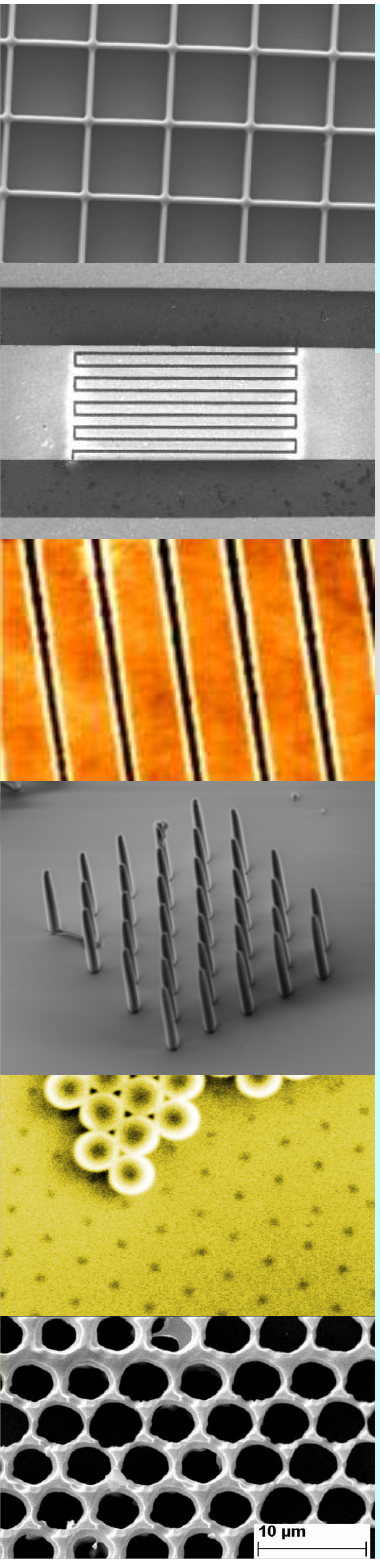

HEPTech
Leading HEP technologies for industry
Technology Transfer opportunities
Magurele, 8-9 October 2013

Laser infrastructure for nanosciences and nanotechnologies

Marian ZAMFIRESCU

National Institute for Lasers Plasma and Radiation Physics
INFLPR - Bucharest

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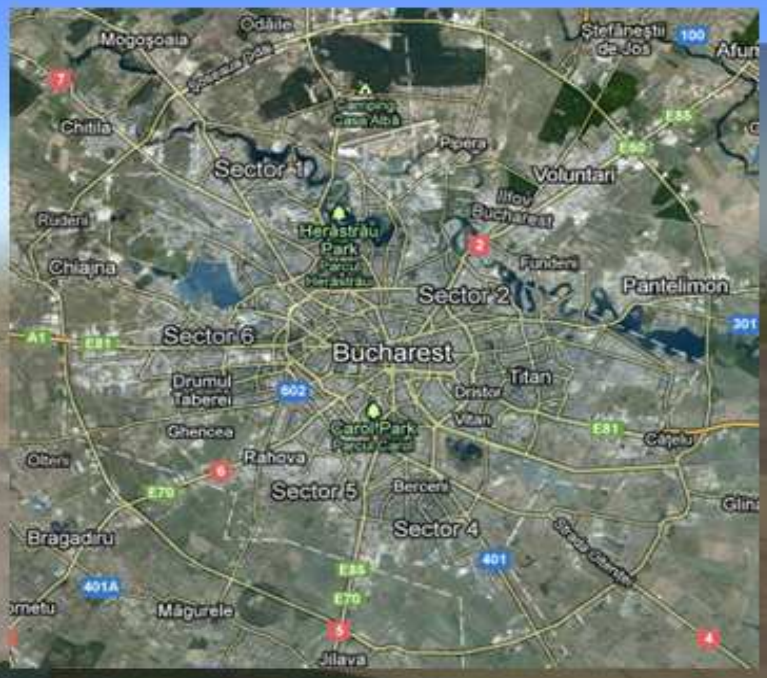


INFLPR

Center for Advances Laser Technologies, CETAL

Faculty of Physics, University of Bucharest

IFA and ELI-NP Head Office

National Institute for Materials Physics

National Institute of Physics and Nuclear Engineering, Department of Computational Physics and Information Technologies

National Institute for Lasers Plasma and Radiation Phyics, Lasers Department

NIPNE Library

Optoelectronica 2001

INFLPR Head Office

Center for Advances Laser Technologies CETAL

N&N at INFLPR

Synthesis of nanomaterials
Laser photochemistry.
Plasma synthesis.

Functionalization of nanomaterials
Plasma processes for functionalization.
Hydrofobic/ hydrofilic laser processed nanostructured surfaces.

Surface nanostructuring
Laser-surface-plasma interactions.
Laser processing of nanostructured thin films.
Nanostructured films by thermionic vacuum arc.

New micro- and nano-scale laser processing technologies.
1D, 2D, 3D Direct laser writing.
Optical near-field laser processing.
Self-organization of laser induced nanostructures.

Nanophotonics
Quantum dots.
Metamaterials.
Photonic bandgap structures.

Applications of nanostructures in biology
Nanostructured surfaces for tissue engineering.
Nanomaterials for drug delivery .

The synthesis of nanomaterials by laser pyrolysis, LCVD and plasma

- Oxides, carbides, nitrides nanoparticles (γ-Fe_2O_3, TiO_2, SnO_2, CN_x, Fe_3C,)
- Metalic nanoparticles (Ti, Sn, Fe)
- Core-Shell iron-carbon nanocomposites
- Carbon nanotubes
- Carbon nanowalls
- Carbon nanofibers

Applications

Magnetic separation of proteins

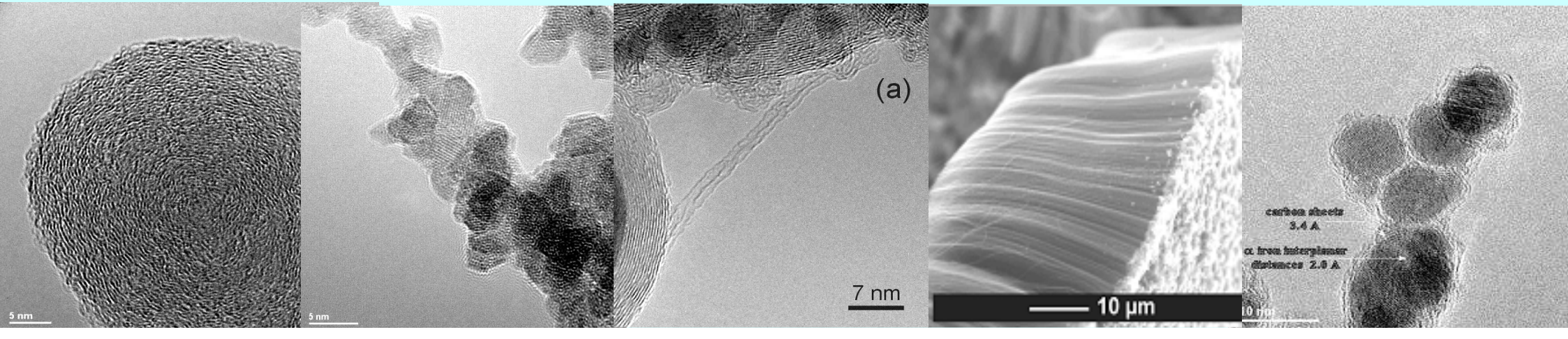
Magnetic sealing

Thermal nanofluids

Catalysts

Composite fillers

Drug delivery and contrast agent for MRI



Nanostructures obtained by pulsed lasers

- Nanometric ceramic and metallic powder (AlN, Cu, Si quantum dots).
- Porous materials fabrication by laser (Al_2O_3 , SiO_2 , TiO_2 , ZrO_2).
- Thin films for photonic crystals.
- Thin films of bio-organic materials and Polymers (MAPLE, PLD).
- Thin films and heterostructures (ferroelectrics, piezoelectrics).

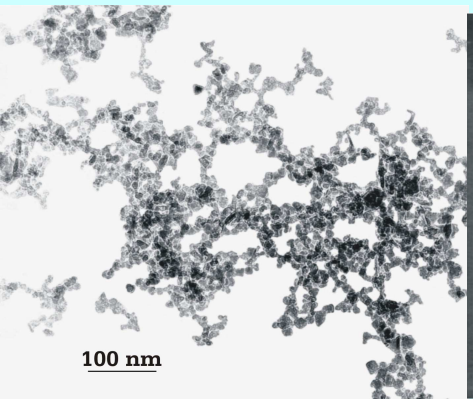
Applications

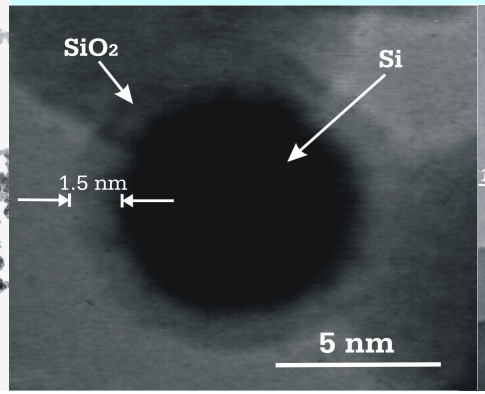
Nanomaterials for catalytic and biological applications.

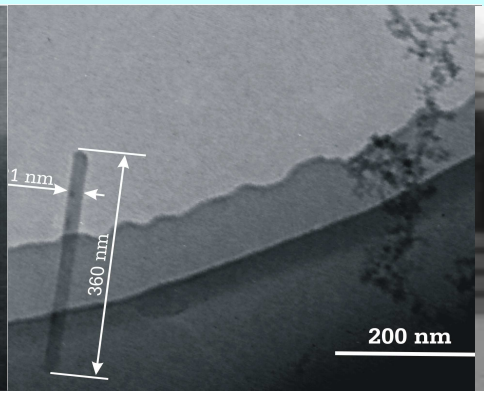
Heterostructures for light emitters and detectors.

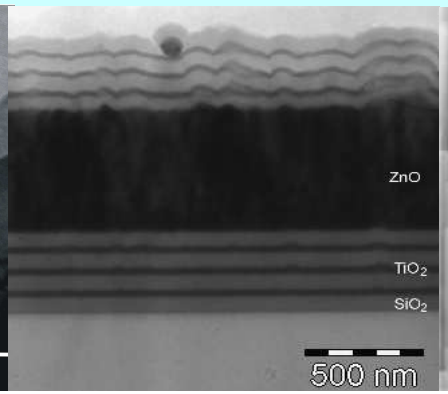
Gas sensors.

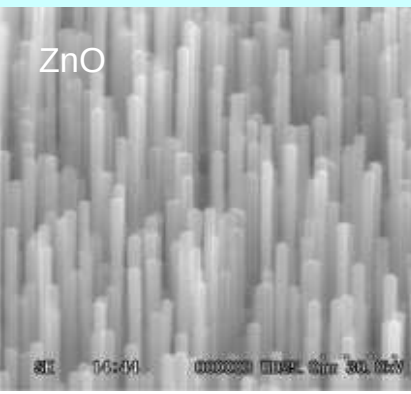
Nanotoxicology – markers.





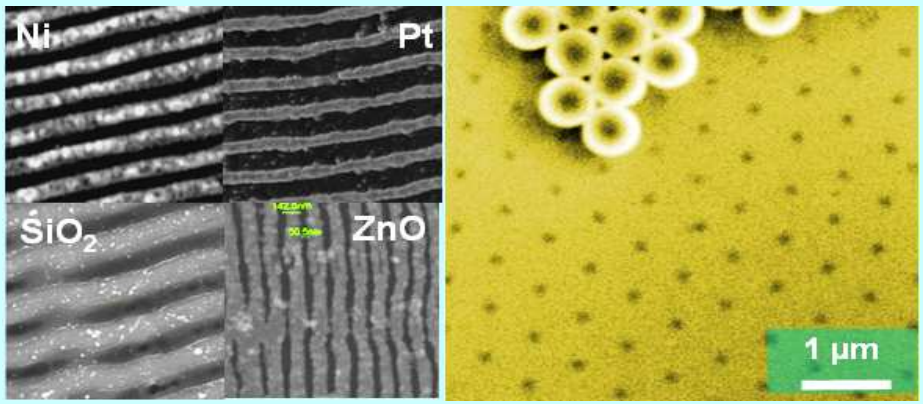


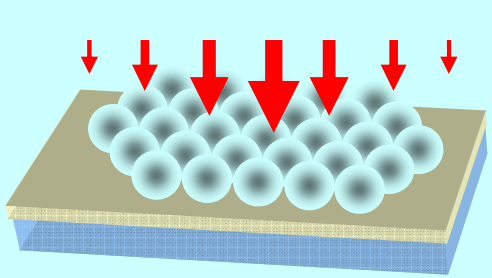


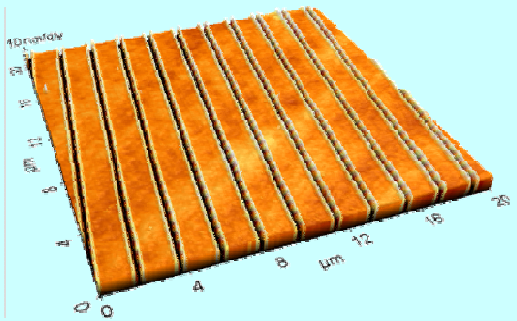


Nano-scale laser processing technologies on large surfaces

- Self-organization of laser induced periodical nanostructures (metals, dielectrics, polymers)
- Near-field laser processing of large surfaces.







Applications

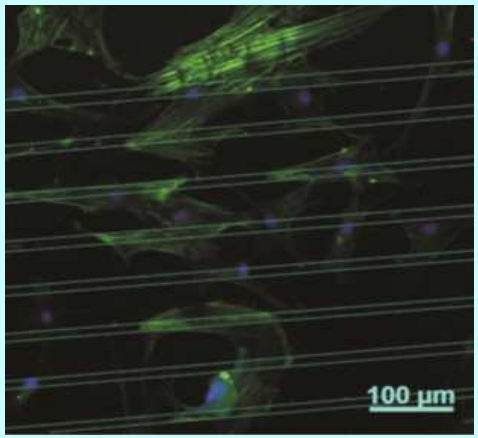
Bio-mimetic surfaces for tissue engineering.

Surfaces with controlled wettability.

Surfaces with increased effective area for sensors.

Nanostructured surfaces for SERS.

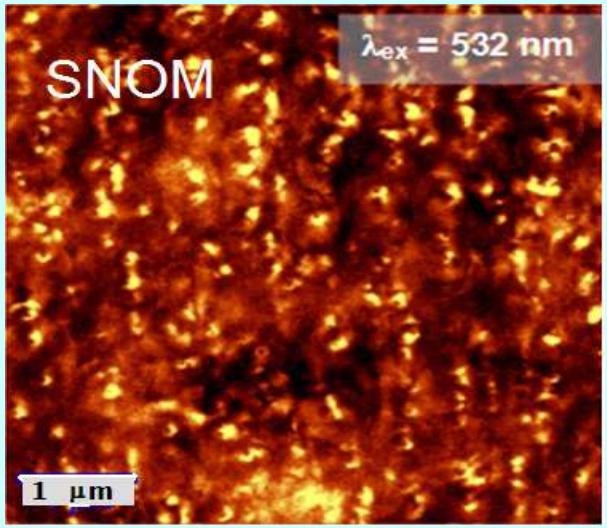
Collour coding for surface marking.



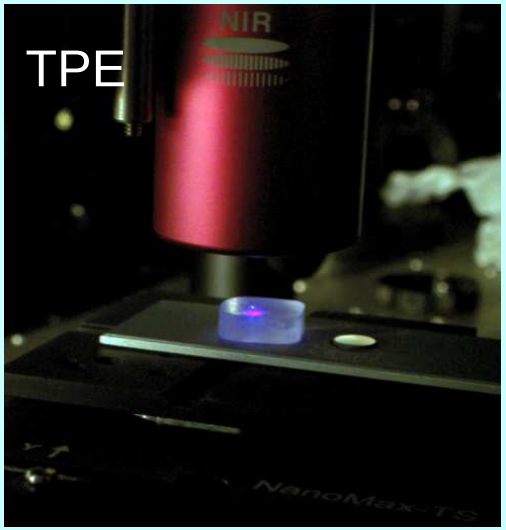
Nanophotonics

- Nonlinear optical characterization of the nanostructures.
- Metamaterials & Photonic bandgap structures.
- Plasmonic nanostructures.
- Quantum dots characterization (Z-scan, SNOM).
- High resolution optical characterization by Two-Photon Emission (TPE).

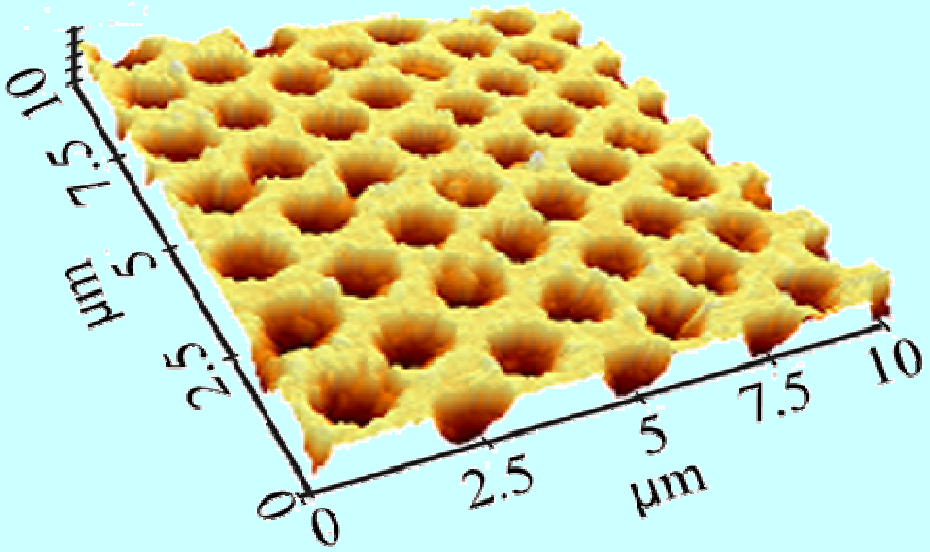
Plasmon nanostructures



TPE microscopy



TiO_2 fs laser patterned film



Center for Advances Laser Technologies CETAL

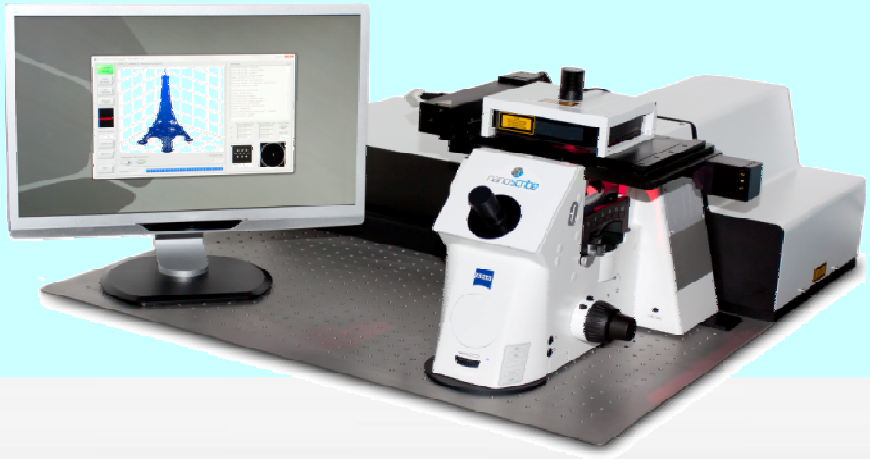
- L1 – High intense laser fields (1 PW laser system)
- L2 – Laser macro- and micro-processing
- L3 – Photonics-based investigations

Main infrastructure of CETAL-L2

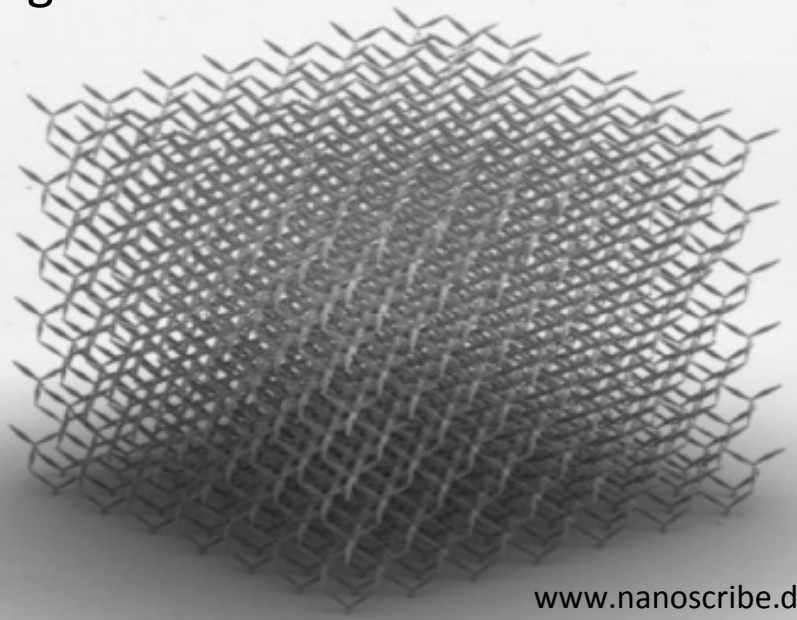
Laser facility for micro- and nanoprocessing

- Laser system for 2D and 3D laser lithography.
- Picoseconds laser for micromachining.
- Pulsed laser deposition system, RHEED compatible.
- Continuum wave and pulsed CO_2 laser for photochemistry and nanomaterials synthesis.
- Clean Room class 10.000 – 100 m^2

Laser system for 2D and 3D laser lithography



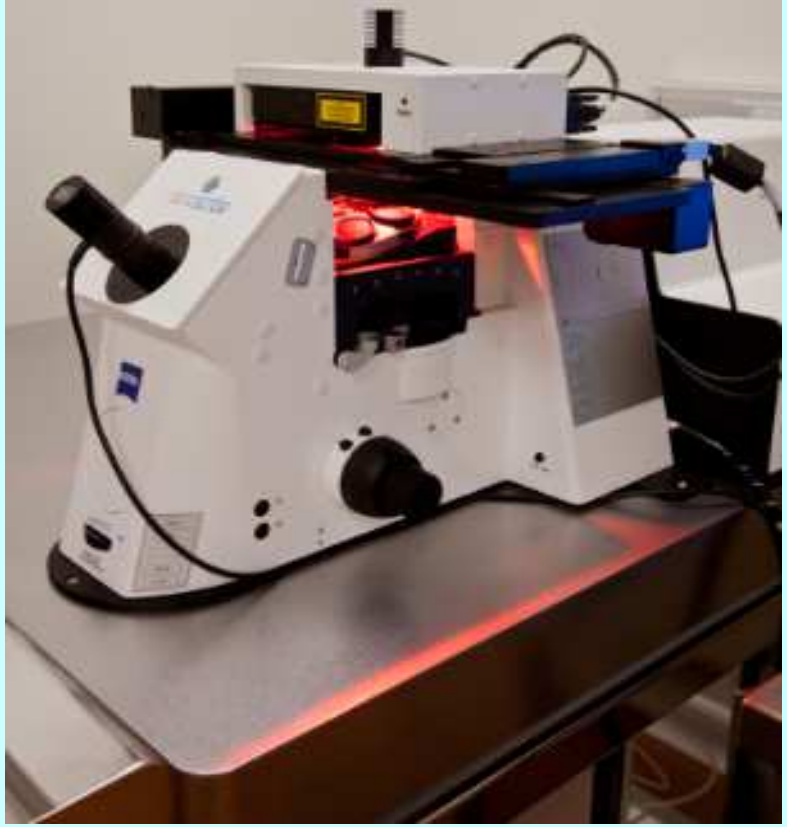
- micro-optics
- photonic crystals and metamaterials
- scaffolds for tissue engineering
- micro-fluidics
- wire bonding
- 2D masks

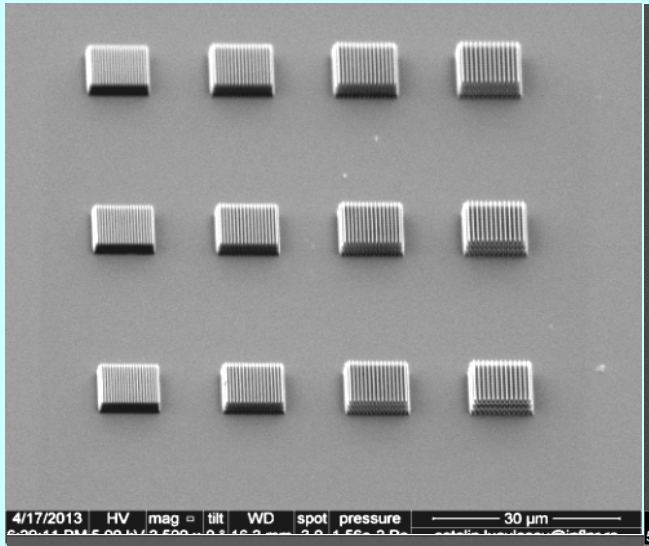


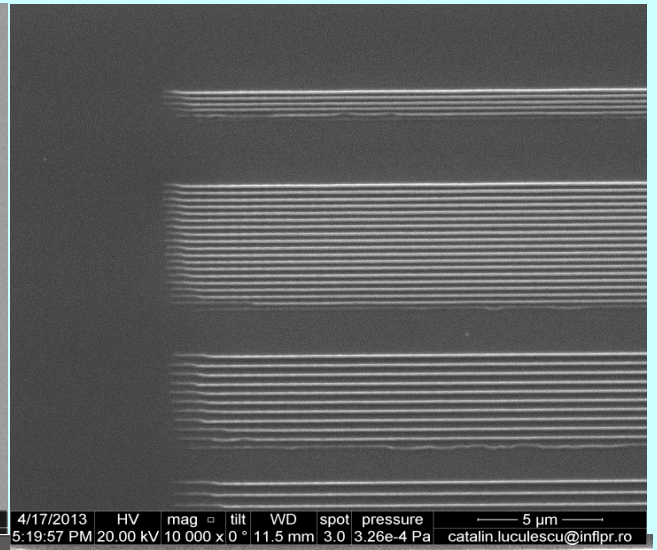
www.nanoscribe.de

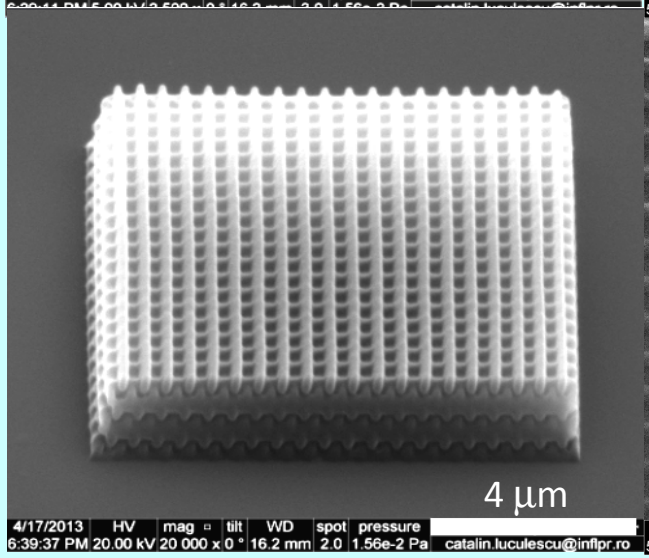
Laser system for 2D and 3D laser lithography

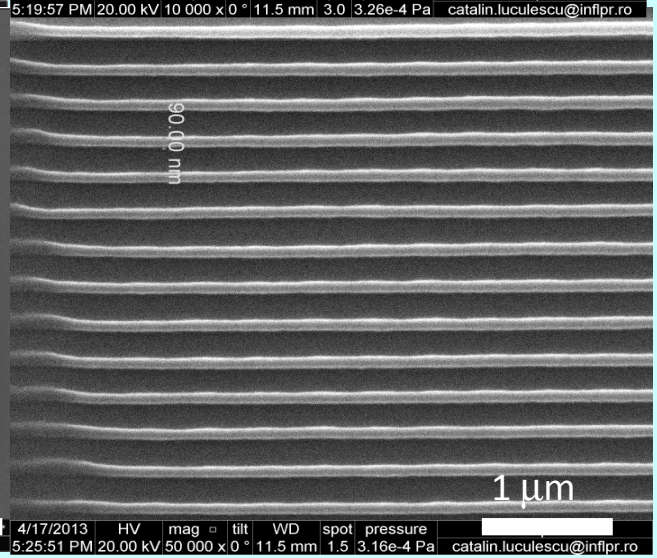
“Photonic professional”
Nanoscribe GmbH





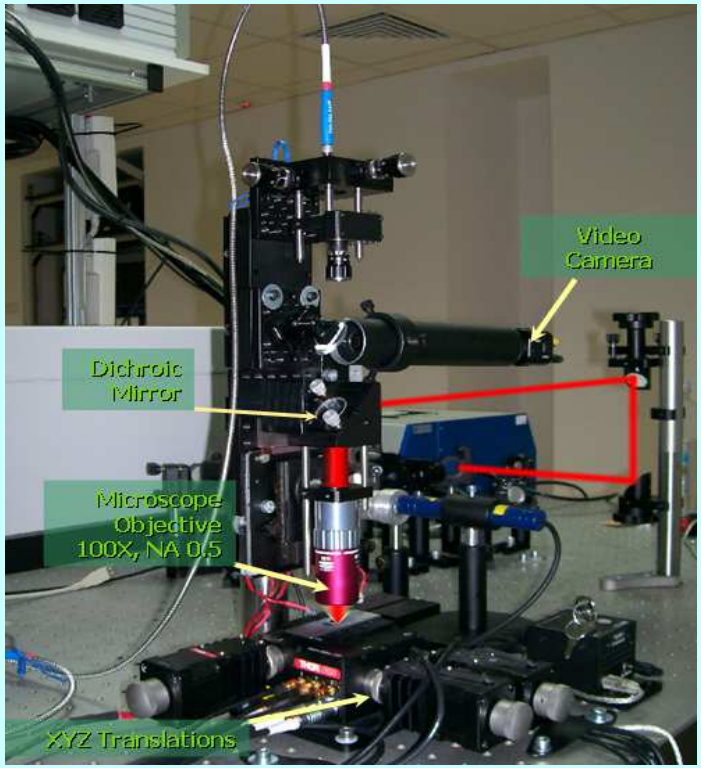


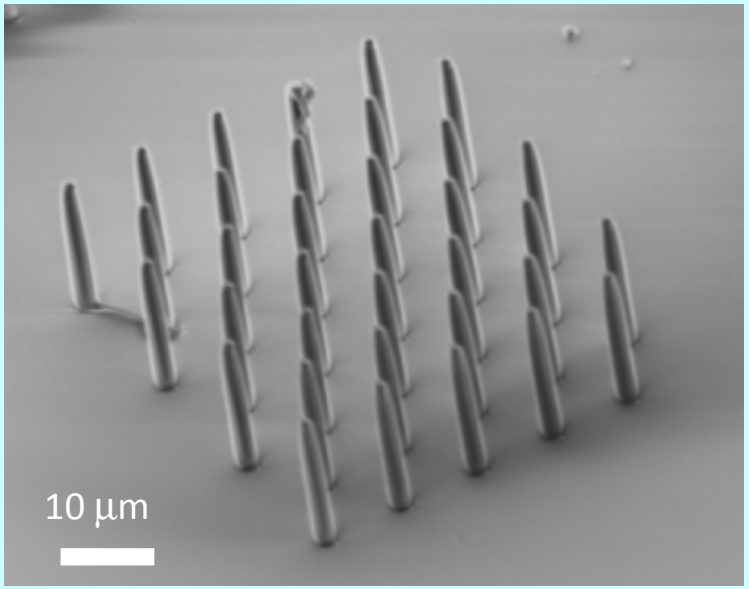


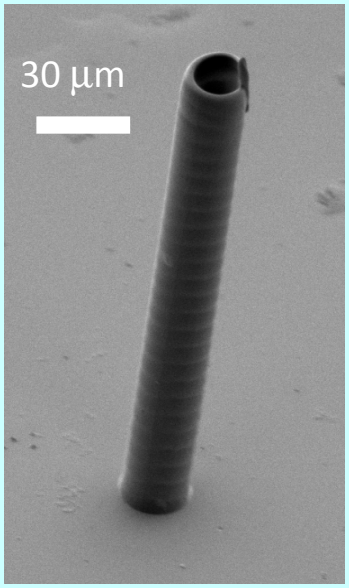


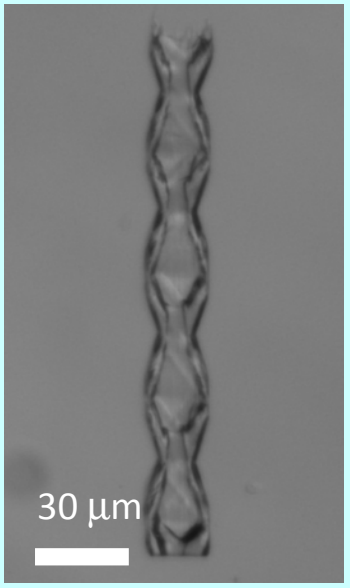
Laser system for 2D and 3D laser lithography

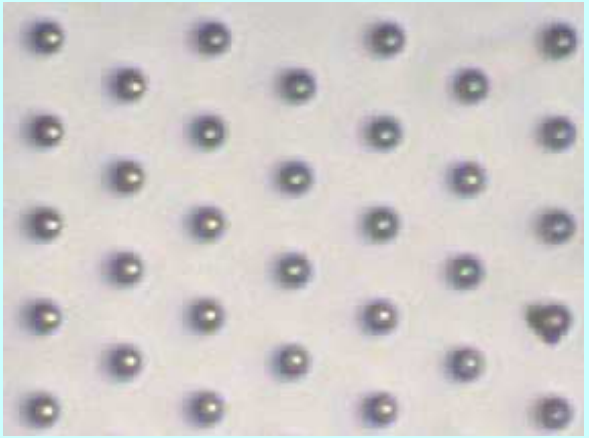
Microstructures previously produced at INFLPR

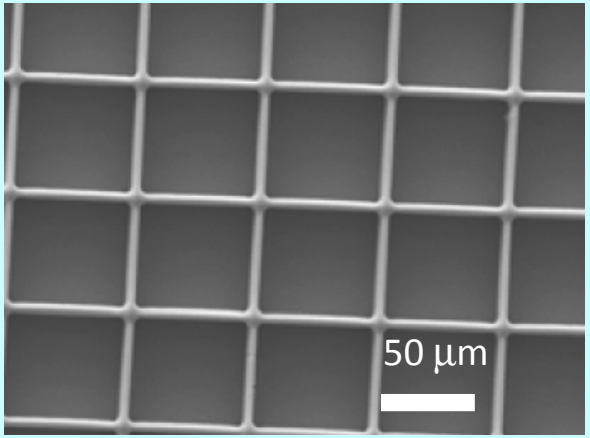












Femtosecond and Picoseconds laser ablation

- Cutting, drilling, dicing
- Laser Induced Forward Transfer (LIFT)
- Matrix-assisted pulsed laser evaporation direct writing (MAPLE-DW)
- Laser ablation with sub-micrometer resolution

LUMERA HYPER RAPID 50

Pulse duration <15 ps

1065 nm - 50 W

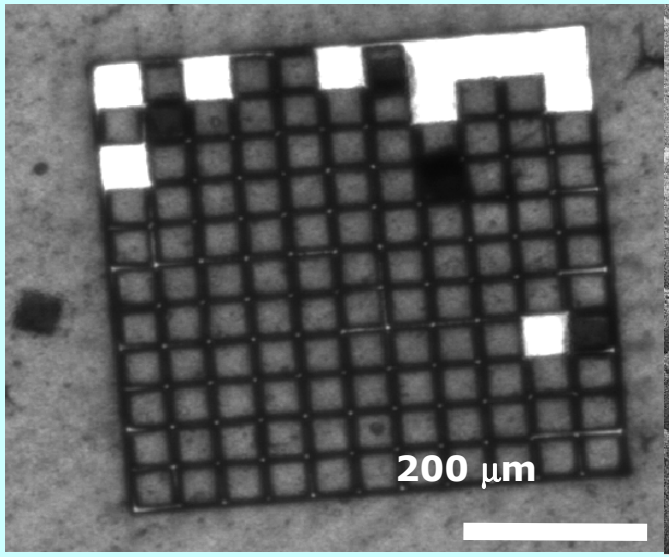
532 nm

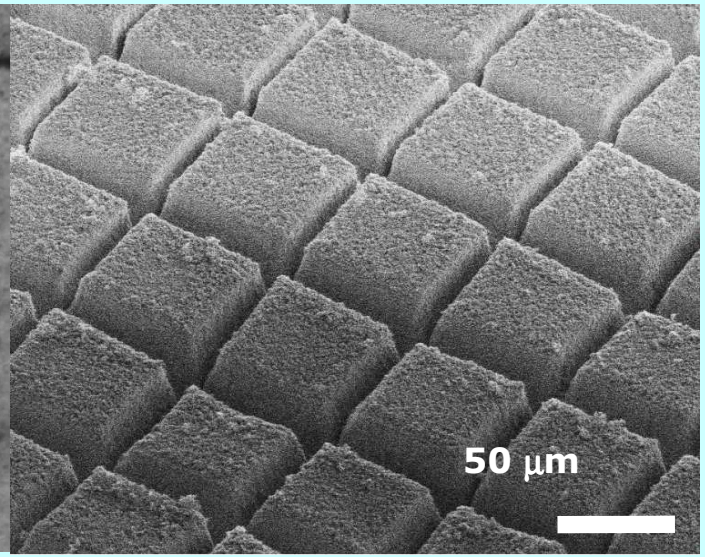
355 nm

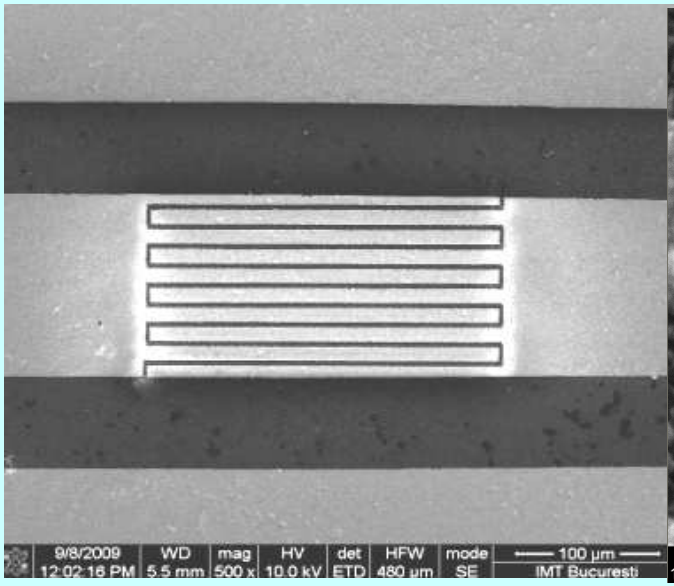
500 kHz

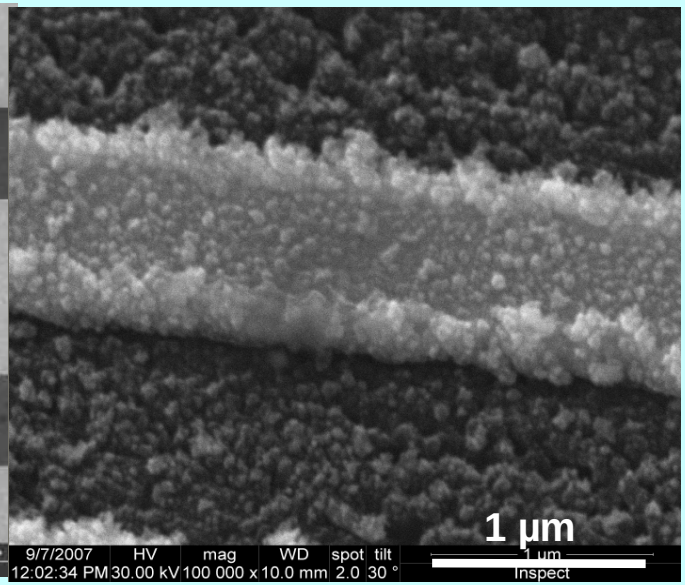
Microstructures fabricated by femtosecond laser ablation

- **Cutting, drilling, dicing :**
  Alumina wafers
  (100 μm thickness)



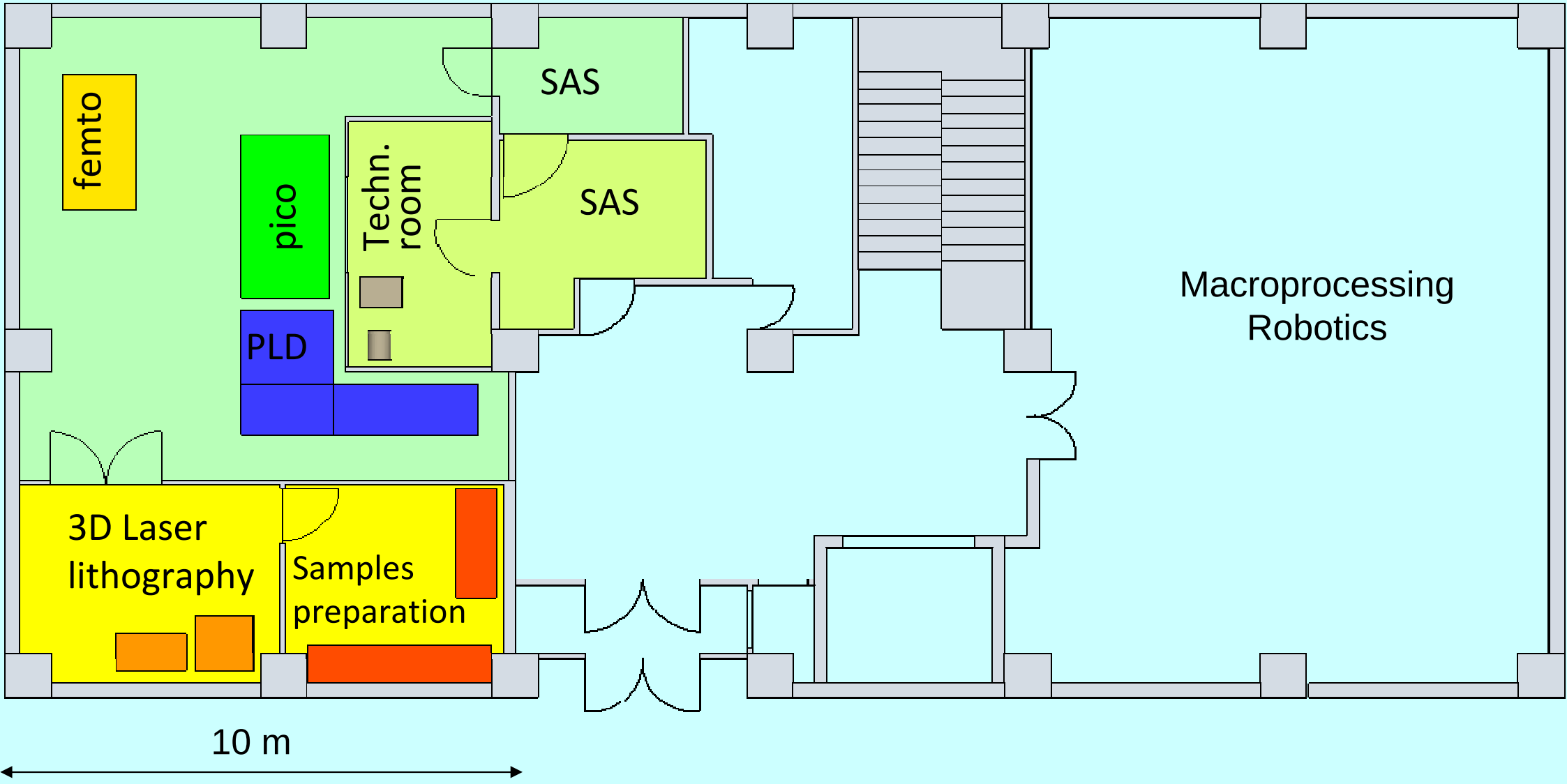






- **Laser ablation with sub-micrometer resolution**
  Gold interdigital capacitors, electrodes for micro-sensors, microwave circuits, etc.

Clean Room class 10.000 (ISO7)



Main infrastructure of CETAL-L2

Laser facility for macroprocessing

TruLaser Cell 3010

TruLaser Robot 5020

TruDisk 3001 **TruPulse 62** **TruMicro 7050**

Main infrastructure of CETAL-L3

Photonics-based investigations

- Raman spectroscopy for imaging and chemical identification.
- Laser-induced breakdown spectroscopy (LIBS) system.
- THz spectrometers.
- Frequency comb laser system 2.5×10^{-12} uncertainty; Vis.-IR.
- CW & pulsed tunable stabilized lasers: 200 -10800 nm
- Spectro-radiometers.
- Spectral analyzers.
- Etalons and software.
- Lambdameter for pulsed lasers.
- Laser beam diagnosis.

1 PW Laser system - CETAL-L1

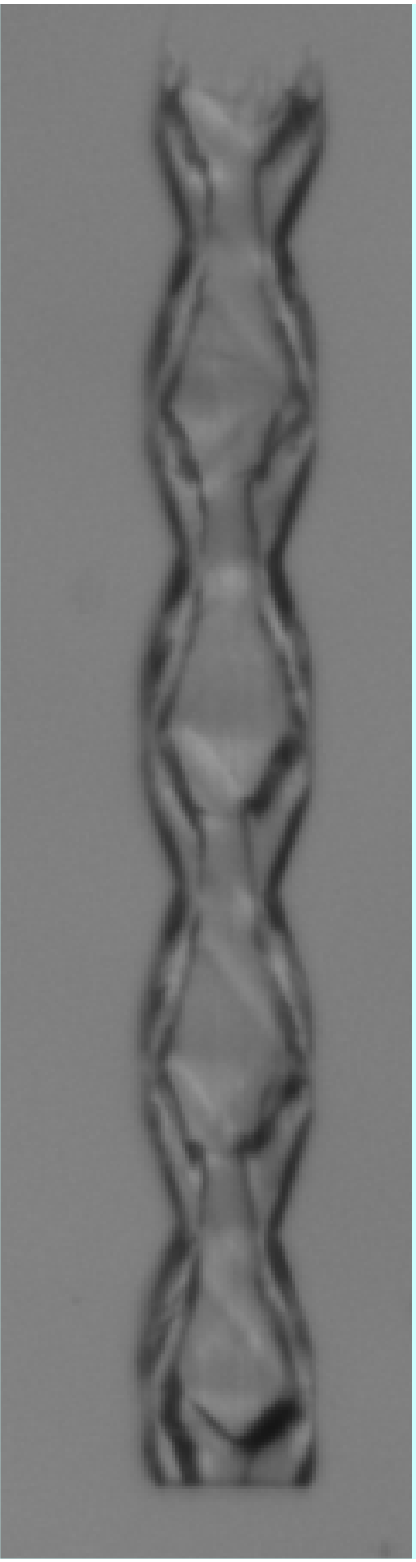
High intense laser fields

Output 1:	**Peak Power**	**1 PW**
	Pulse duration	**25 fs**
	Rep. Rate.	**0.1 Hz**
Output 2:	**Peak Power**	**45 TW**
	Pulse duration	**25 fs**
	Rep. Rate.	**10 Hz**
Output 3:	**Peak Power**	**1GW**
	Pulse duration	**30 fs**
	Rep. Rate.	**1 KHz**

Conclusions

INFLPR:

- ❑ has expertise on nanomaterials synthesis and functionalization of various materials.
- ❑ developed new laser based technologies for nanostructuring.
- ❑ is involved in applications of nanomaterials and nanostructures on optics, electronics, medicine, chemistry etc.
- ❑ offers the acces to a new research infrastructure (CETAL), and provides research services to industrial entities.
- ❑ is ready to join the EU efforts to develop regional R&D activities.



Thank you!

www.inflpr.ro
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