Project Meeting
Eindhoven

Victor Calzadilla, Dominik Heiss
Andrea Fiore, Meint Smit

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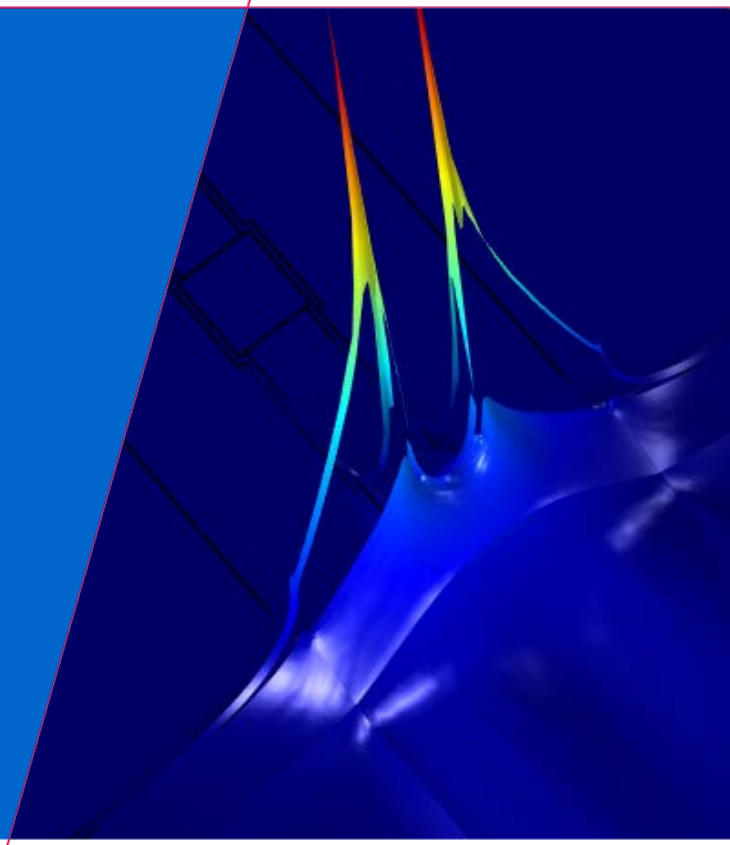

NAVOLCHI

TU/e Technische Universiteit Eindhoven University of Technology

Where innovation starts

Contents

1. Tasks
2. Milestones and deliverables
3. Current status of nanolaser
   - Summary of simulation results
   - Results of 1st fabrication run
   - Plan for 2nd run
4. Cooperation with other partners
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Tasks

	Names of the tasks	Time period [months]
Task 3.1	Modelling of device structure (plasmonic laser) and optimization of bonding technology	1 – 6
Task 3.3	Fabrication of nano plasmonic laser	7 – 30

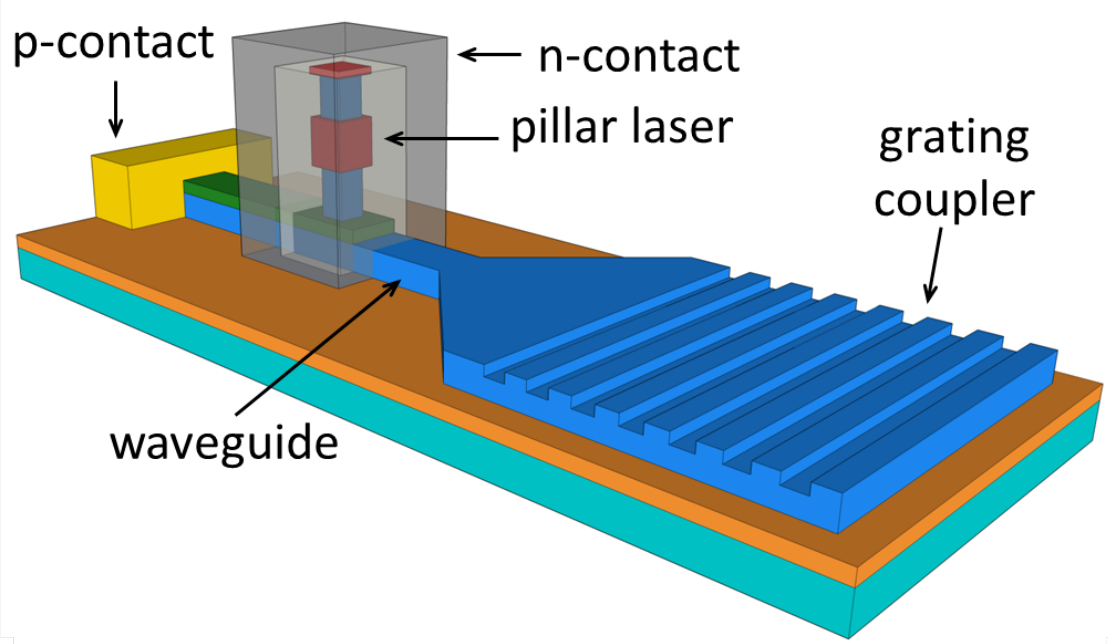
Milestones and deliverables

	Names of the milestones	Month
MS8	Decision on an optimized structure for metallic/plasmonic nanolaser and its coupling to a Si-waveguide	6
MS10	Grown wafer structure for plasmonic lasers	12
*MS13	Initial characterization of unbonded plasmonic lasers	18
MS15	Initial testing of bonded plasmonic lasers	24

	Names of the deliverables	Month
D3.1	Report on studies of optimized structure for metallic/plasmonic nanolaser and its coupling to Si-waveguide	12
D3.3	Fabrication of plasmonic laser device	24

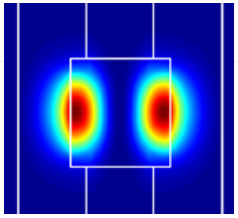
*MS13: has become obsolete by modification of fabrication process

Laser structure



InP (3.17)
InGaAs (3.55)
InGaAsP (3.36)
Si (3.47)
SiO_x/SiN_x (1.45/1.95)
BCB (1.45)
Ag (0.14 + 11.4i)
Au (0.53 + 10.8i)

Pillar laser: 300nm x 400nm x 1µm

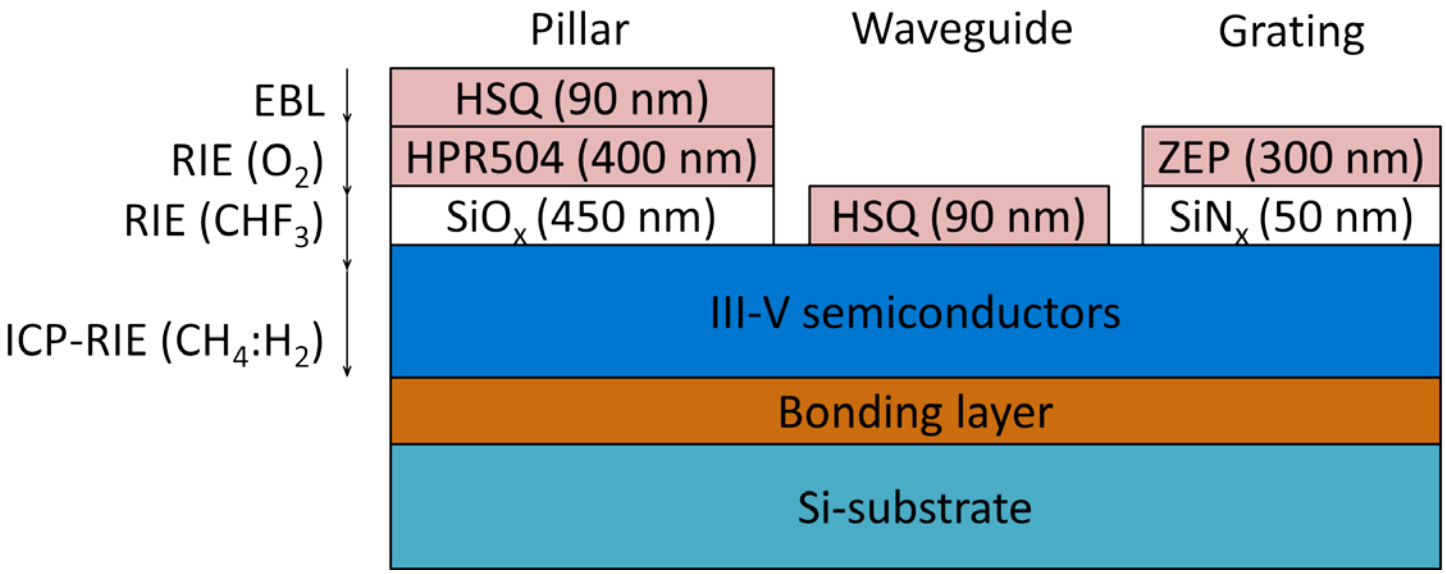


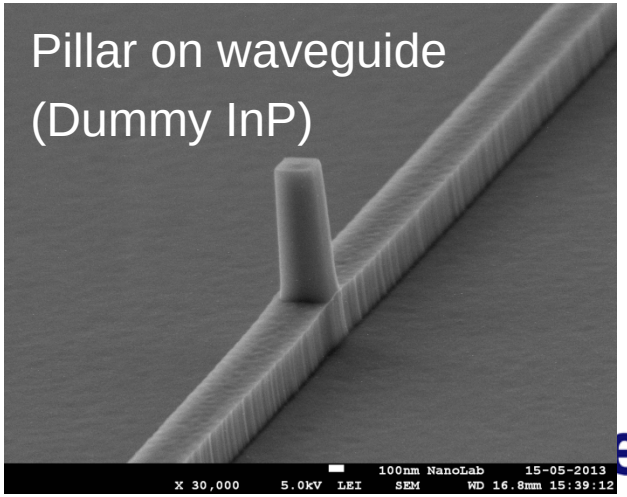
TE mode

Main simulation results

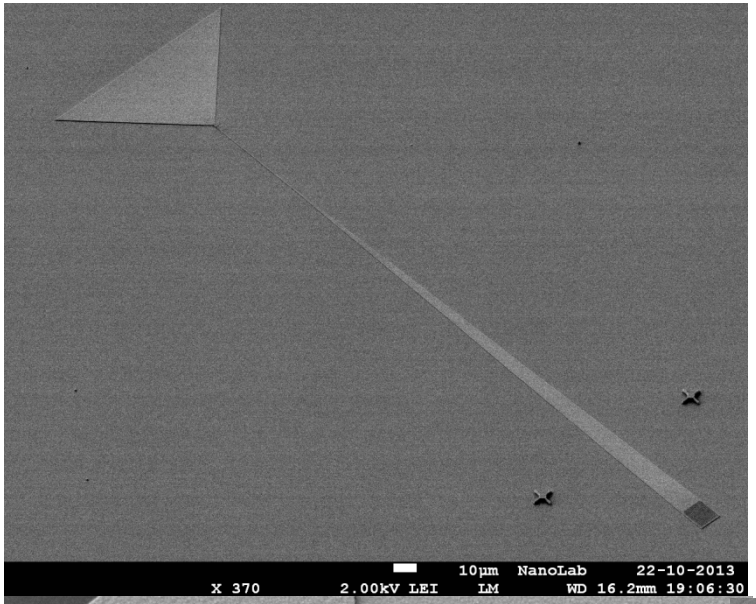
- Optical simulations
  - Q ~ 530
  - Threshold gain ~ 800 cm^{-1}
- Electrical simulations
  - Threshold current ~ 120 µA
  - Differential efficiency ~ 0.16
  - Output power (estimated) ~ 40 µW @ 420 µA (2V)

Fabrication technology development

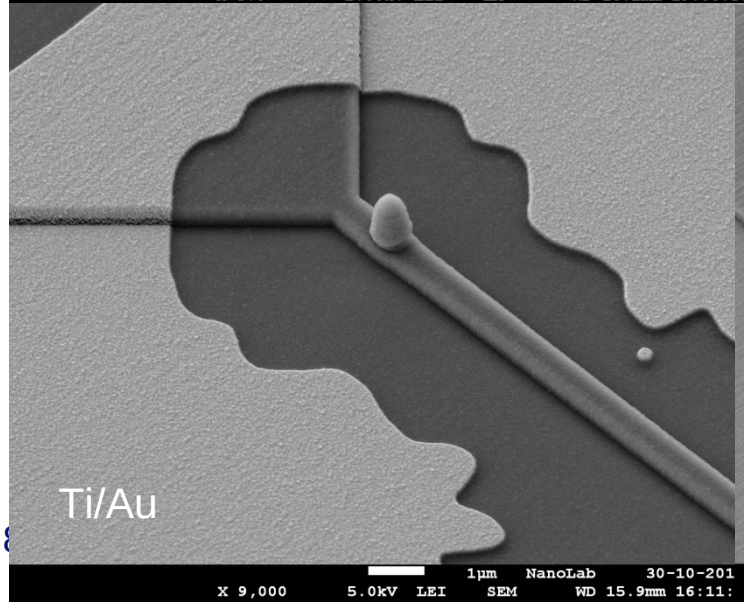


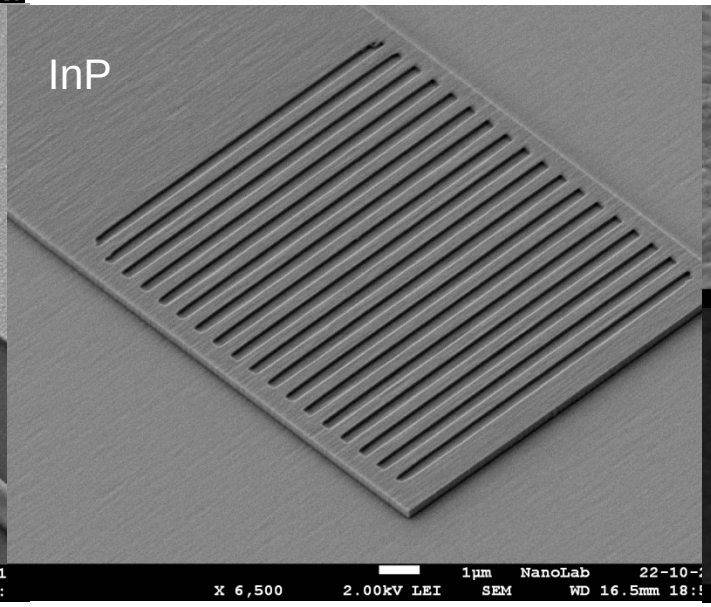


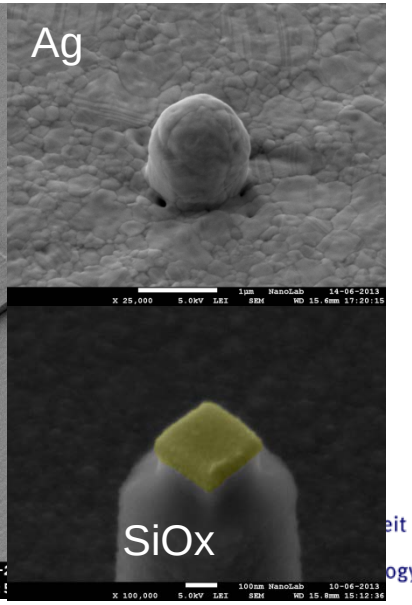
1st run: main achievements



- ✓ Integration of EBL and optical lithography steps in InP-membrane processing
- ✓ Creation of metallic adhesion pads
- ✓ Resist planarization and contacts deposition
- ✓ ~80% of processing with no problems



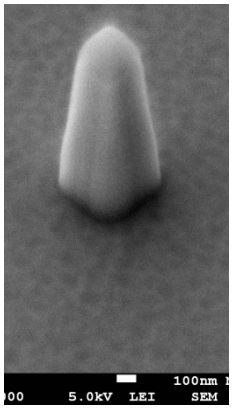




1st run: main issues and solutions

- Non-vertical etch of bonded samples (probably due to BCB)

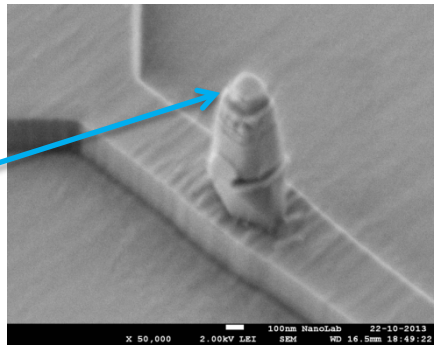
Sidewall slope ~ 5 degrees



Possible solution by recipe tuning, for example:
- Lower pressure
- Lower RF power

- Unprotected pillar due to mask erosion

Top of pillar was etched



Additional lithography step to protect pillar with photoresist

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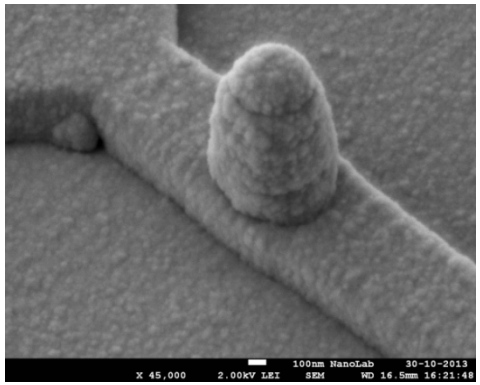
1st run: main issues and solutions

- Low quality of SiO_2

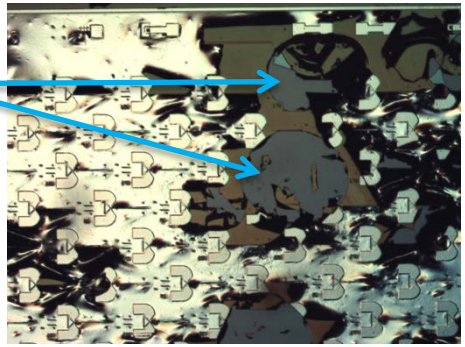


- Modify PECVD recipe

- Outgasing (BCB?) during silver annealing (>400C)

Round defects

One device:



- Reduce annealing temperature
- Cure BCB at higher temperature during bonding process

- Annealed silver was not etched with Degussa (KCN)

- Use fresh Degussa

Plan for 2nd run

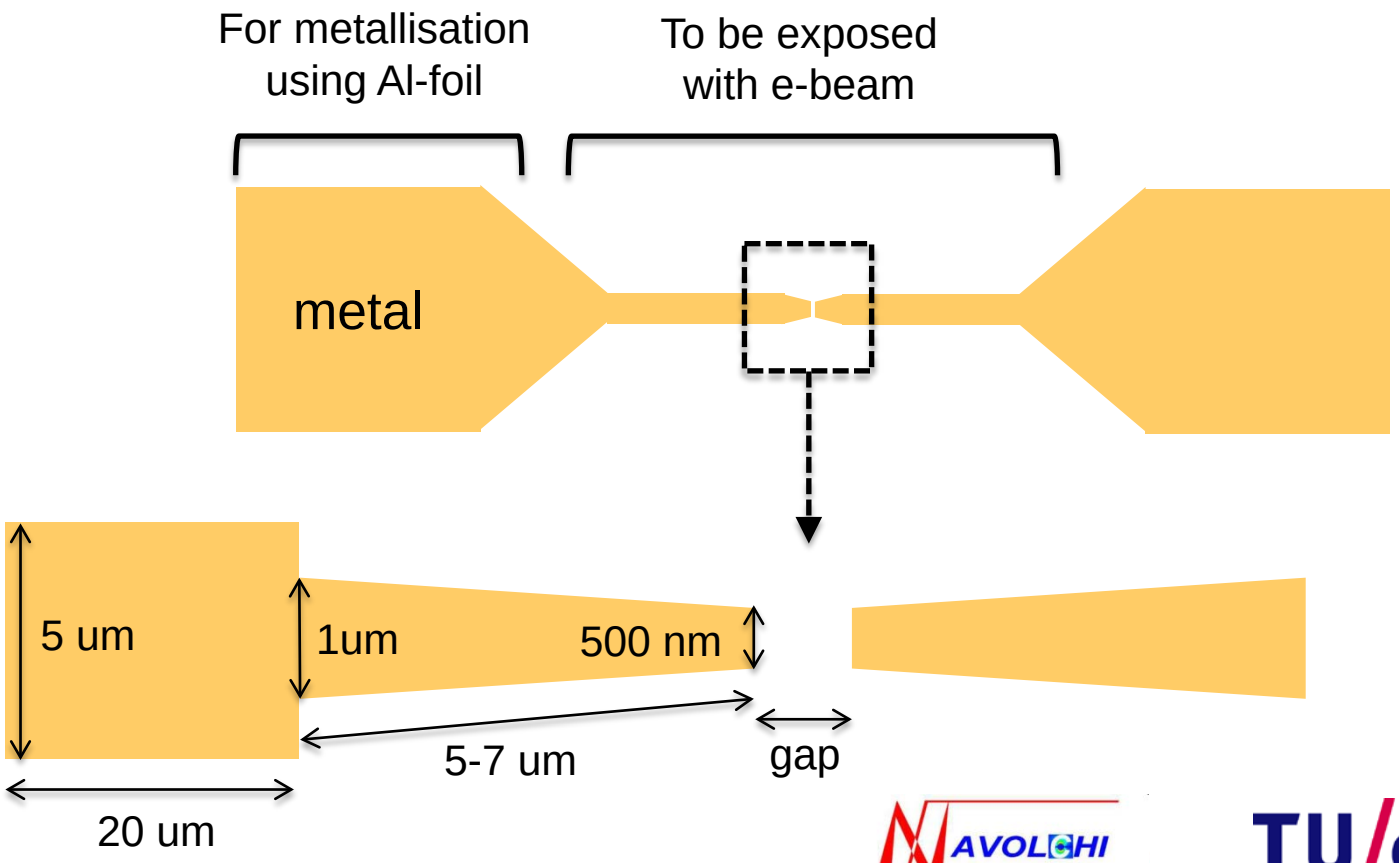
- Technology development
  - Work on 1st run issues
  - Time: ~ 2 months
- Lasers fabrication
  - Contents: wafer growth, wafer bonding, fabrication run
  - Time: ~ 2 months
- Characterization (if run is successful)
  - Time: ~ 1-2 month

Other technical issues regarding the laser

- No growth of n-InGaAs is possible in our cleanroom at the moment
- Dicing of bonded samples
  - Could IMEC do dicing tests of bonded samples?
  - Is it better to do bonding on thin Si-wafers?
- New wafer bondings from UGhent will be required

Cooperation with UVEG

- Fabrication of nanogap at TUe for plasmonic detector
  - Thickness: 100 nm thick Au, gap: 50-100 nm
  - Separation distance?



Conclusions

- Milestones and deliverables: 1M and 1D are delayed

- Plan for next months:
  - Work on technology issues identified in 1st run
  - Do a second run of lasers
  - Fabricate nanogaps for Valencia