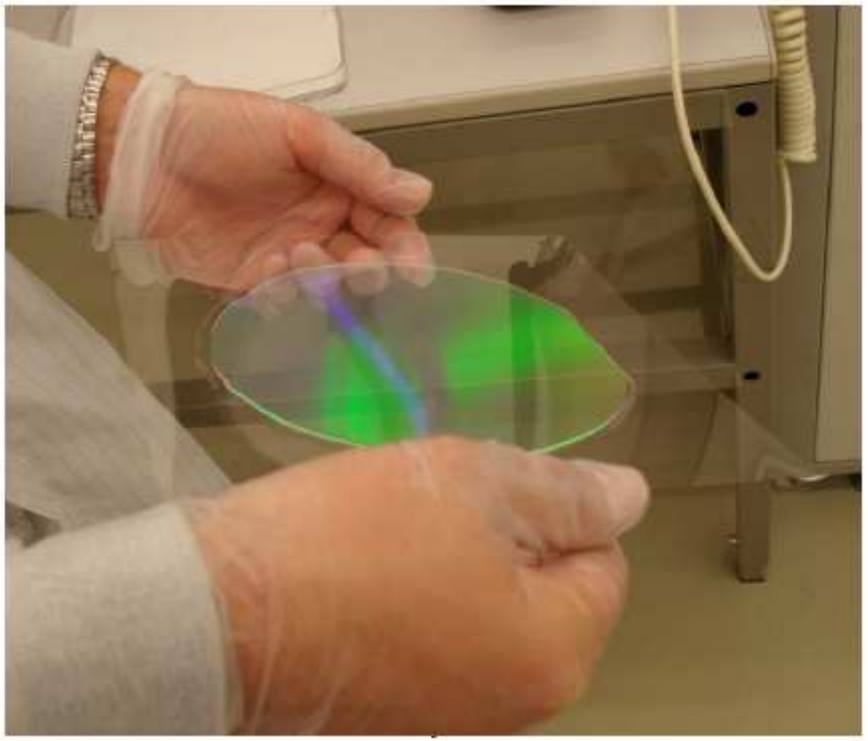
NIL vs. soft printing

	NIL hard stamp	**SL** soft stamp
speed	+	+
low costs	+	+
resolution	+	+
placement accuracy	+	o
pattern fidelity	+	-
release	o	+
dealing with dust	-	+



SCIL - Substrate Conformal Imprint Lithography





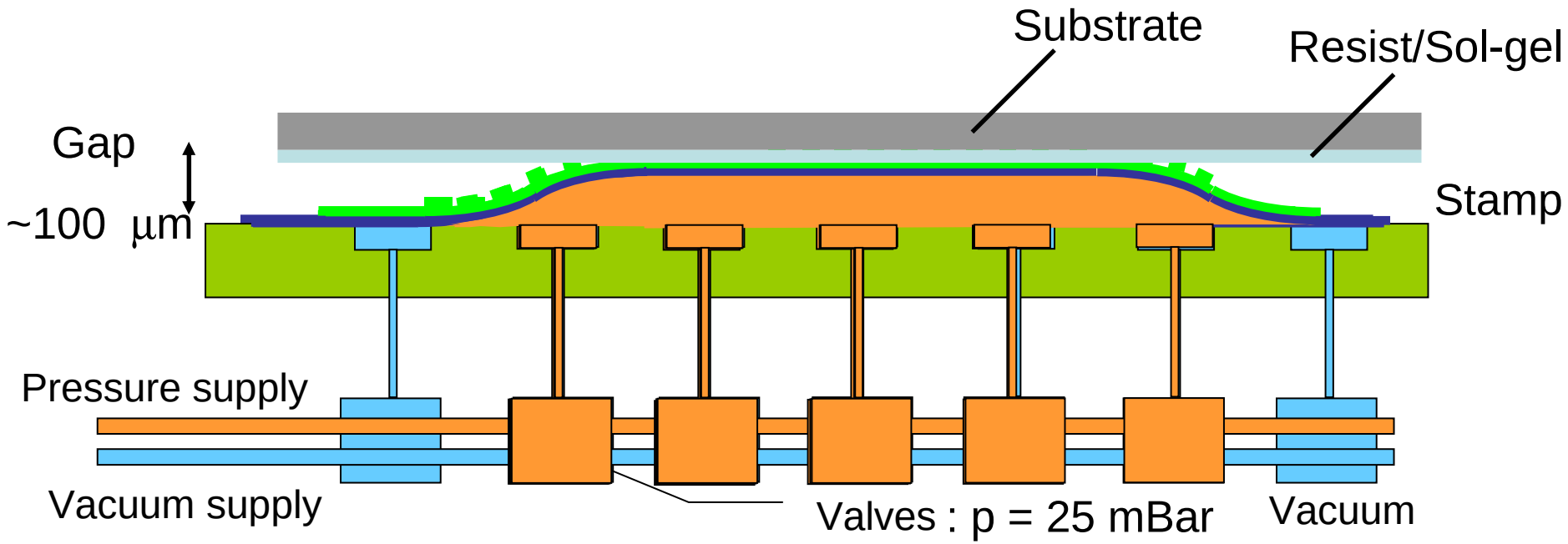
SCIL composite stamp

SCIL - Substrate Conformal Imprint Lithography

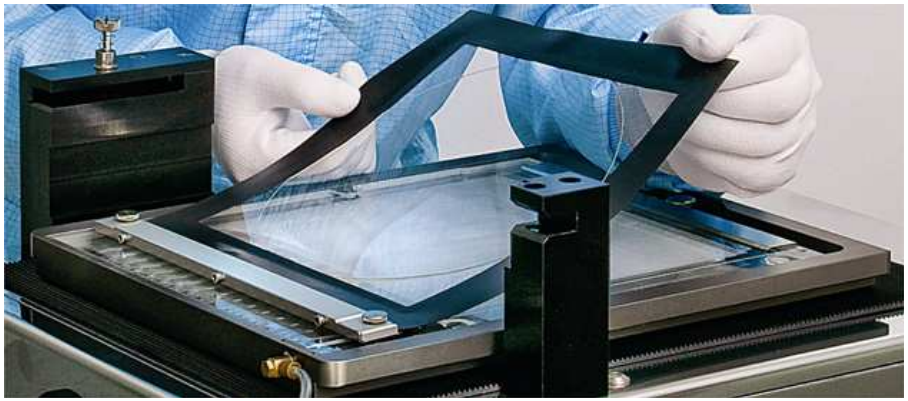
	NIL	SL	SCIL
speed	+	+	+
low costs	+	+	+
resolution	+	-	+
placement accuracy	+	-	+
pattern fidelity	+	-	+
release	-	+	+
dealing with dust	-	+	+

SCIL - Substrate Conformal Imprint Lithography

SCIL printing principle

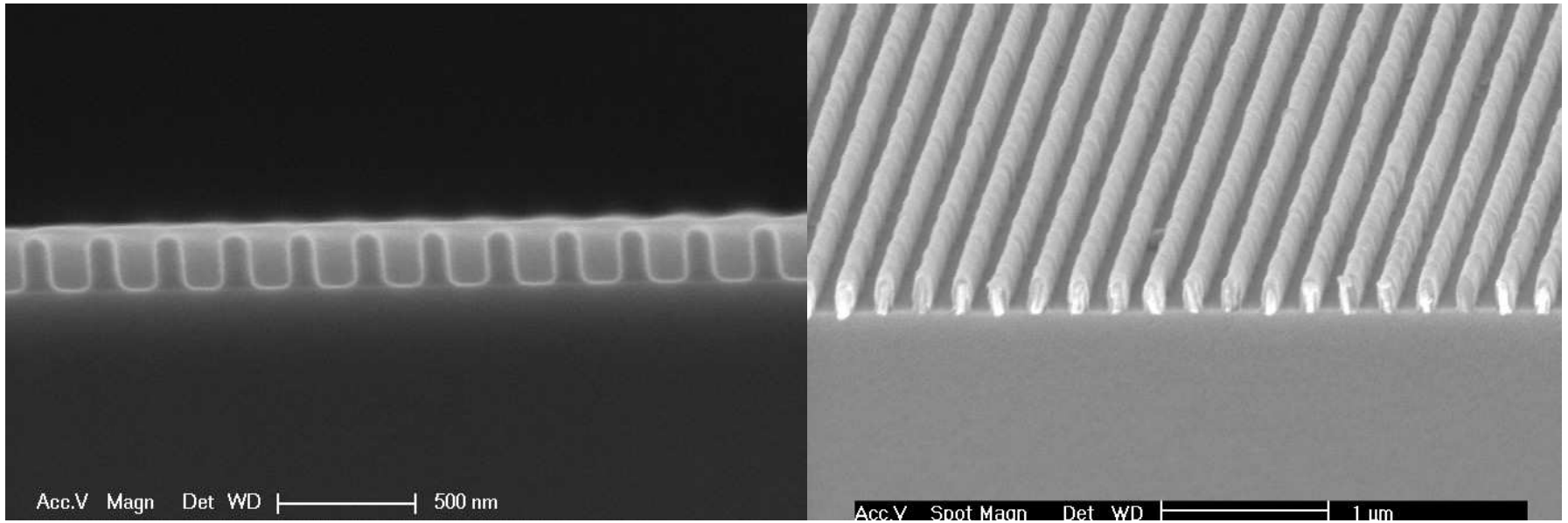


SCIL - Substrate Conformal Imprint Lithography



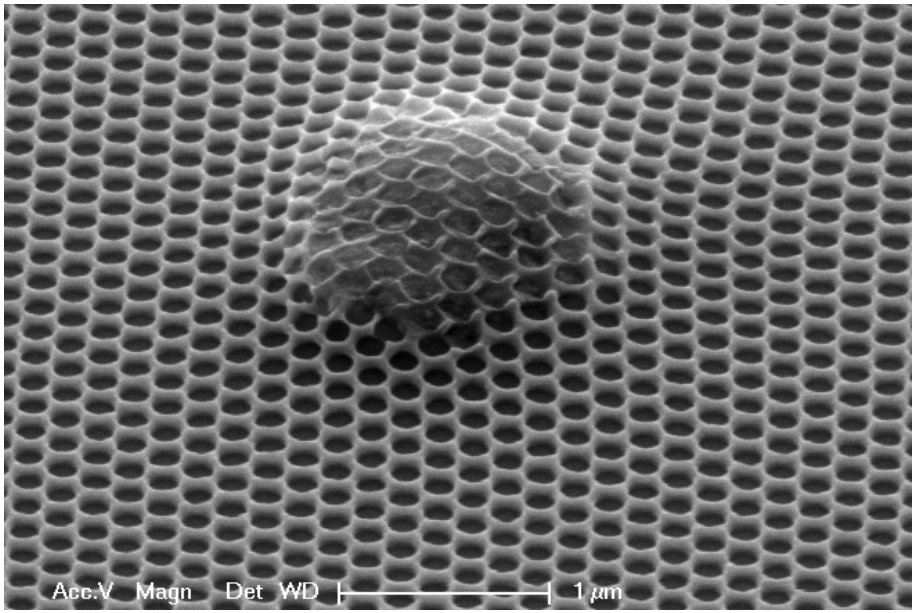
SCIL imprint module on Süss MA 6/8 mask aligner

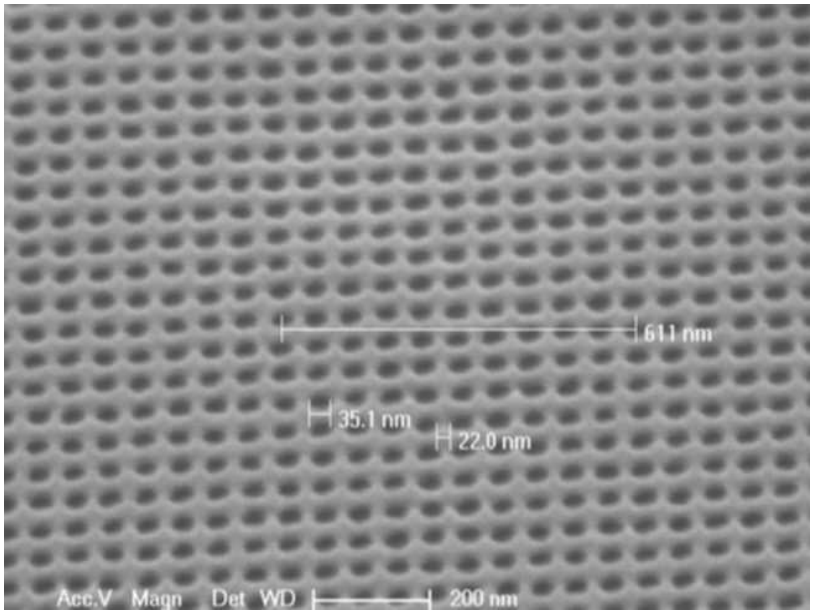
E-beam → SCIL



- Creating quartz-like templates from patterned and cured sol-gel material on quartz substrates
- Using resist or sol-gel material as etch mask for transferring pattern into other materials

E-beam → SCIL

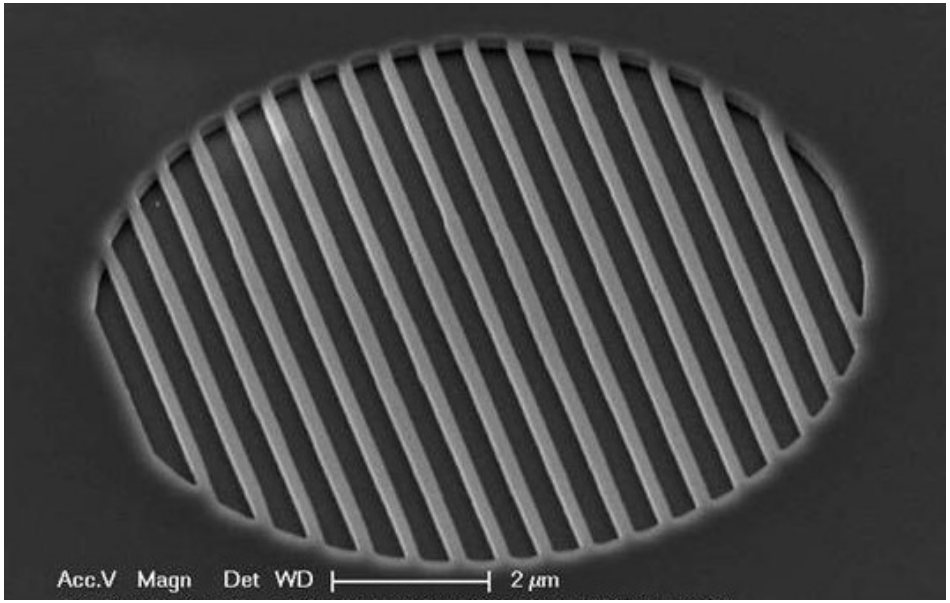




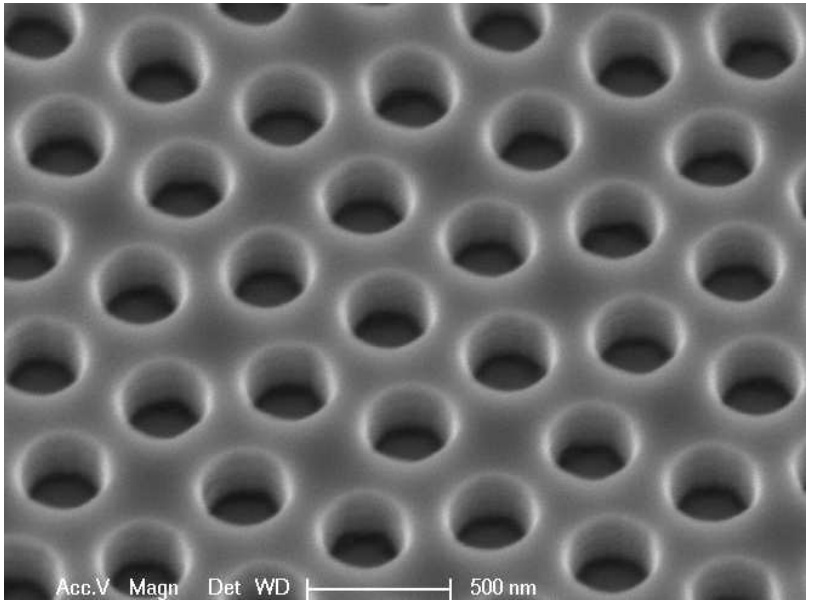
Substrate conformal: no stamp damage & only local deformations

High resolution – 30nm dense dot array

E-beam → SCIL



gratings for VCELs
(picture courtesy Ulm Photonics)

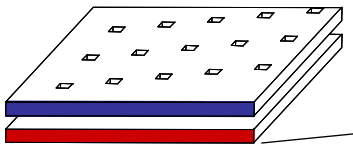


photonic crystal etched in GaN

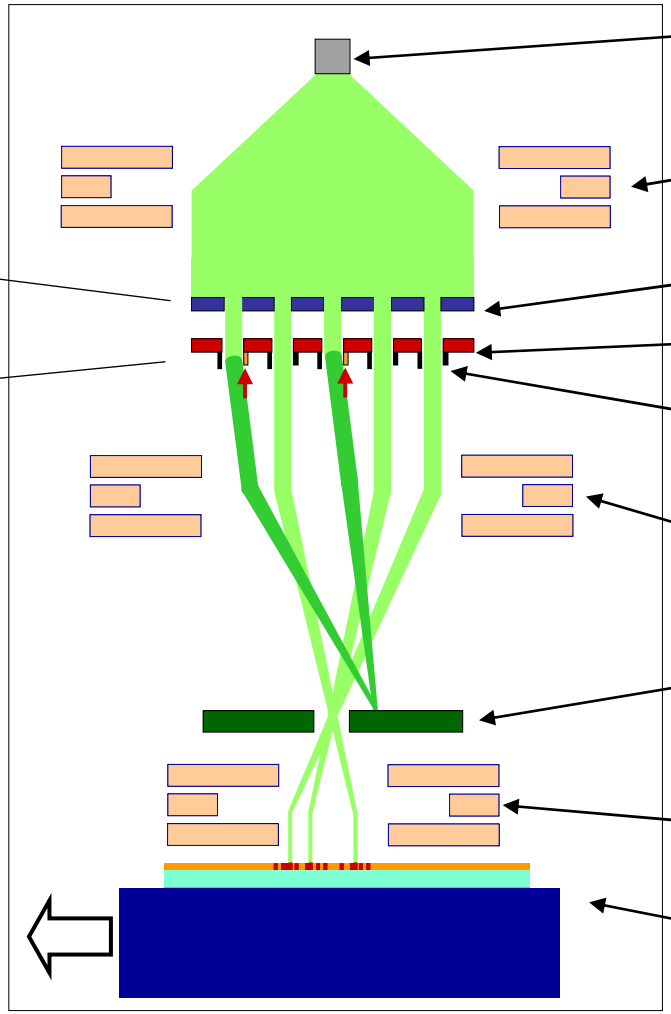
EUMINAfab

APS

programmable
Aperture Plate System



200x reduction
projection optics



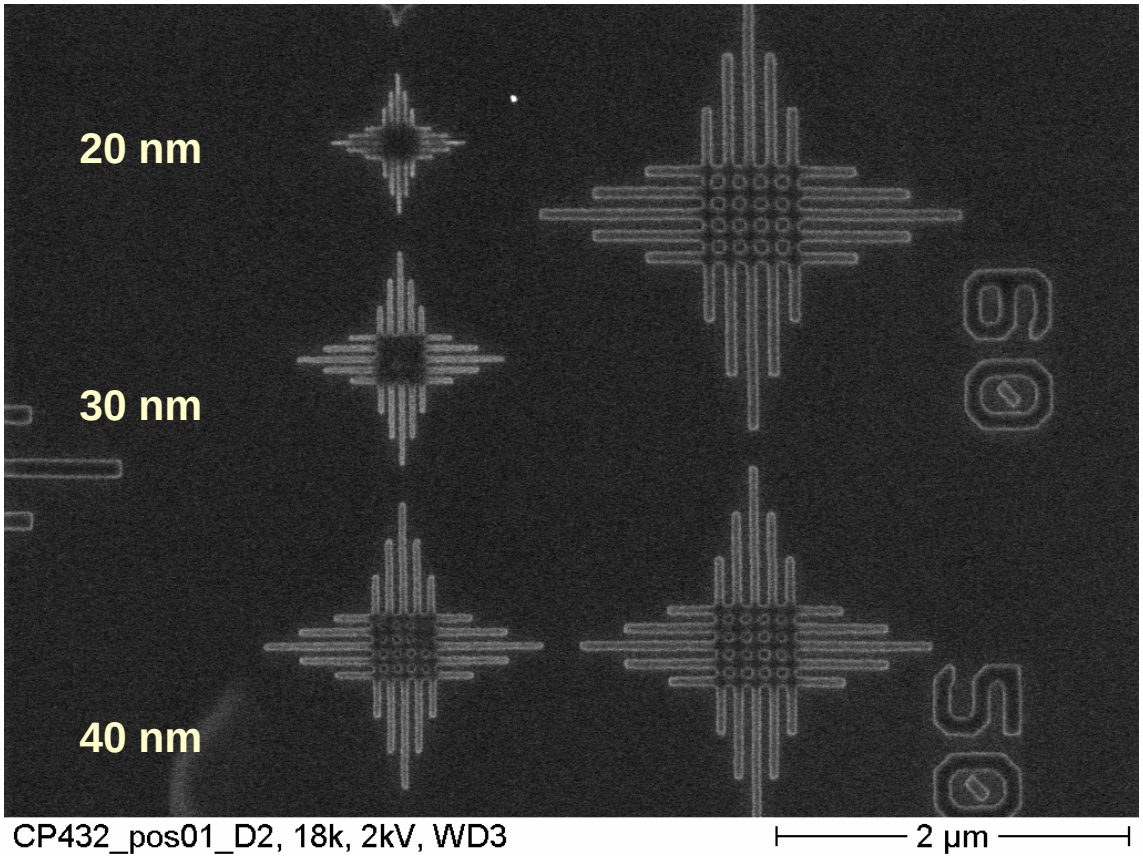
MiPlaza

KIT Karlsruhe Institute of Technology

Charpan

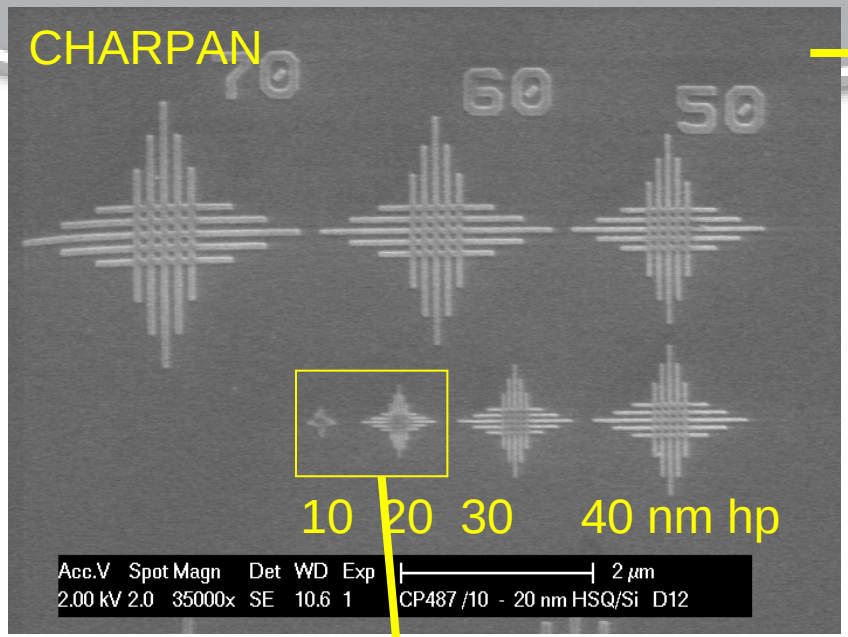
1:1

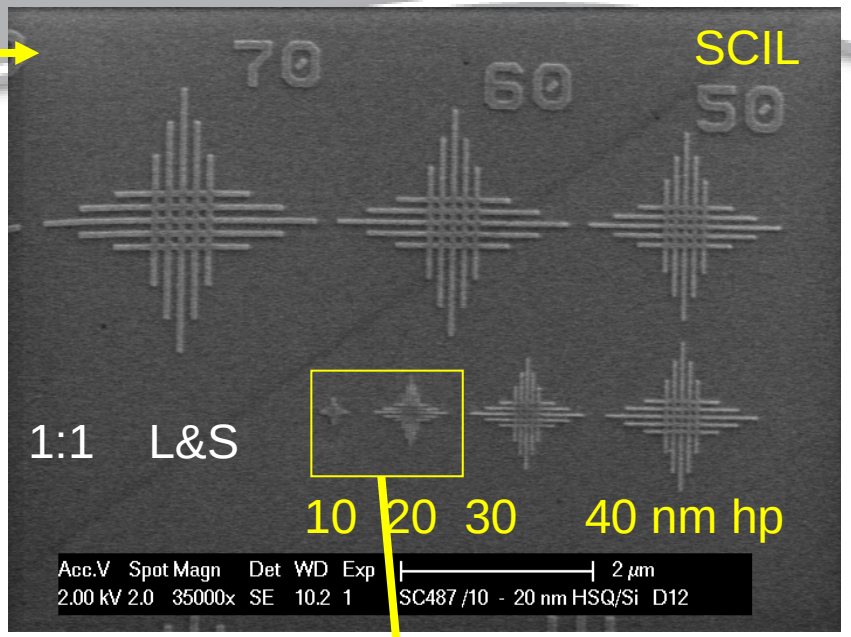
L & S

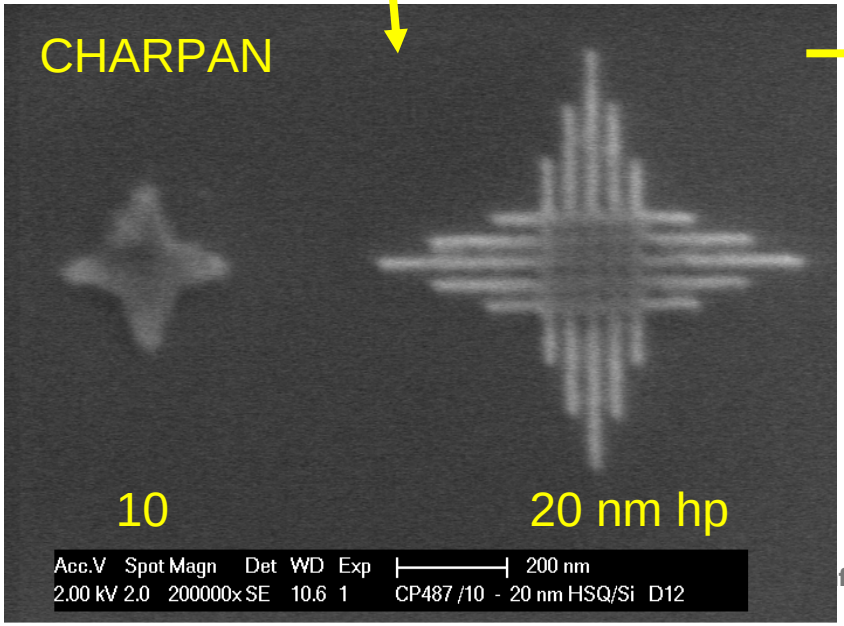


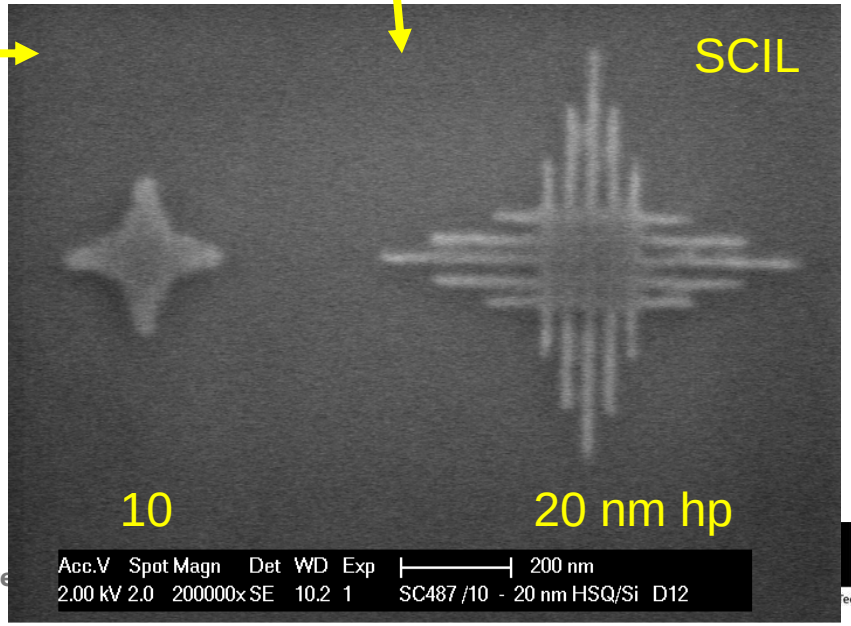
CHARPAN CMOS-APS exposure result: 10keV H_3^+⇨ 20nm HSQ

Charpan → SCIL



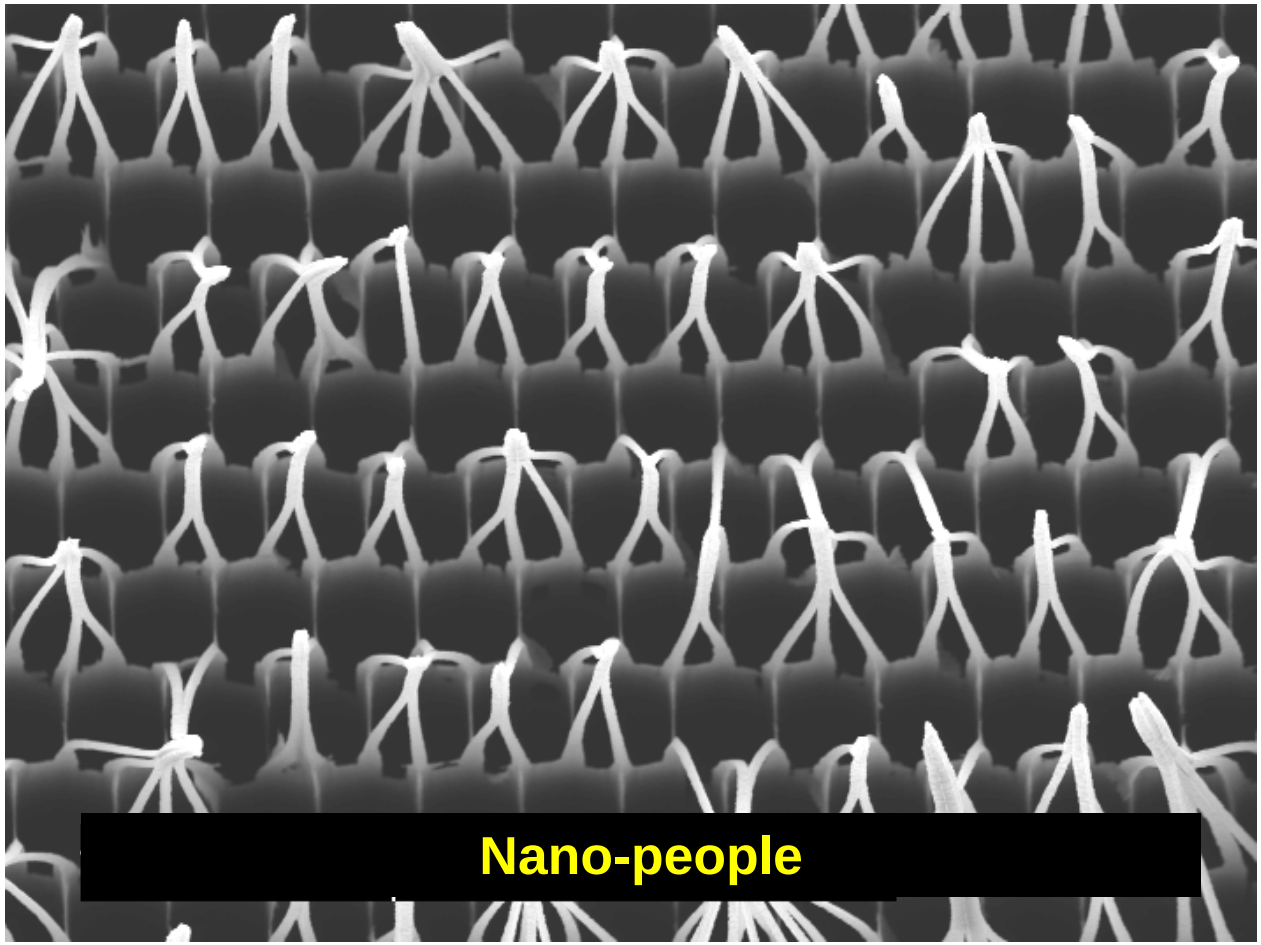






EuminaFab Service options

- **Optical lithography (> 400nm)**
- **Direct write by e-beam**
- **Nano-imprint by SCIL with e-beam master**
- **Comprehensive set of adjacent enabling technologies, like deposition, etching, measuring, ……**


Nano-people