LILS (BN124), Department of Physics, Faculty of Applied Science (FSA)
University "Politehnica" of Bucharest (UPB)
Spl. Independentei 313, 060042 Bucharest, Romania
Tel: 004021.402.98.08

**L**aboratory for **I**nteraction of **L**aser radiation with **S**ubstance (LILS)
(**L**aborator pentru studiul **i**nteracției radiației **l**aser cu **s**ubstanța)

**LILS location: University "POLITEHNICA" of Bucharest (UPB), Dep. of Physics, BN124**

Laboratory coordinator/ contact person:
Dr. Mihai STAFE, email: mihai.stafe@physics.pub.ro, mihai.stafe@upb.ro

People at UPB working currently/previously at LILS:
Dr. Ioan M. Popescu (emeritus)
Dr. Niculae N. Pușcaș (emeritus)
Dr. Constantin Neguțu
Dr. Adrian N. Ducariu
Dr. Ionuț Vlădoiu
PhD student Ioana Spirea
PhD student Constantin Gabriel Popa
Graduate students from IALA Master program of FSA Faculty of UPB
Undergraduate students from ETTI Faculty of UPB

External current/previous collaborations:
Dr. Aurelian Popescu (INOE2000, Magurele, Romania)
Dr. Daniel Ursescu (INFLPR/ ELI-NP, Magurele, Romania)
Dr. Istvan Foldes (Dep. of Physics, Univ. of Szeged, Hungary)
Dr. Aurelian Marcu (INFLPR, Magurele, Romania)
Dr. Ioan Dâncuș (INFLPR/ ELI-NP, Magurele, Romania)

**Purpose of LILS activity:**
- providing knowledge by studding the fundamental phenomena involved in the interaction of high-power pulsed lasers with substance (solid, liquid, gas, plasma);
- training students for the growing field of the applications involving high-power pulsed lasers;
- developing collaborative relations with research groups in the field of applications of high-power lasers, for mutual benefits in terms of knowledge, experience, and developments.

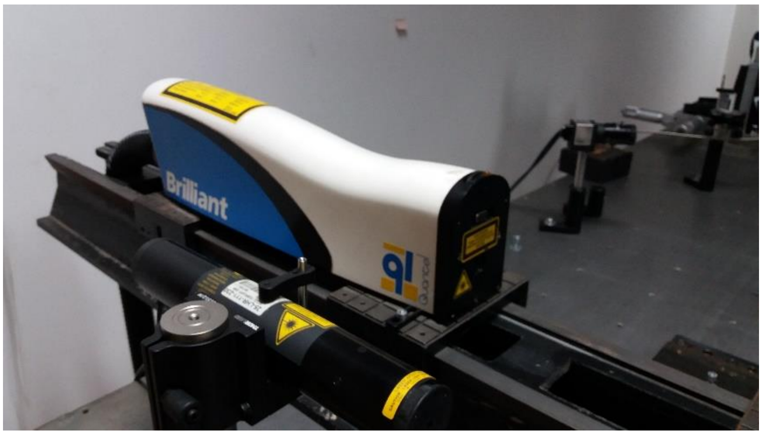
**Research field:**
- laser ablation by using high power lasers with nanosecond- femtosecond pulses;
- micro and nano-structuring by pulsed laser ablation;
- pulsed laser deposition;
- non-linear optical phenomena in ablation plasmas.

**Equipment at LILS**

High power lasers (10 MW- 10 GW) with short and ultrashort pulses (5 ns- 200 fs) in UV-VIS-IR spectral domain:

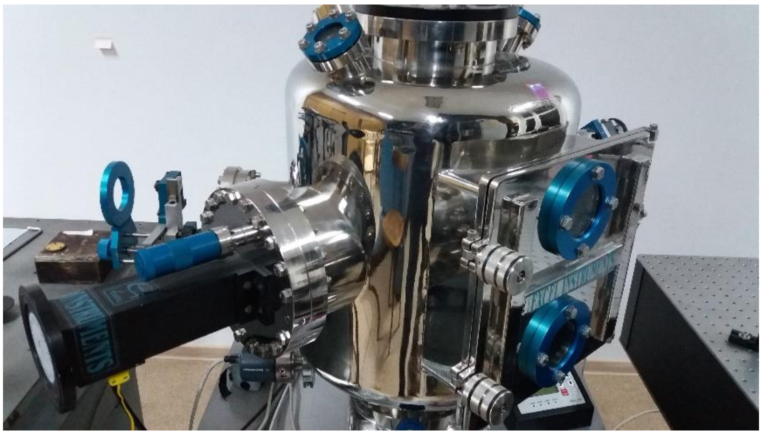
1. Yb-KGW mode-locked with CPA laser "Light Conversion":
   - 200 fs-10 ps variable pulse duration;
   - 1 mJ/pulse- variable, pulse frequency: from single pulse to 5 kHz repetition rate;
   - 1030 nm fundamental wavelength and harmonics 2 (515 nm) and 3 (343 nm);
   - optical parametric amplifier for tuning the output wavelength from 310-2600 nm;
   - 2 mm beam diameter, maximum focused intensity: 500 TW/cm$^2$.


2. Nd-YAG Q-Switched laser "Quantel-Brilliant":
   - 5 ns pulse duration
   - 300 mJ/pulse- variable, pulse frequency: from single pulse to 10 Hz repetition rate;
   - 1064 nm fundamental wavelength and harmonics 2 (150 mJ/pulse at 532 nm wavelength) and 3 (70 mJ at 354 nm wavelength);
   - 6 mm beam diameter, maximum focused intensity: 10 TW/cm$^2$.



3. Argon Laser continuous wave “Melles Griot”, wavelength tunable (120 mW at 488, 130 mW at 514 nm), 1 mm beam diameter, $M^2$ 1.2


4. Vacuum chamber ($10^{-5}$ mbar) for pulsed laser deposition, with oil free vacuum pumps system.

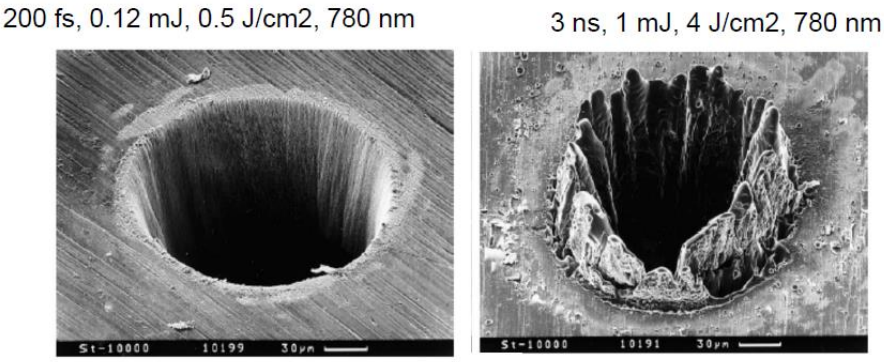


5. Fiber optic spectrometer “Ocean Optics” in the spectral range 200-600 nm, 0.1 nm resolution, and fiber optic monochromator "Acton Research" in the spectral range 200-1400 nm, 0.25 nm resolution.

**Research at LILS:**

1. solid material processing at micro and nanoscale resolution by laser ablation with short (ns) and ultrashort (ps-fs) laser pulses;

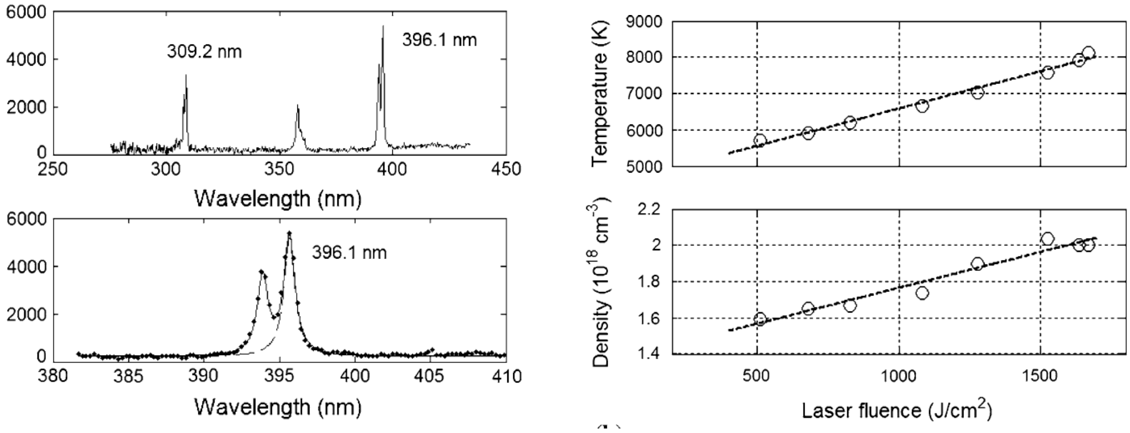
Example: electron microscopy images of craters drilled in 0.1 mm steel foil with femtosecond and nanosecond lasers




Bibliography: Appl. Phys. A **63**, 109-115 (1996)

2. production and spatial- temporal characterization of the laser- ablation plasmas by optical spectroscopy and imaging techniques;

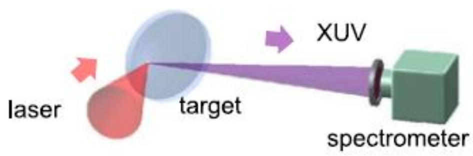
Example: spectrum of ablation plasma on Al target produced with nanosecond laser

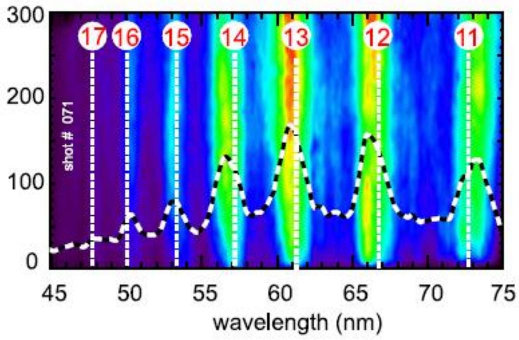



Bibliography: Plasma Chem Plasma Process **32**, 643–653 (2012)

3. studies of the highly non-linear optical phenomena occurring in ablation plasmas;

Example: harmonics 11-17 obtained when focusing IR femtosecond laser on a sooth solid surface

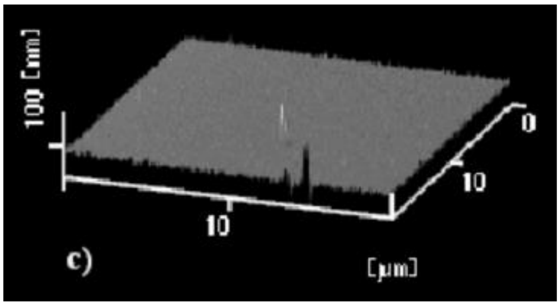



Bibliography: Appl. Phys B **101**, 511-521 (2010)

4. pulsed laser deposition of thin films

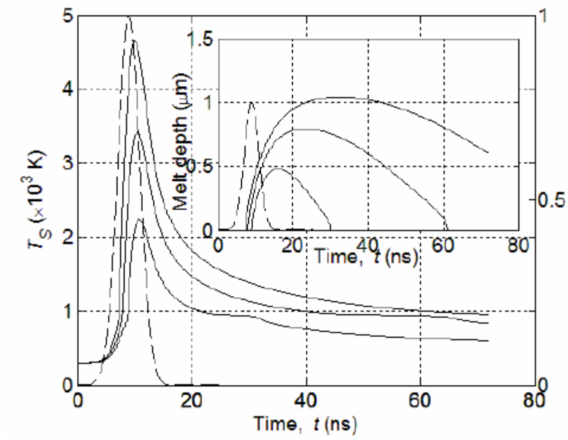
Example: AFM microscopy image of a YBCO film deposited with nanosecond laser on a substrate positioned 1 cm away from the ablated target




Bibliography: Thin solid films **360**, 166-172 (2000)

5. numerical simulation of the laser ablation process.

Example: temperature of Al target surface and melt-pool depth (inset) under nanosecond laser




Bibliography: J. Appl. Phys **112**, 123112 (2012)

**Main research projects at LILS:**

1. national project PN II (2008-2010)- experimental and theoretical study of the modification of mechanical, optical and thermal properties of solids under laser radiation;
2. national project PN II (2012- 2015), “MEMOPLAS**”**- develop optical memory system based on dichroism induced in chalcogenide glasses under intense, linearly polarized laser radiation.
3. national project PN II (2012-2016), “UFOUV**”**- optimization of high harmonics generation process in noble gas jets with ultrafast laser facility;
4. European/national project CAPACITATI/ RO-CERN/ ELINP (20014-2016), “HHGDE”- study of the non-linear phenomenon of high harmonics generation and estimation of the radiation doses;
5. European project POC (2016-2018), “INOVABIOMED”- develop the UPB (including LILS) infrastructure.

**Publication list**

**I) Relevant books:**

1. Stafe Mihai, Marcu Aurelian, Puscas Niculae, "*Pulsed Laser Ablation of Solids- Basics, Theory and Applications*", Springer Series in Surface Sciences, Vol. 53, Springer-Verlag Berlin Heidelberg (2014)
2. I.M. Popescu, C. Negutu, M. Stafe, „*Non-linear optics*"- in Romanian, at "Politehnica" Press, Bucharest (2016)

**II) Relevant papers:**

1. M. Stafe, C. Negutu, N. N. Puscas, "*Third harmonic from air breakdown plasma induced by nanosecond laser pulses"*, Applied Physics B **124**, 106 (2018)
2. M. Stafe, "*Theoretical photo-thermo-hydrodynamic approach to the laser ablation of metals"*, Journal of Applied Physics **112**, 123112 (2012)
3. M. Stafe, C. Negutu, "*Ablation plasma spectroscopy for monitoring in real-time the pulsed laser ablation of metals"*, Plasma Chemistry and Plasma Processing **32,** 643 (2012)
4. P. Heissler, R. Horlein, M. Stafe, J.M. Mikhailova, Y. Nomura, D. Herrmann, R. Tautz, S.G. Rykovanov, I.B. Foldes, K. Varju, F. Tavella, A. Marcinkevicius, F. Krausz, L. Veisz, G.D. Tsakiris, "*Towards single attosecond pulses using harmonic emission from solid density plasmas"*, Applied Physics B **101**, 511-521 (2010)
5. M. Stafe, C. Neguţu, I. M. Popescu, "*Theoretical determination of the ablation rate of metals in multiple-nanosecond laser pulses irradiation regime"*, Applied Surface Science **253**, 6353-6348 (2007)

Mai, 2019