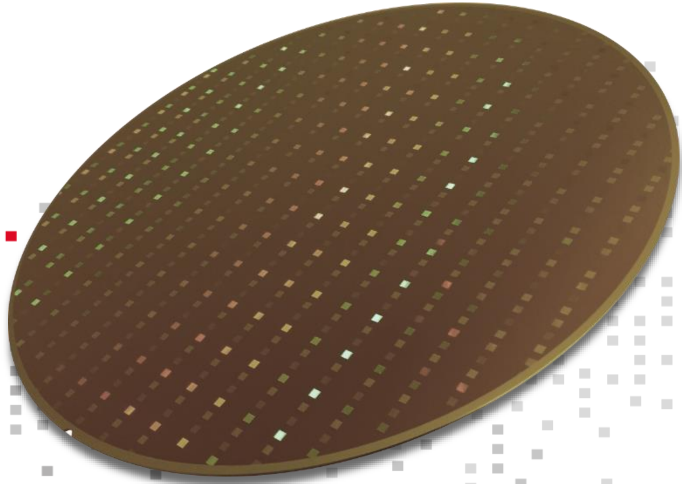
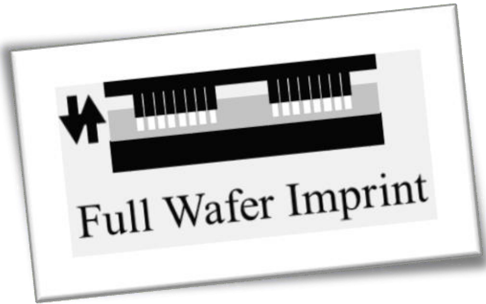


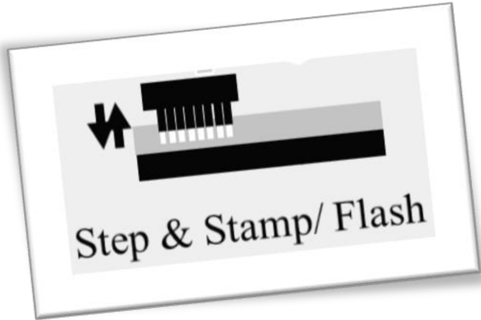
THE INSPIRE PROGRAM: PROGRESSES AND PERSPECTIVES

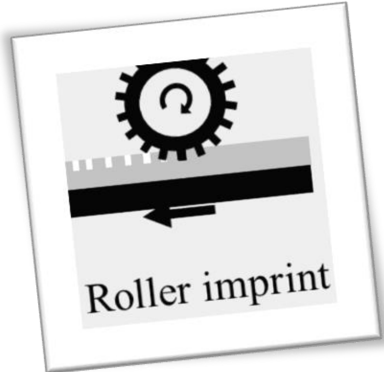
LETI Lithography Workshop | Leti Days

leti ceatech

NANOIMPRINT LITHOGRAPHY: 3 OPTIONS







Wafer Scale Soft NanoImprint Lithography

master

soft stamp fab

demolding

NIL

Imprinted substrate

substrate

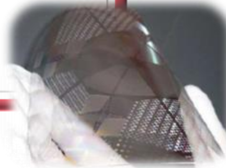
coating

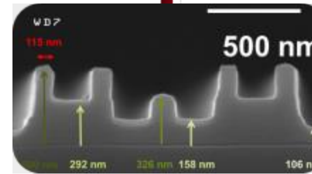
example of
imprinted device

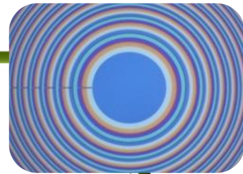
THE POTENTIAL OF THE NANOIMPRINT TECHNOLOGY

High Resolution
Large surface
3D complex shapes
More than Silicon substrates
Non flat substrates

Permanent resist layer
High & low index materials
Bio compatible materials
Etching mask layer







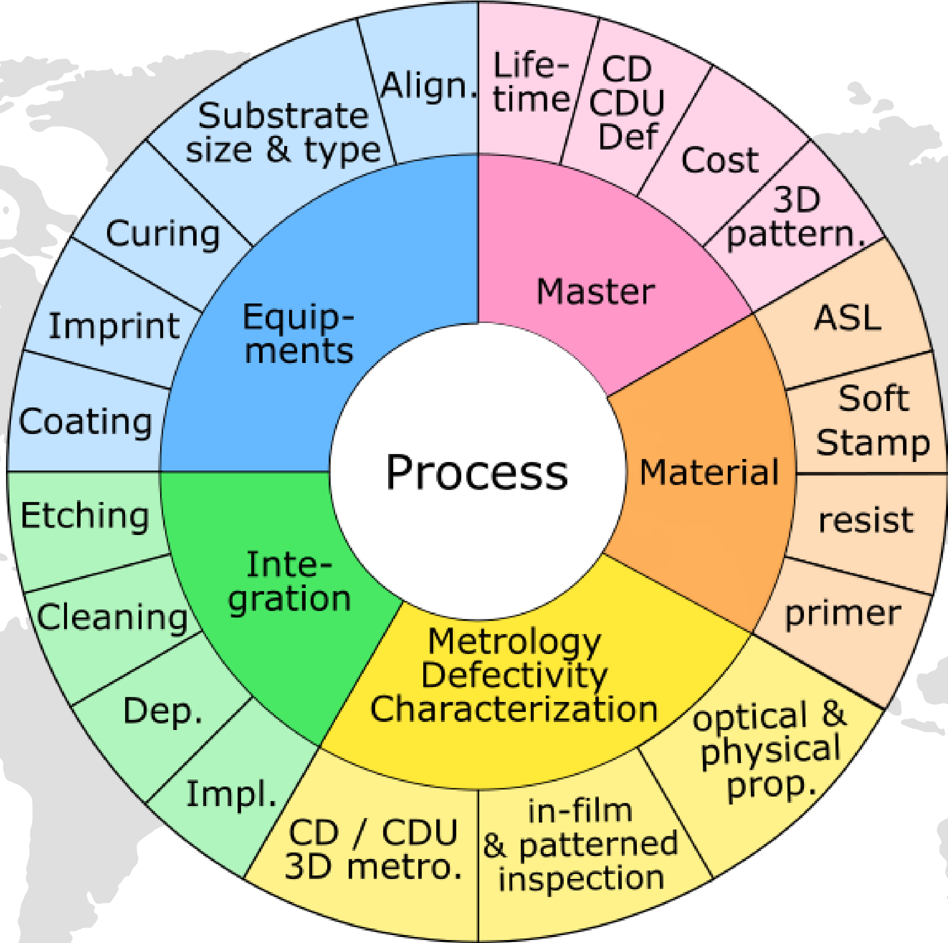
Photonics
Biomedical
Data storage
Optics & Display

High volume manufacturing
Throughput
Alignment & integration

THE NANOIMPRINT VALUE CHAIN

REPLICATION

STANDARDIZATION



MATERIALS COMPATIBILITY

ASSESSMENT

SCALING

CHARACTERIZATION

EVALUATION

EVG-LETI SOLUTION: INSPIRE PROGRAM, KICK-OFF IN JUNE 2015

inspire

- Imprint materials
- PreProcessing module
- SmartNIL technology
- Upgrades for advanced processes

Tool acquired by Leti in 2016

- Master program
- Material benchmark
- Technology assessment: CDU-overlay-defectivity
- ramp-up of integrated process

LETI ECOSYSTEM FOR INSPIRE PROGRAM

Up to 200 mm wafers
Si / glass

REPLICATION

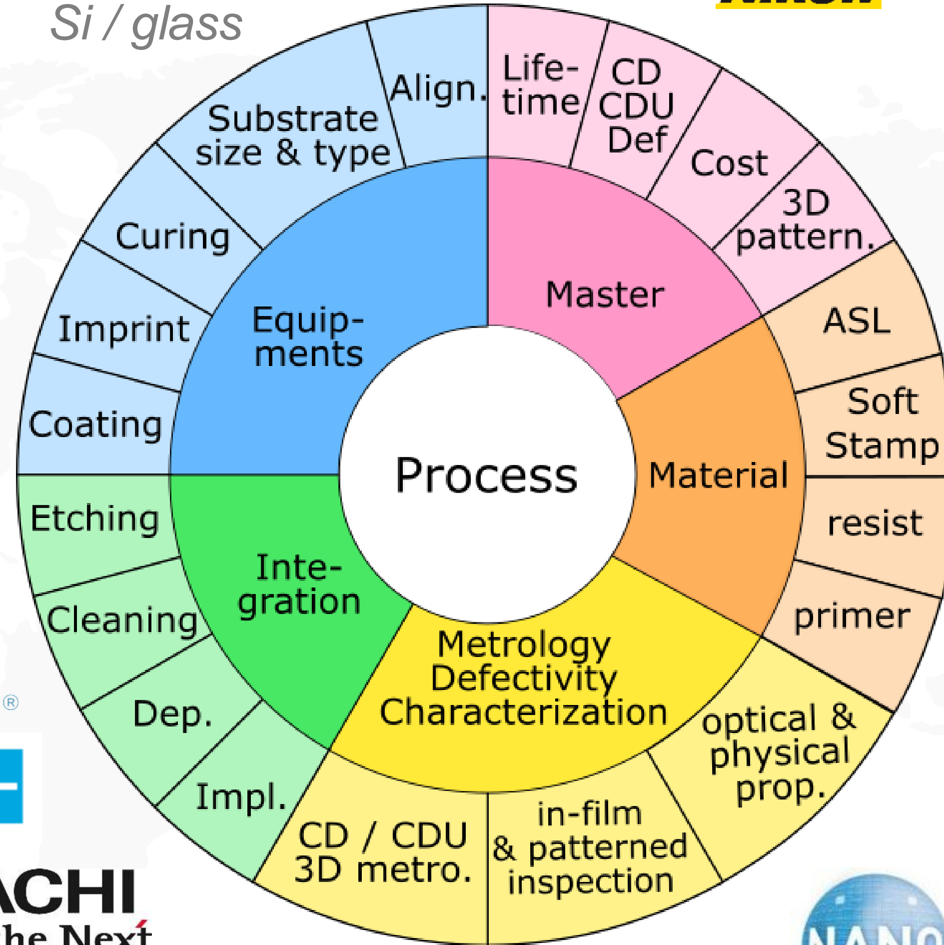
STANDARDIZATION

MATERIALS COMPATIBILITY

ASSESSMENT

CHARACTERIZATION

EVALUATION



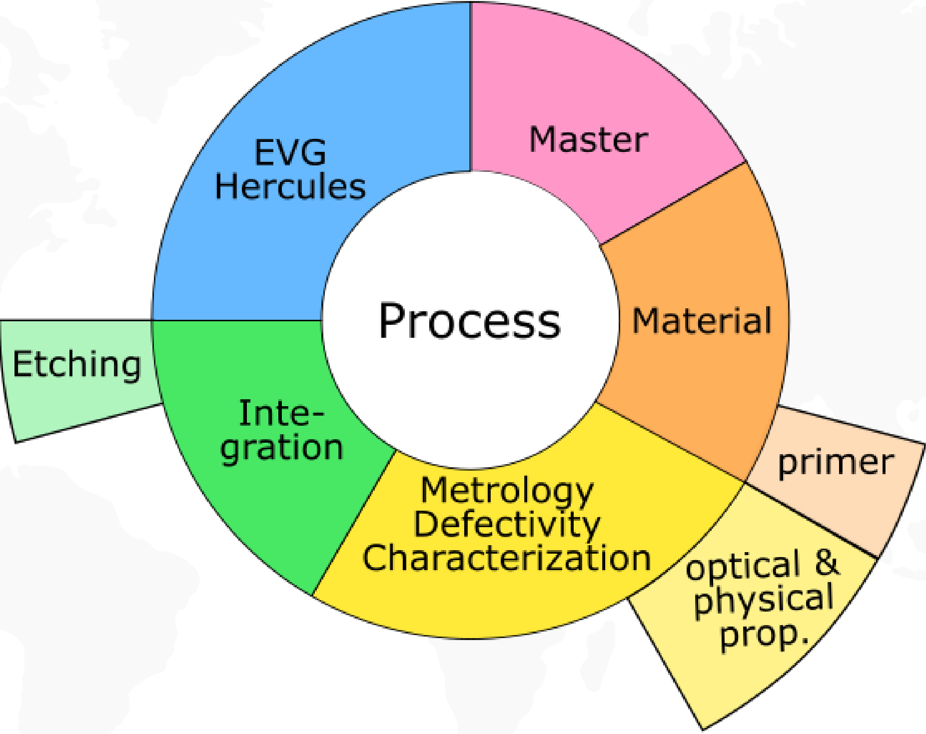
MAIN ACHIEVEMENTS WITHIN THE INSPIRE PROGRAM

REPLICATION

STANDARDIZATION

MATERIALS COMPATIBILITY

ASSESSMENT

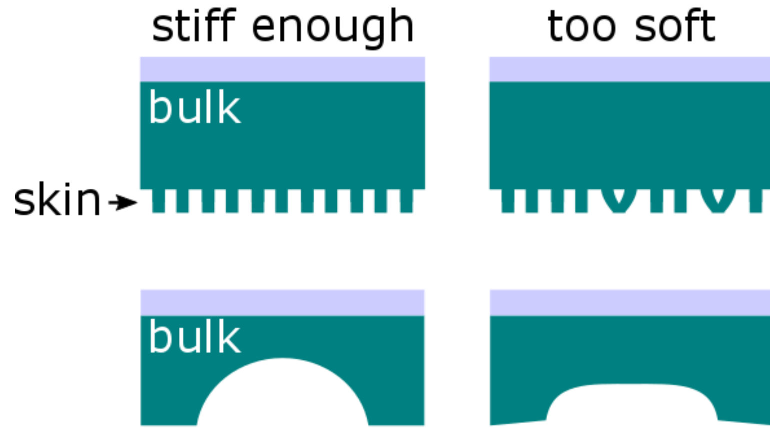


CHARACTERIZATION

EVALUATION

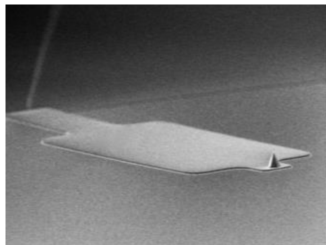
ADVANCED MECHANICAL CHARACTERIZATION FOR SOFT STAMPS

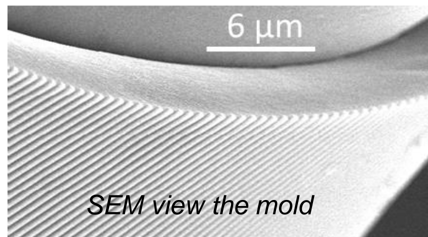
- **Soft stamp stiffness impact**

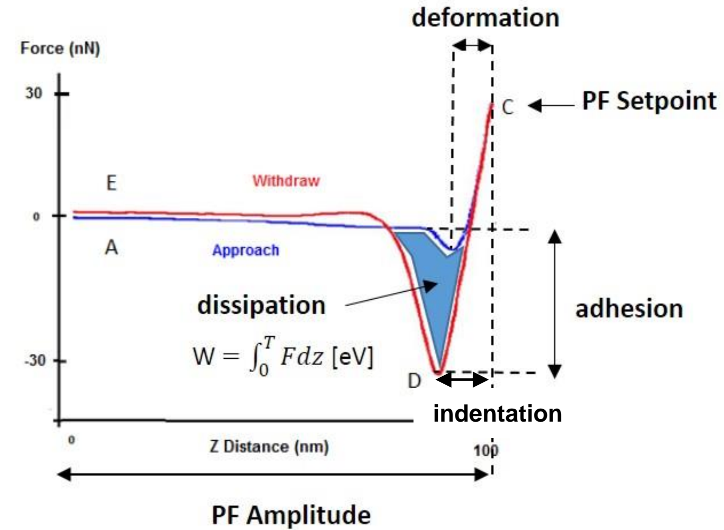


- **Stiffness characterization**
  - is performed locally at the near surface
  - Is correlated to the material process window

Shape	Resonant Freq. kHz			Spring Const. N/m			Length µm			Width µm		
	Nom.	Min.	Max.	Nom.	Min.	Max.	Nom.	Min.	Max.	Nom.	Min.	Max.
Special	55	35	75	0.25	0.10	0.40	110	100	120	40	38	42



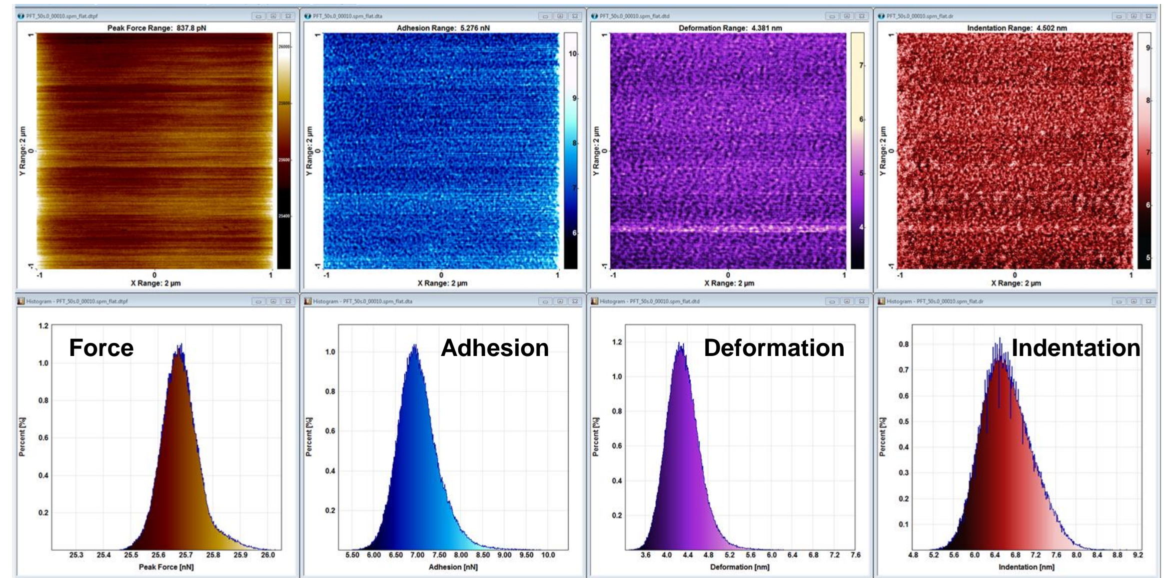




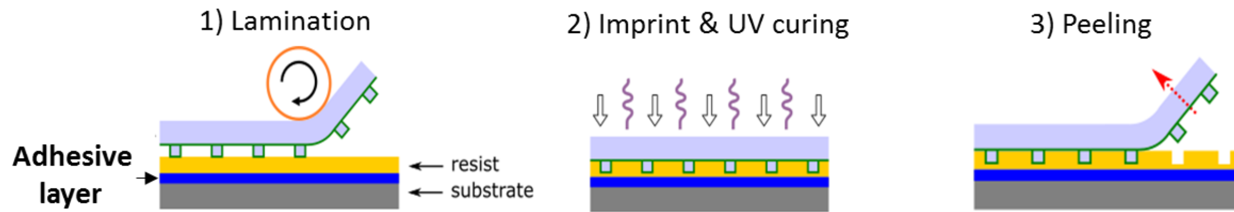
$$P = \frac{E}{(1-\nu^2)}\left(\frac{R^2+a^2}{2}\,\mathrm{Log}\left(\frac{R+a}{R-a}\right) - a\,R\right)$$

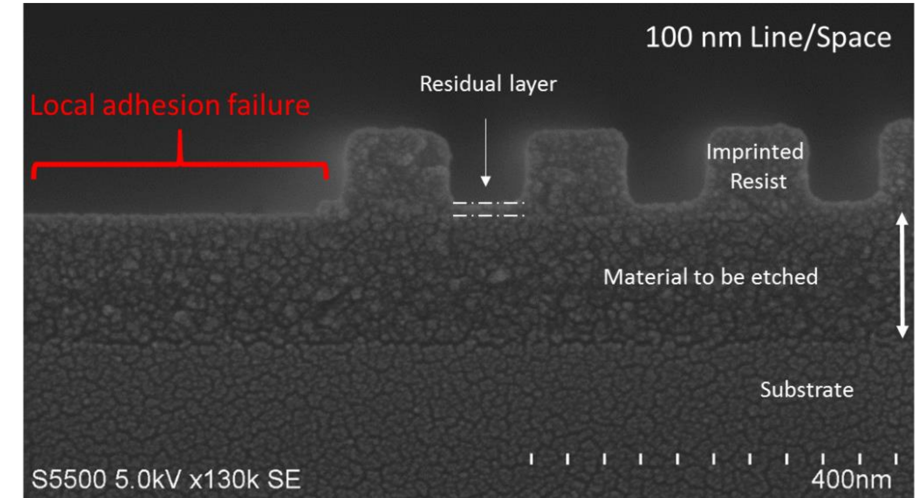
$$\delta = \frac{a}{2}\,\mathrm{Log}\left(\frac{R+a}{R-a}\right)$$

Mechanical and adhesion properties



ARKEMA NANOSTRENGTH PRIMER QUALIFICATION





- **Adhesive layer needs to be**
  - thin, homogeneous and,
  - prevent resist pick off during peeling

- **Four different primer were developed by ARKEMA**
  - 4 parameters are monitored for quality, peeling tests are performed for performances

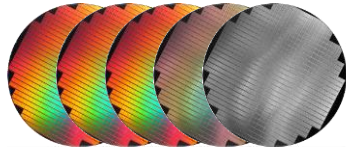
Adhesive layer	Thickness (nm)	Roughness Rq (nm)	Uniform layer	Contact angle ° (water)
Prim1-ARK	9	0.3	✓	65±2
Prim2-ARK	4	0.3	✓	87± 2
Prim3-ARK	6	0.4	✓	52± 2
Prim4-ARK	6	0.2	✓	102± 2

Adhesive layer	Silicon	Borofloat Glass
Prim1-ARK	Failure	-
Prim2-ARK	Failure	-
Prim3-ARK	ok	ok
Prim4-ARK	Dewetting	-

- **Primer compatible with EVG, MRT, Obducat and several other resists**

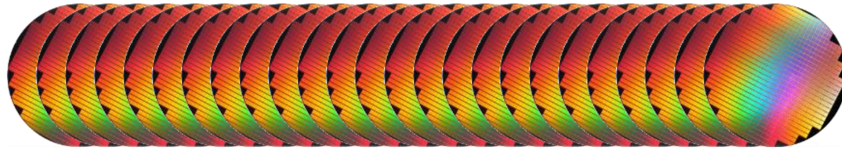
CUSTOMER APPLICATION, PATTERNING OF SUB 100 NM CONTACTS

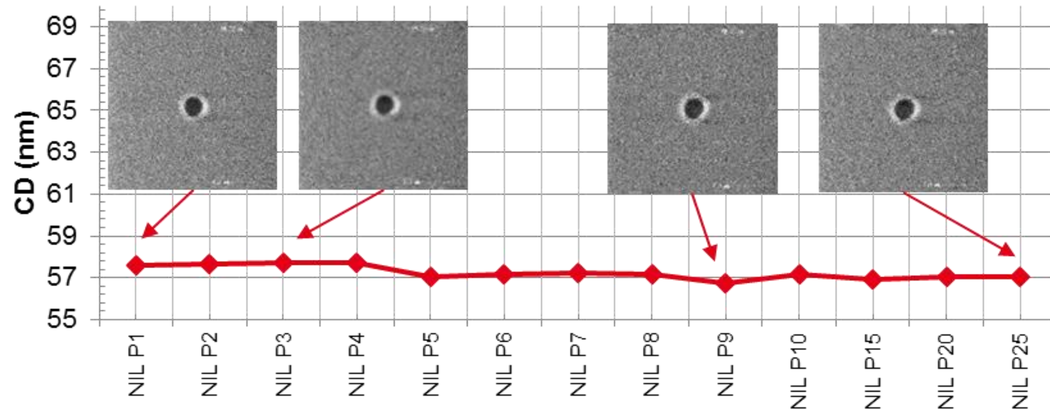
- **2017**



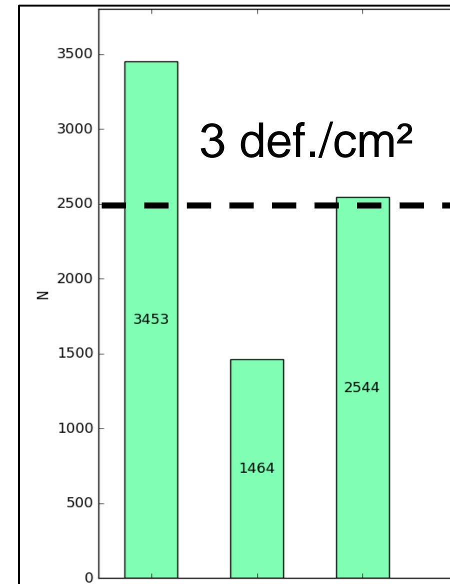
Material and process issues identified
New materials developped by EVG

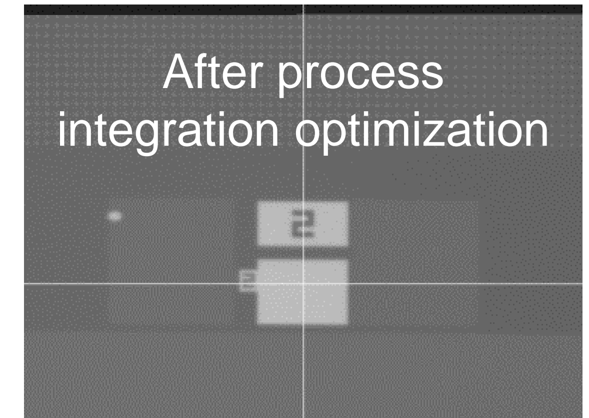
- **2018**





Defectivity inspection post etching





High resolution feature replication with HERCULES tool ready for pre-production

NIL 2019 Road-map

	Q1	Q2	Q3	Q4
Overlay Optical litho on NIL			★ 800 nm OVL	★ 500 nm OVL
Integration		★ 1 defect/cm² on sub 100 nm products		★ 0.5 defect/cm² on sub 100 nm products
External platform access	★ Metrology and Master platform access for NIL end-users			

LETI ECOSYSTEM FOR TECHNOLOGY VALIDATION