European Cooperation in the field of Scientific and Technical Research
COST Action MP0601 *Short Wavelength Laboratory Sources*

COST Action MP0601 Working Group Meeting
Kraków (Poland), 27-28 May 2010

Application of laser plasma EUV sources in processing polymers and nanimaging

H. Fiedorowicz, A. Bartnik, P. Wachulak, R. Jarocki, J. Kostecki,
A. Szczurek, M. Szczurek

Institute of Optoelectronics, Military University of Technology,
Warsaw, Poland

OUTLINE

- **INTRODUCTION**
  - extreme ultraviolet (EUV),
  - laser plasma EUV source,

- **LASER PLASMA EUV SOURCE**
  - gas puff target approach,
  - compact laser plasma EUV source,
  - EUV optics,

- **PROCESSING OF POLYMERS**
  - micro- and nanostructuring,
  - modification of polymer surfaces,

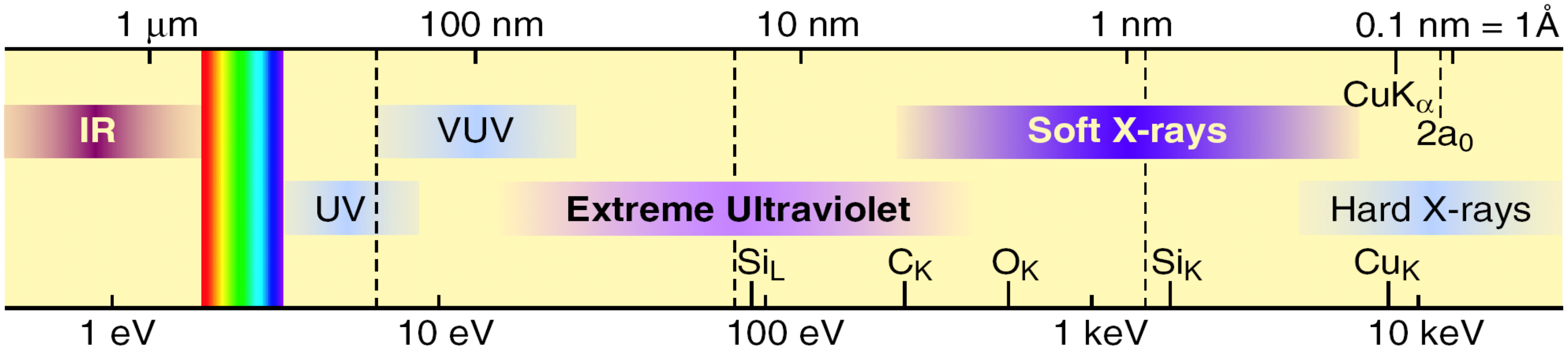
- **NANOIMAGING**
  - EUV microscope based on a Fresnel optics,

- **CONCLUSIONS**

INTRODUCTION

- **extreme ultraviolet (EUV)**

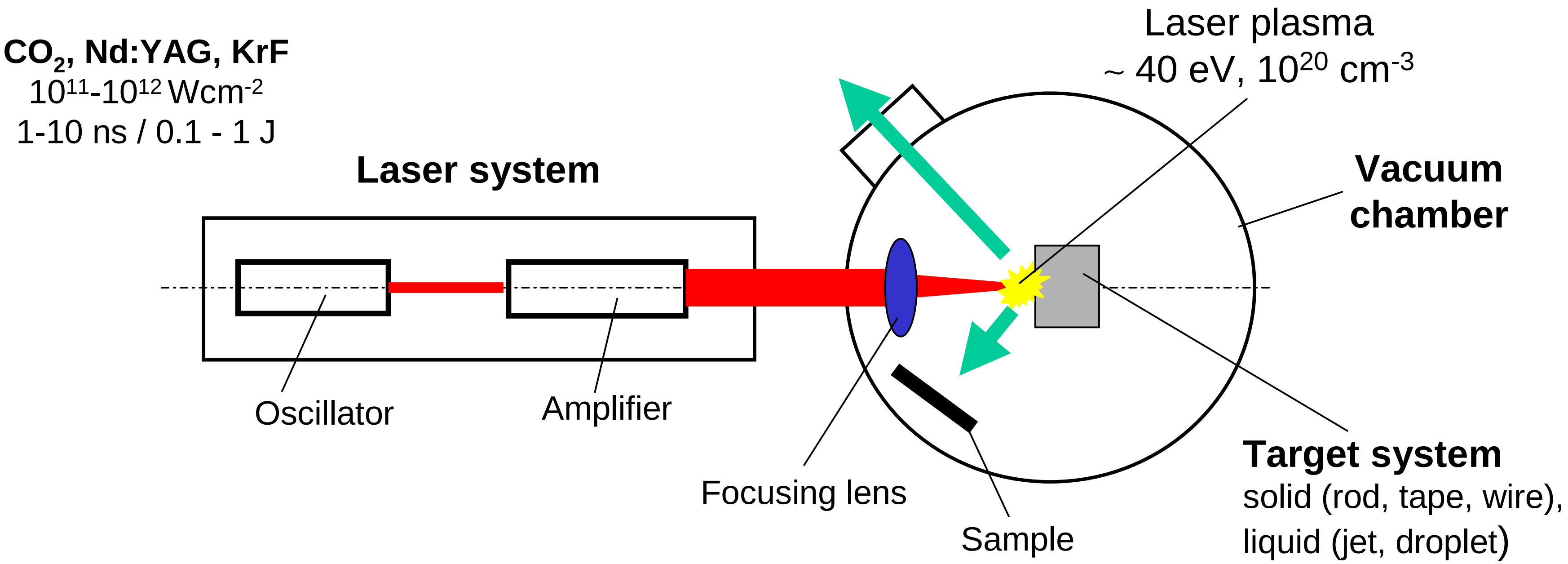
D. T. Attwood *Soft X-rays and Extreme Ultraviolet Radiation: Principles and Applications* (Cambridge University Press, Cambridge, 1999)



- **motivation for using EUV**
  - nanometer resolution
  - nanometer penetration depth

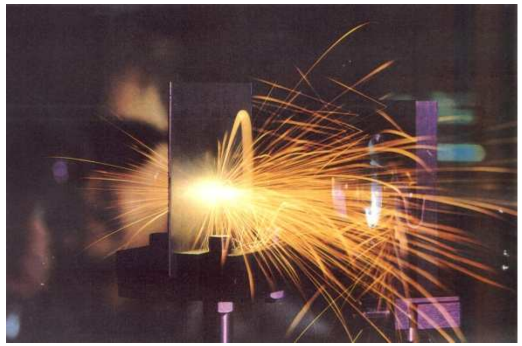
- **generation of EUV**
  - e-tubes
  - synchrotrons, FELs
  - plasma sources (discharge plasmas, **laser plasmas)**

LASER PLASMA EUV SOURCE



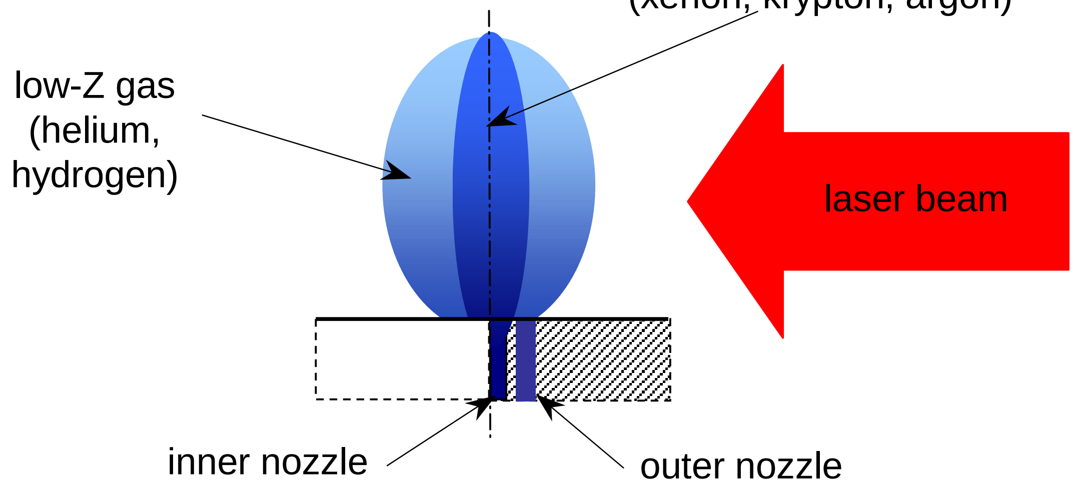
- **SOURCE CHARACTERISTICS**
  - high single pulse brightness
  - short pulse duration
  - easy tuning of wavelength
  - low investment costs

- **MAIN DISADVANTAGES OF A SOURCE BASED ON A SOLID TARGET**
  - laser target operation
  - **target debris production**

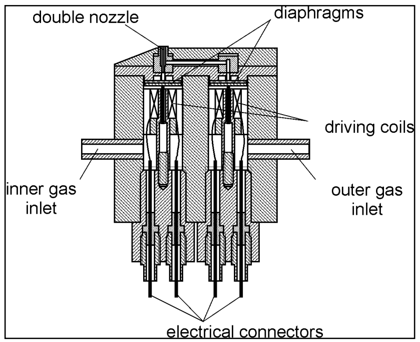


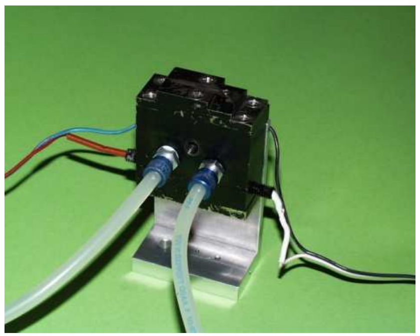
DOUBLE-STREAM GAS PUFF TARGET

• **schematic of a double-stream gas puff target**

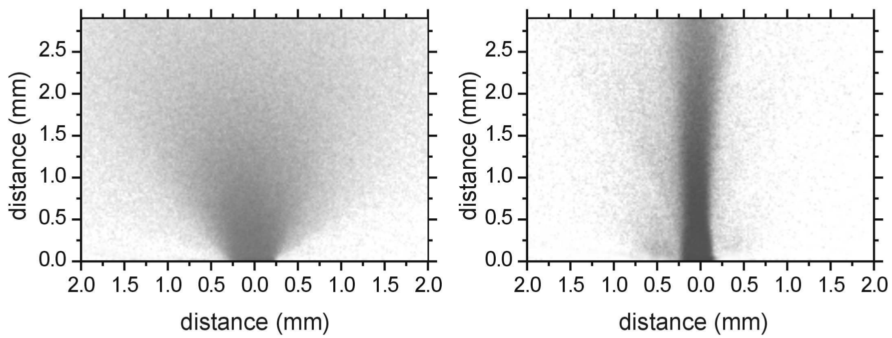


• **electromagnetic valve system**





• **X-ray backlighting images**

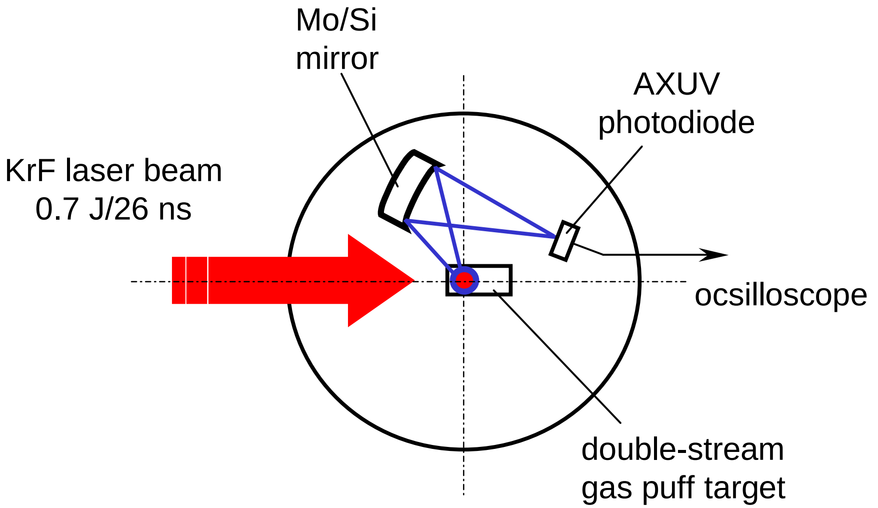


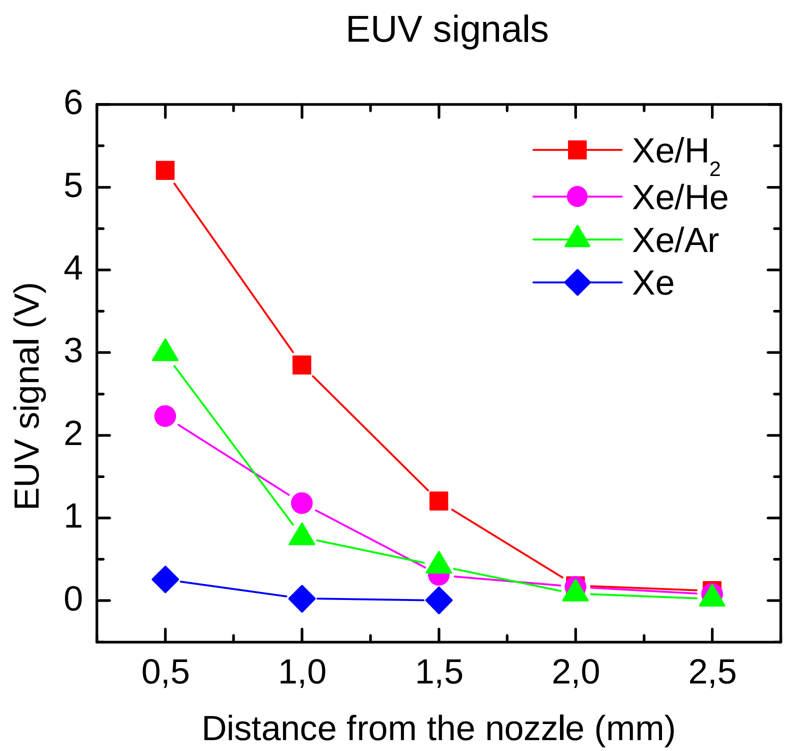
H. Fiedorowicz *et al., Appl.Phys. B* ***70*** *(2000) 305*

EUV EMISSION STUDIES

- **KrF laser (Institute of Plasma Physics, Nieuwegein, The Netherlands)**

Schematic of the experimental setup

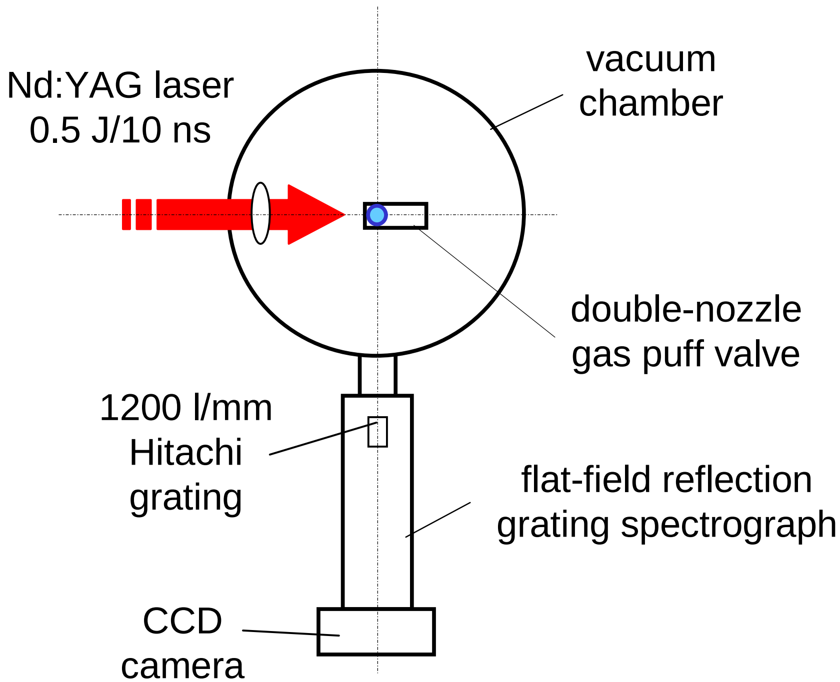


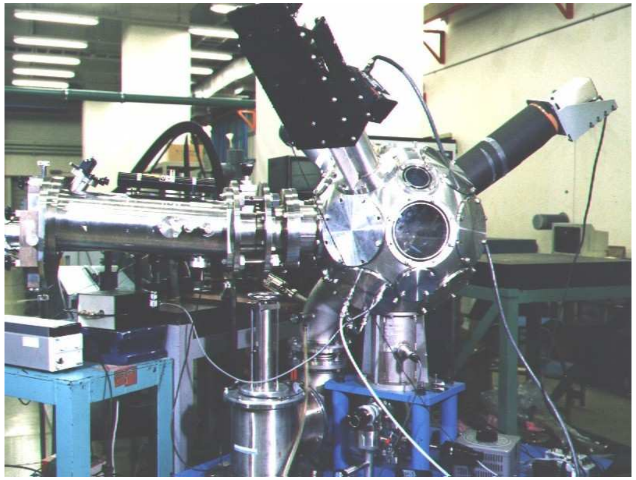


Patent No.: US 6,469,310 B1

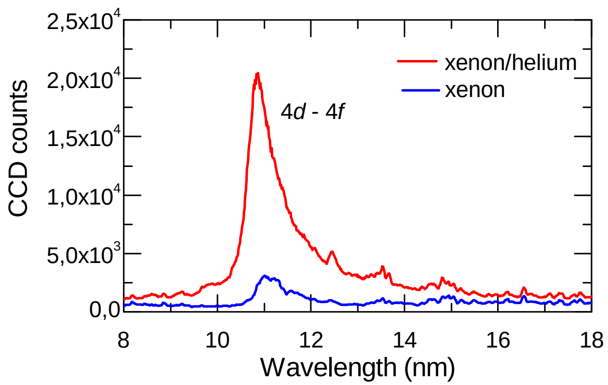
EUV EMISSION STUDIES

- **Nd:YAG laser (Institute of Laser Engineering, Osaka, Japan)**





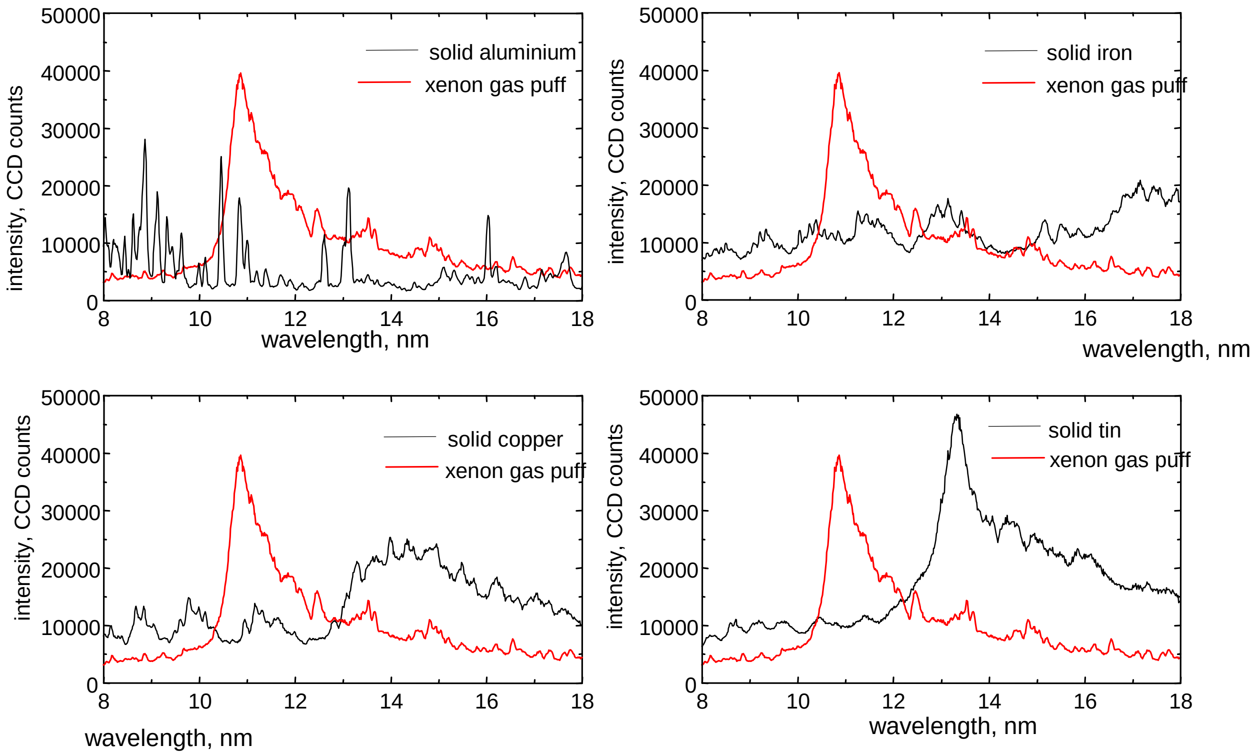
EUV spectra



H. Fiedorowicz *et al., Opt. Communications* ***164*** *(2002) 161*

EUV EMISSION STUDIES

EUV emission from a double-stream xenon/helium gas puff target irradiated with a Nd:YAG laser (0.5J/10ns)



ILE, Osaka

IOE, Warsaw

- **Elimination of debris**
- **Operation with repetition**
- **Conversion efficiency improvement**

H. Fiedorowicz *et al., Opt. Communications* ***164*** *(2002) 161*

LASER PLASMA EUV SOURCE

- a compact laser-plasma EUV source based on a gas puff target for metrology applications

MEDEA+

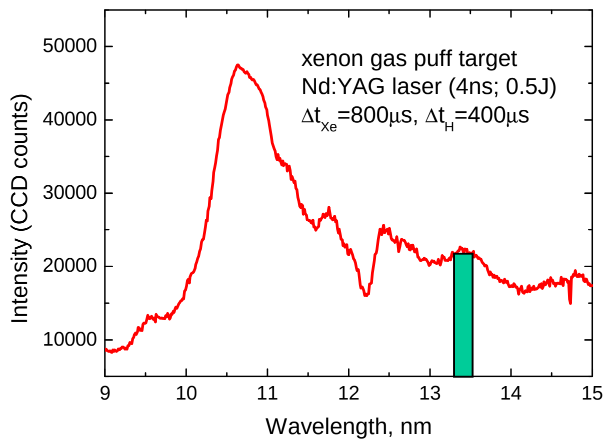
Nd:YAG laser (EKSPLA)

vacuum chamber

10 cm

gas puff valve

EUV spectrum for xenon



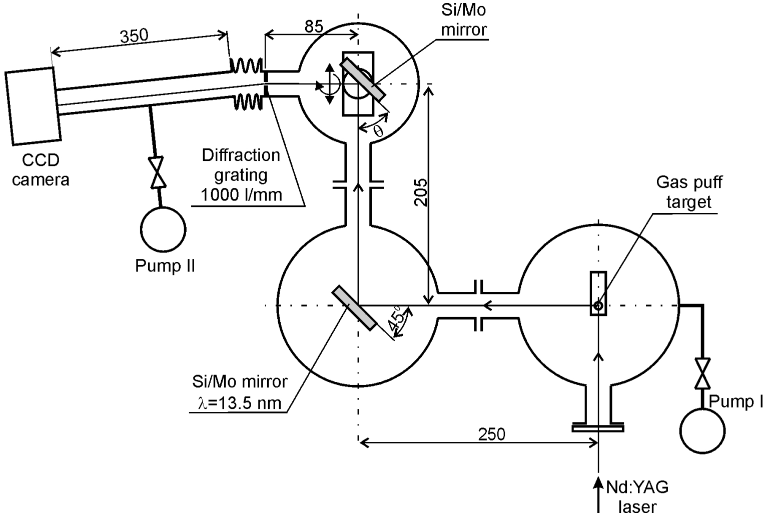
CE at 13.5 nm

~ 1.5 %

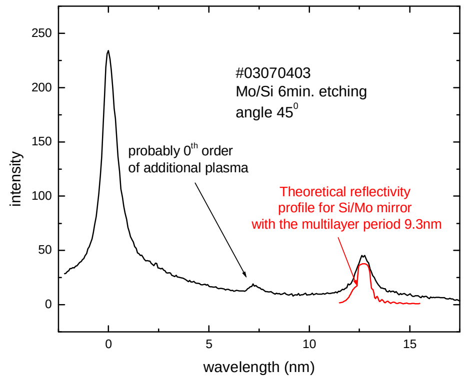
H. Fiedorowicz *et al., J.Alloys&Compounds* ***401*** *(2004) 99*

EUV METROLOGY

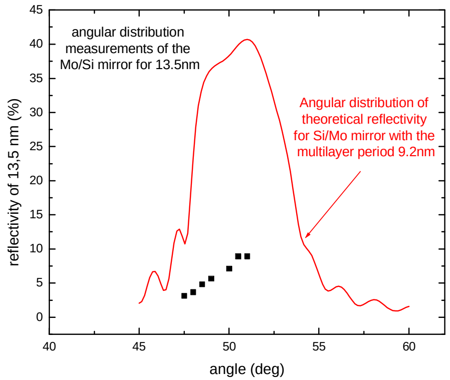
- **characterization of Mo/Si multilayer mirrors**



- spectral distribution at 45°

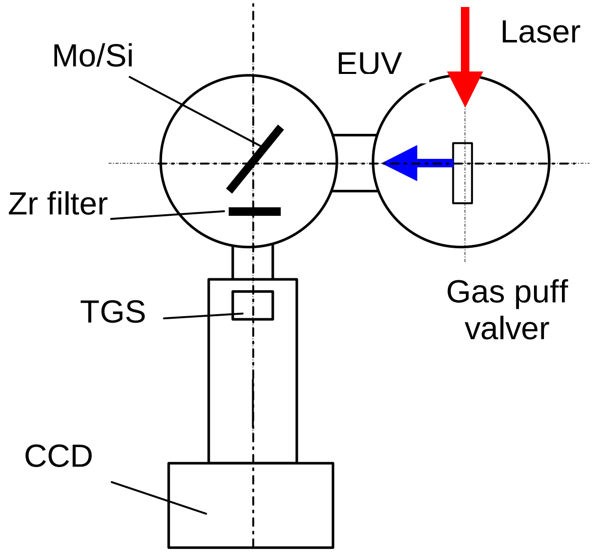


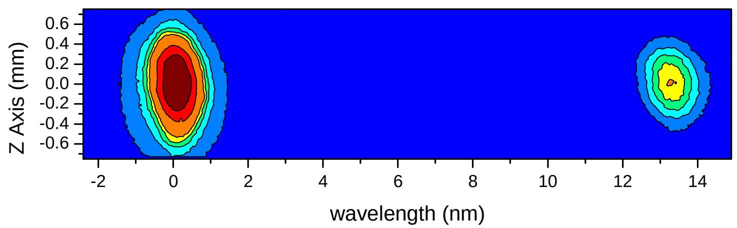
- angular distribution at 13.5nm



Collaboration with REFLEX s.r.o. Prague, Czech Republic

- **degradation of Mo/Si multilayer mirrors irradiated with EUV pulses**





Collaboration with IOF, Jena, Germany

PROCESSING POLYMERS WITH SYNCHROTRON

Direct photo-etching of polymers with synchrotron radiation – a single photon carries enough energy to break any chemical bond and create small fragments of a polymer chain. Similar to photo-etching with UV light (UV laser ablation).

Ritsumeikan University Synchrotron Research Center

Ritsumeikan University SR Center

Synchrotron Aurora:

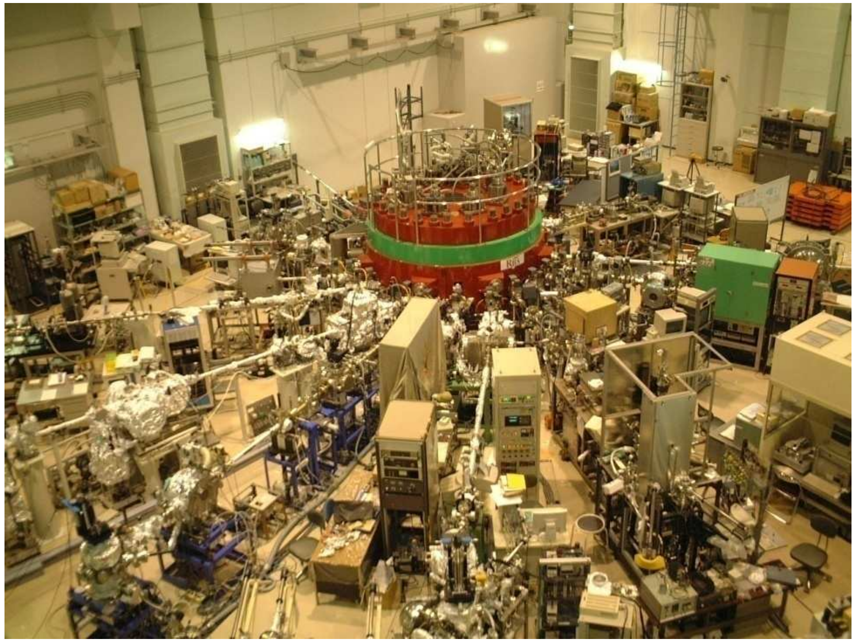
- electron energy: 575 MeV
- critical wavelength: 1.5 nm
- $3x10^{17}$ph/s/cm^2 at a sample surface

Non-thermal ablation of PTFE demonstrated:

- ablation depth: 240µm
- aspect ratio: 11

Advantages (as compared to LIGA):

- dry process,
- EUV radiation preferred (smaller facility and no high-contrast masks are required).



Y. Zhang, T. Katoh, M. Washio, H. Yamada, S. Hamada, Appl. Phys. Lett., ***67*** *(6) (1995) 872*

PROCESSING POLYMERS WITH SYNCHROTRON

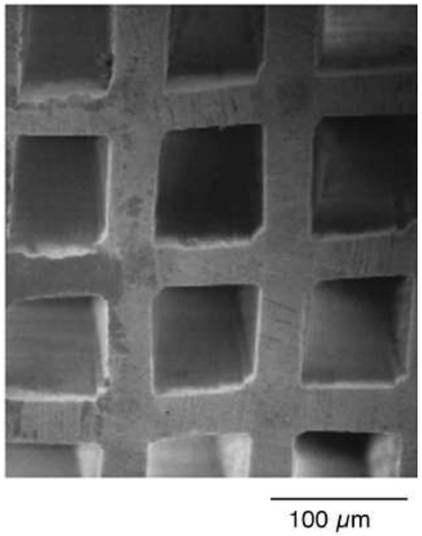
***UVSOR at the Institute for Molecular Science, Okazaki National Research Institute, Japan*.**

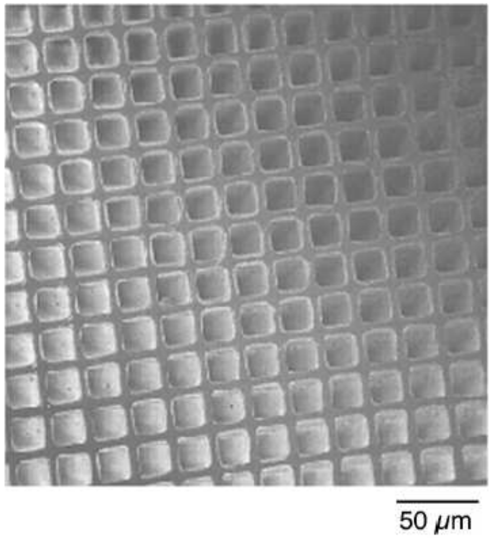
National Institutes of Natural Sciences
分子科学研究所
Institute for Molecular Science

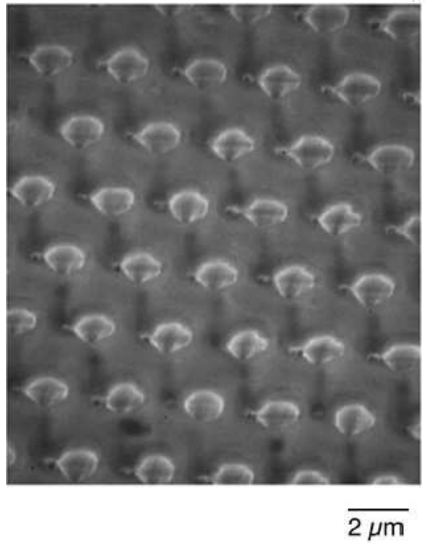
UVSOR Facility.

High Aspect Ration Micromachining of PTFE (Teflon)

- 1-mm-thick Teflon
- aspect ratio: 50
- 10 nm wavelength







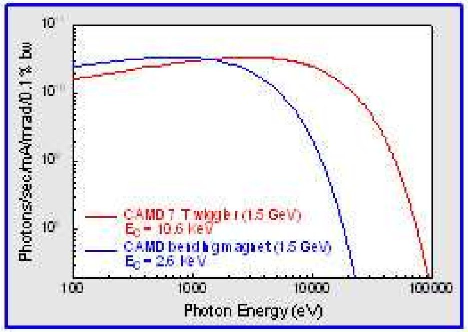
M. Inayoshi et al. J. Vac. Sci. Technol. B ***17*** *(1999) 949*

PROCESSING POLYMERS WITH SYNCHROTRON

The J. Bennett Johnston, Sr.
CAMD
Center for Advanced Microstructures and Devices

Synchrotron CAMD Louisiana State Univ:

- electron energy: 1.5 GeV
- critical energy:2.5 keV
- integrated power density 35 mW/horizontal cm

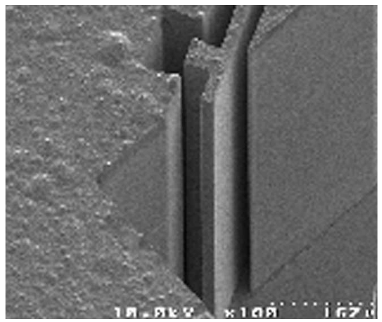


CAMD Experimental Hall

Soft X-ray ablation of heated Teflon

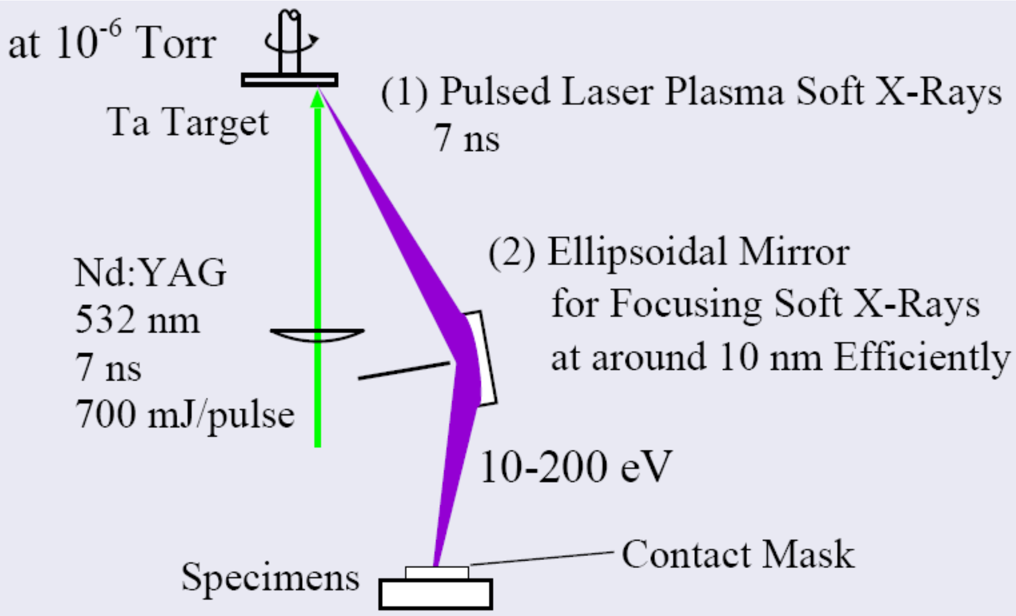
Non-thermal x-ray ablation of PTFE demonstrated:

- ablation rate: **40µm/h**
- strong temperature dependent
- photochemical changes of x-ray irradiated samples

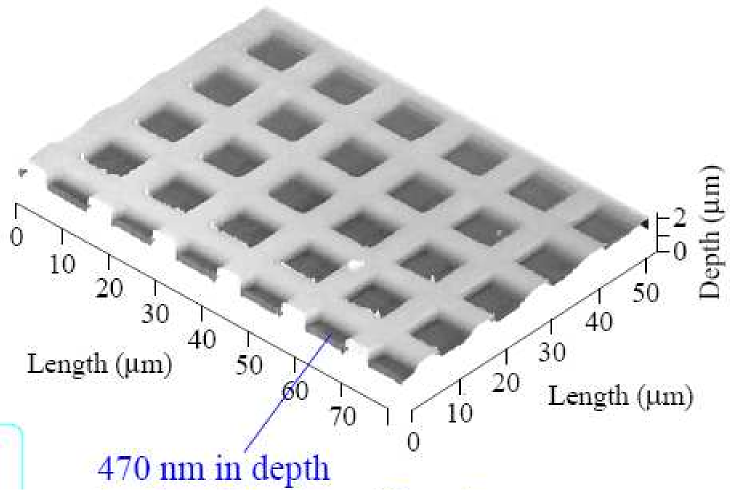


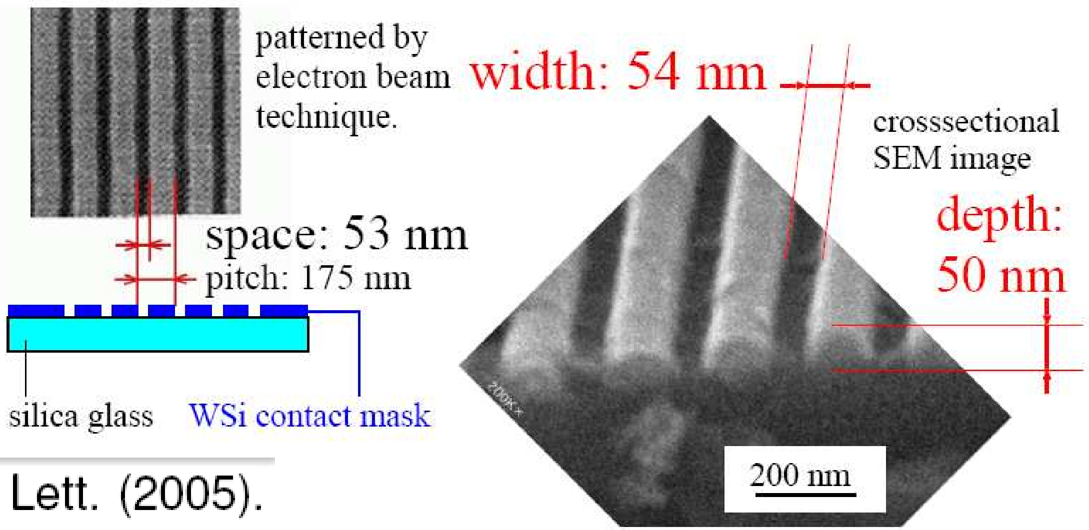
M. Feldman, G. S. Lee, D. Noel, C. Khan Malek, R. Bass
J. Vac Sci. Technol. B., ***18*** *(6) (2000) 2976*

EUV PROCESSING OF SILICA



University of Tsukuba, Japan

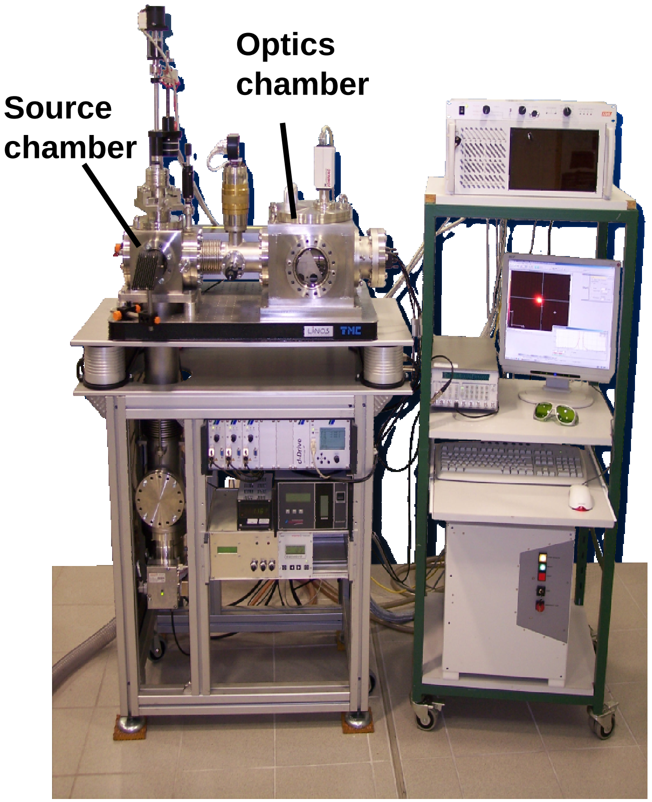


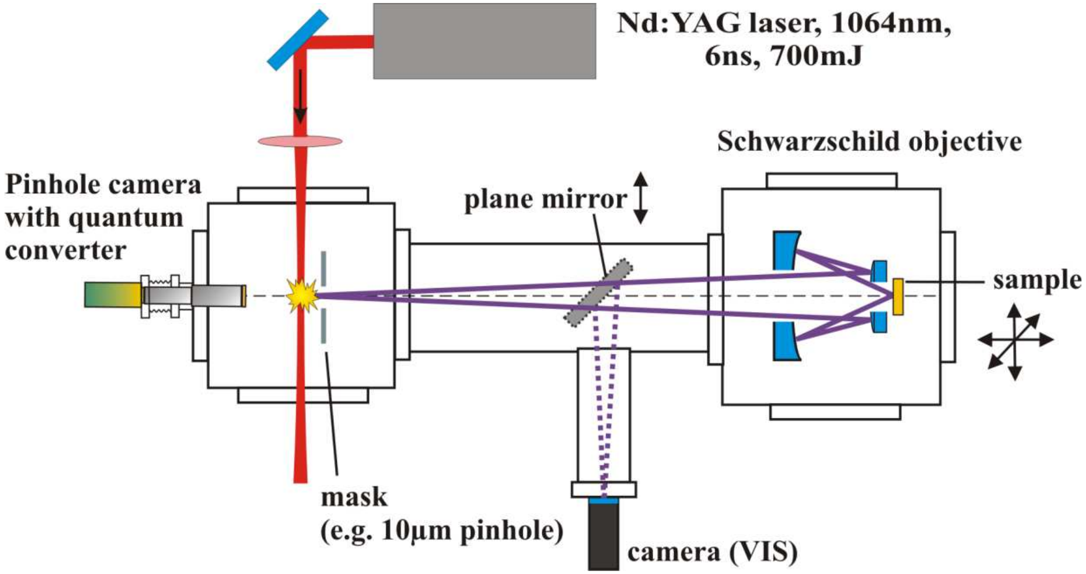


 T. Makimura et al. Appl. Phys. Lett. (2005).

EUV PROCESSING POLYMERS

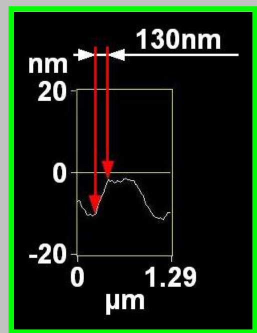
Laser-Laboratorium Gottingen, Germany

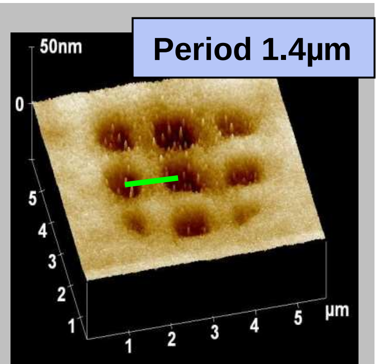




Resolution: 130nm

(NA 0.25)

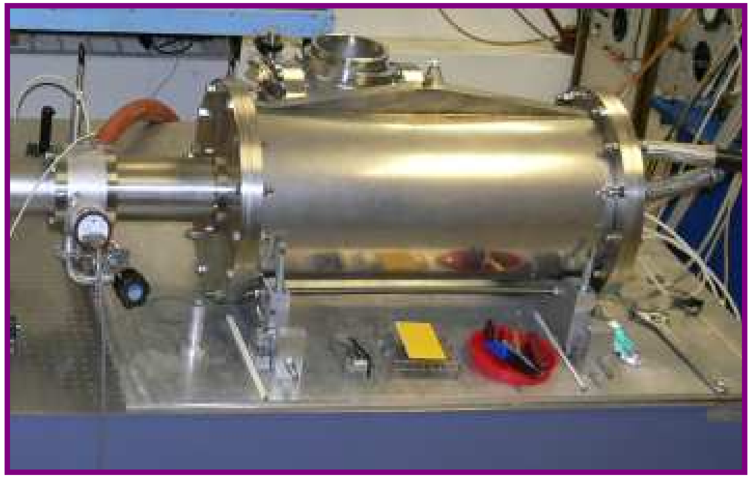


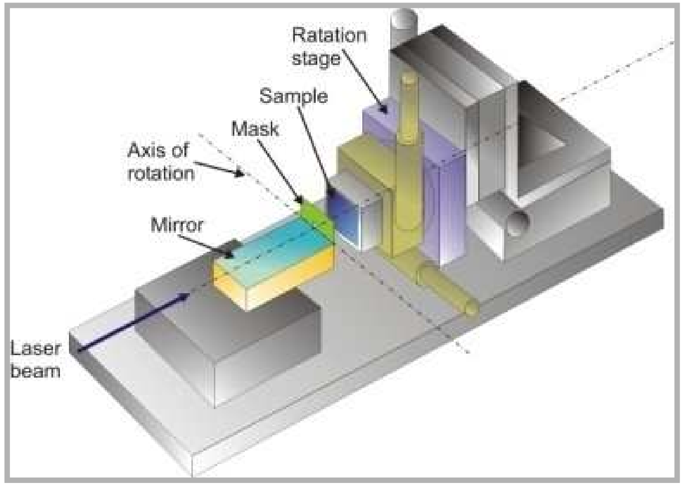


*F. Barkusky, K. Mann, T. Feigl, Rev. Sci. Instr., **76**, 105102 (2005)*

NANOPATTERNING USING EUV LASER

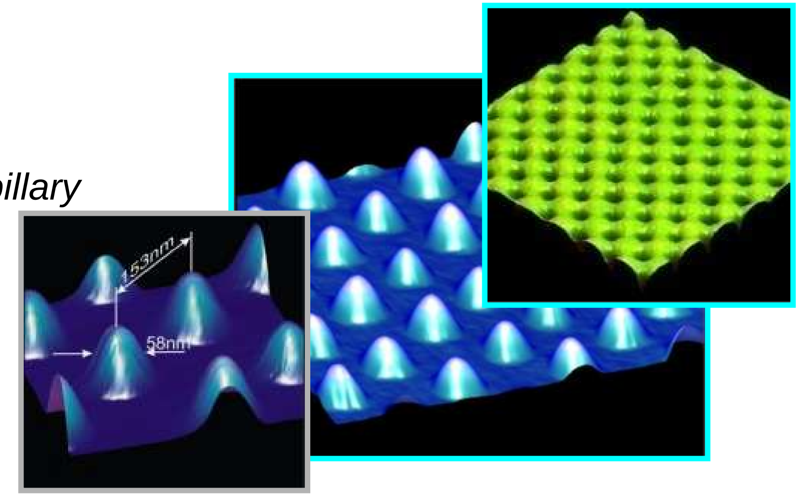
NSF ERC for Extreme Ultraviolet Science & Technology,
Colorado State University, Fort Collins, USA





- *Wavelength: λ=46.9 nm*
- *Repetition rate: 4 Hz*
- *High energy per pulse max - 0.8 mJ*
- *High monochromaticity: $\Delta\lambda/\lambda=1\times10^{-4}$*
- *Coherence radius: R_c = 550 μm at 0.157m from 36cm capillary*
- *Very compact*

Pillars with FWHM down to 58 nm (1.2λ) were obtained with period 153nm at high dose

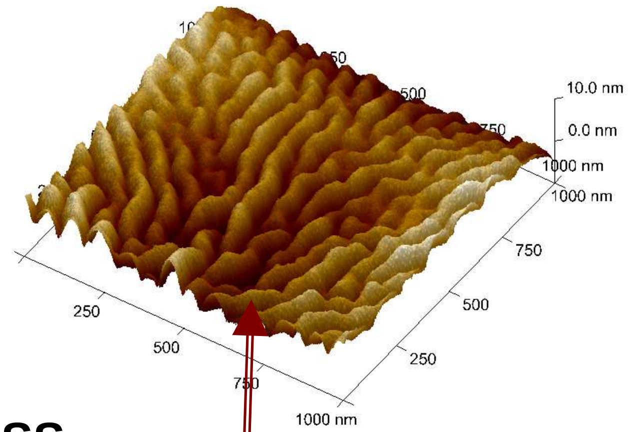


Wachulak et al. Opto-electronics Review, 16 (2008) 444

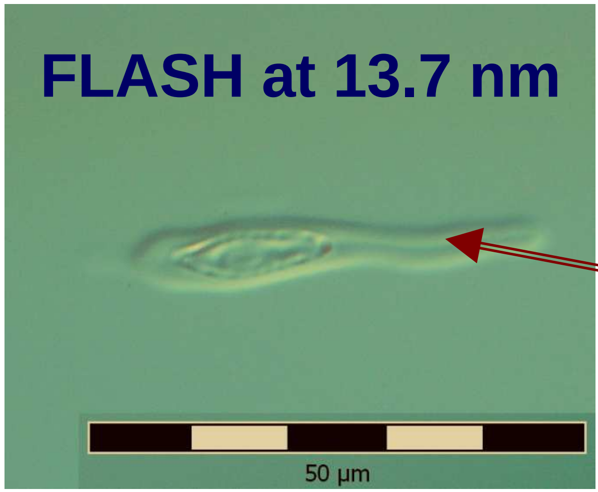
LIPSS : Laser-Induced Periodic Surface Structures

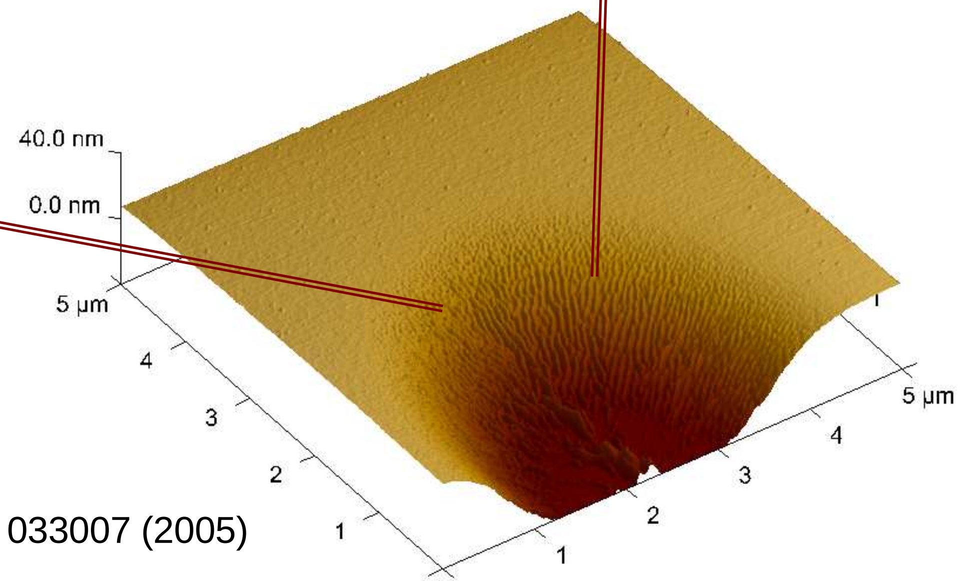
LIPSS - spontaneously-grown ripples on the FEL laser-illuminated surfaces.

LIPSS-I are formed due to the interference of the incident laser beam with a wave diffracted by periodic features on material surface



60-nm LIPSS

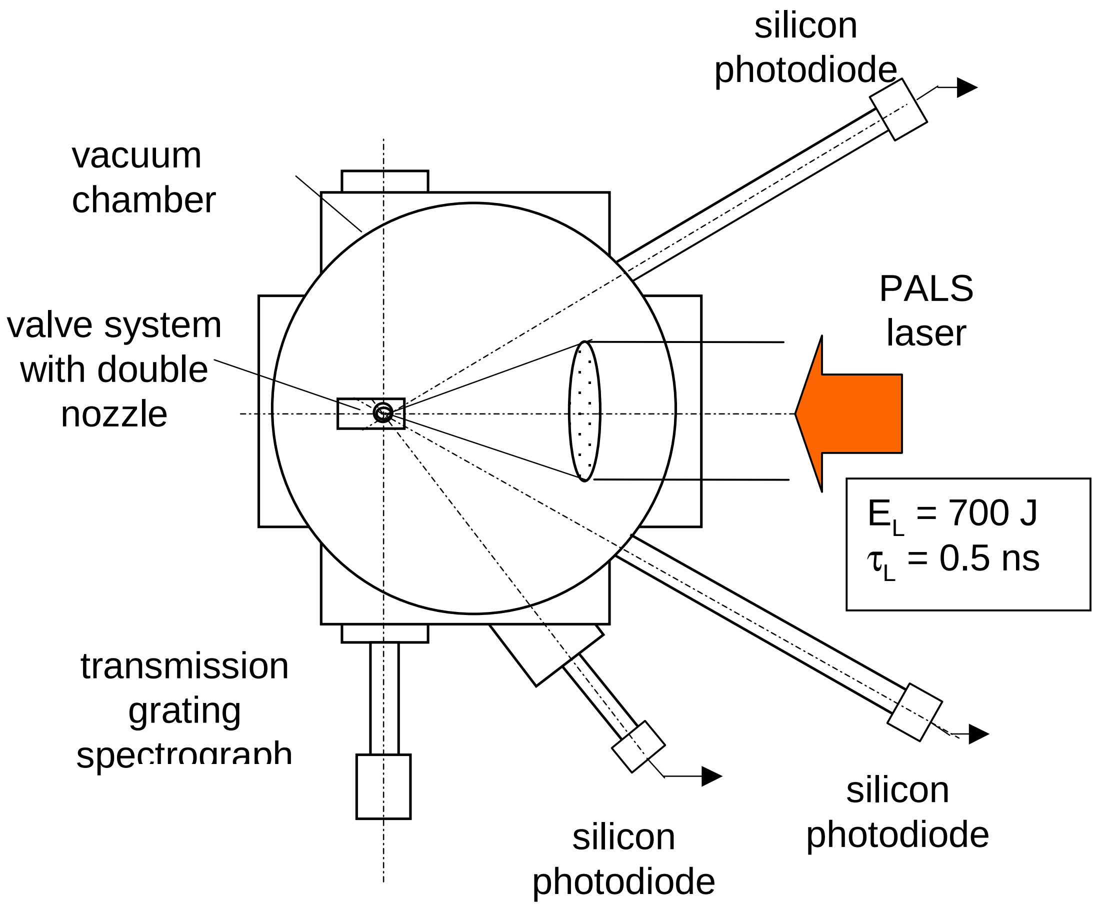




L. Juha et al. *J. Microlith. Microfab. Microsyst.* **4**, 033007 (2005)

PRAGUE ASTERIX LASER SYSTEM (PALS)

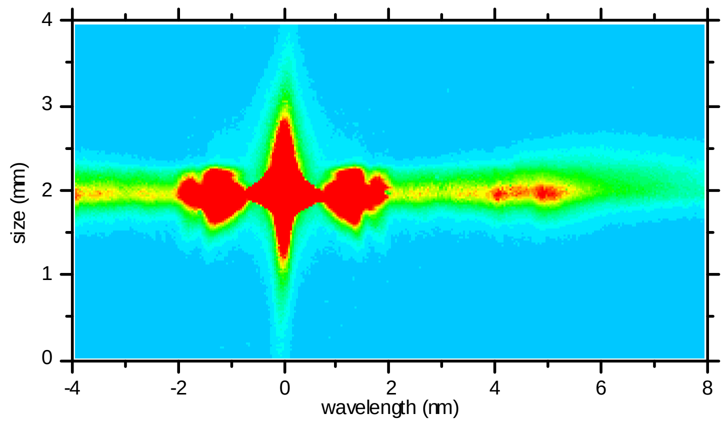
Experimental setup



K. Jungwirth *et al., Phys. Plasmas 8 (2001) 2495*

SOFT X-RAY EMISSION FROM XENON

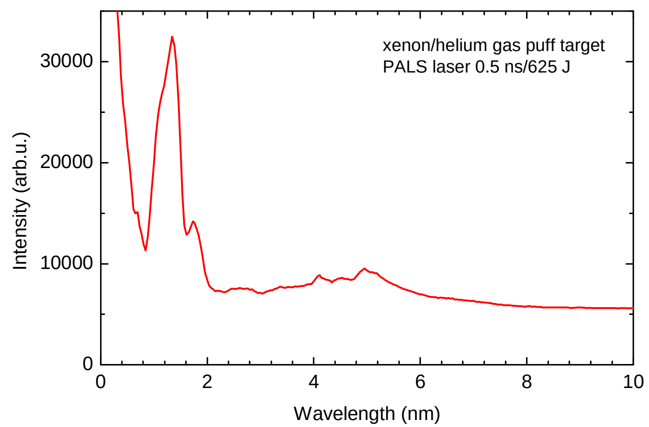
Soft x-ray spectrum for xenon/helium gas puff target irradiated with the PALS laser



(0.5 ns/540 J)

X-ray emission measured with the silicon photodiode

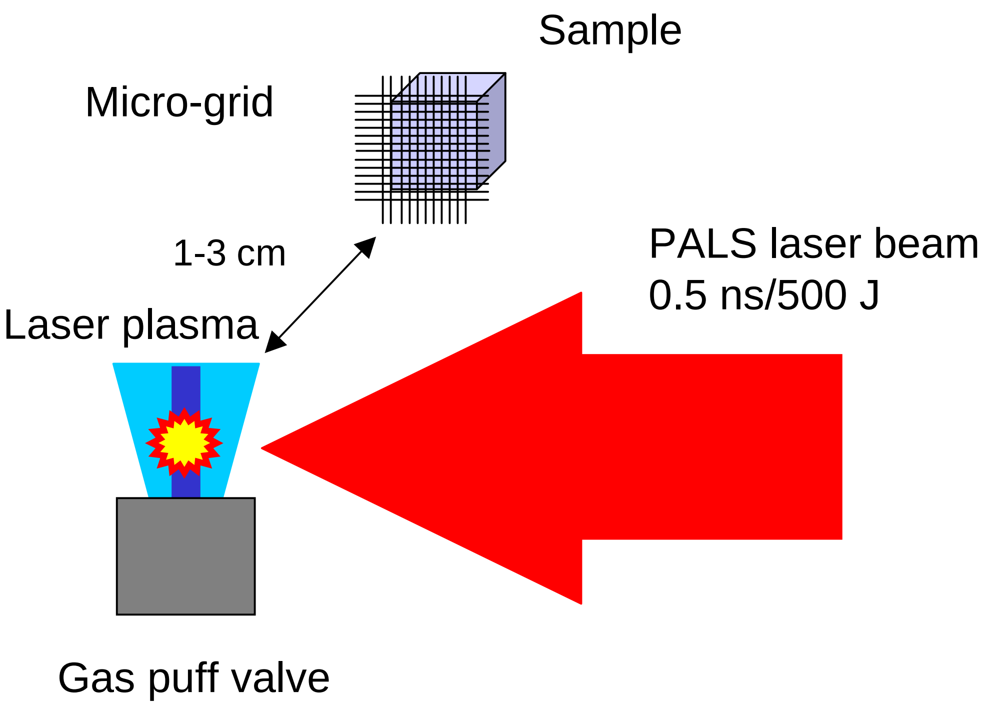
0.5 nm	10 J	2%
1-2 nm	160 J	30%
3-7 nm	*160 J*	*30% (?)*

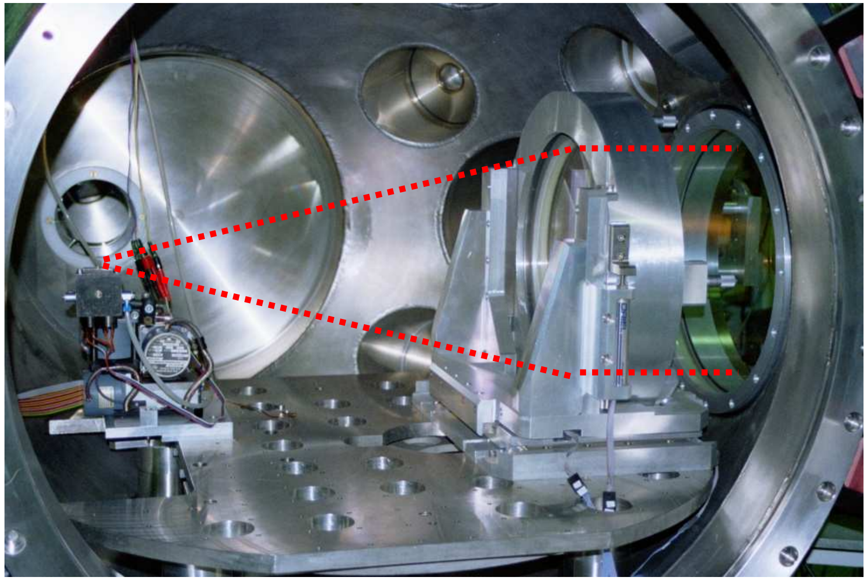


H. Fiedorowicz *et al. J.Alloys&Compounds* 362 (2004) 67

EXPERIMENT ON SOFT X-RAY PHOTO-ETCHING

Schematic of the experiment



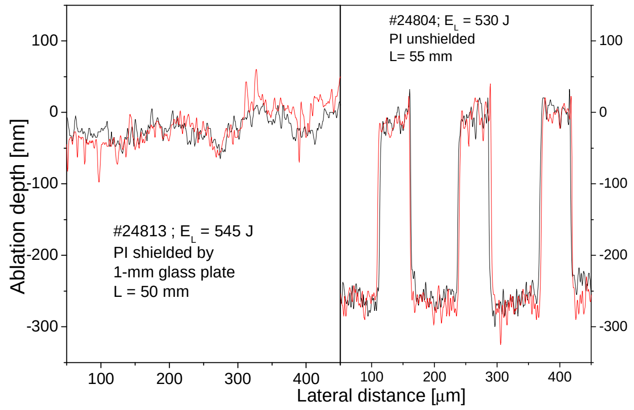


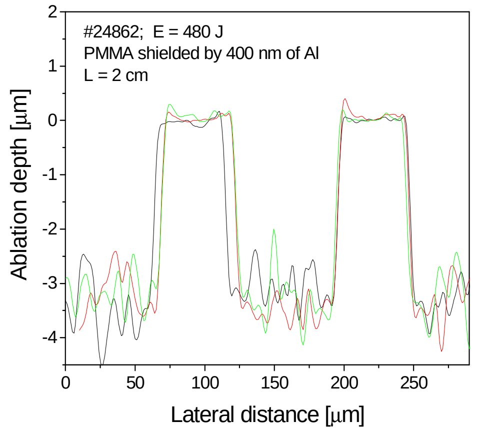
Advantages of using the gas puff target

- elimination of target debris,
- reduction of ions,
- high conversion efficiency.

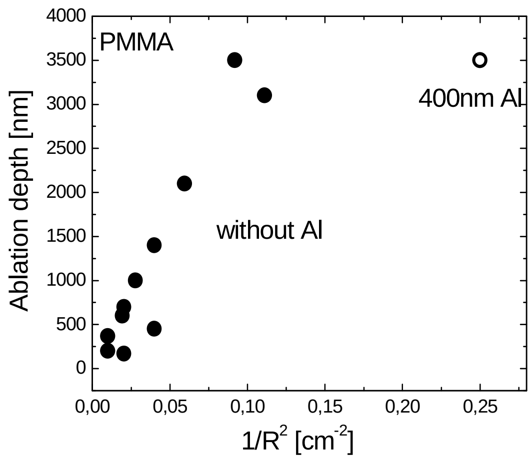
SOFT X-RAY PHOTO-ETCHING OF POLYMERS

Depth profiles of the structures formed by soft X-ray photo-etching using LPXS

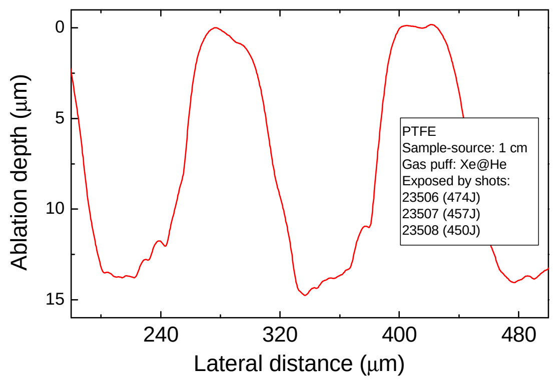




Ablation depth vs sample-source distance

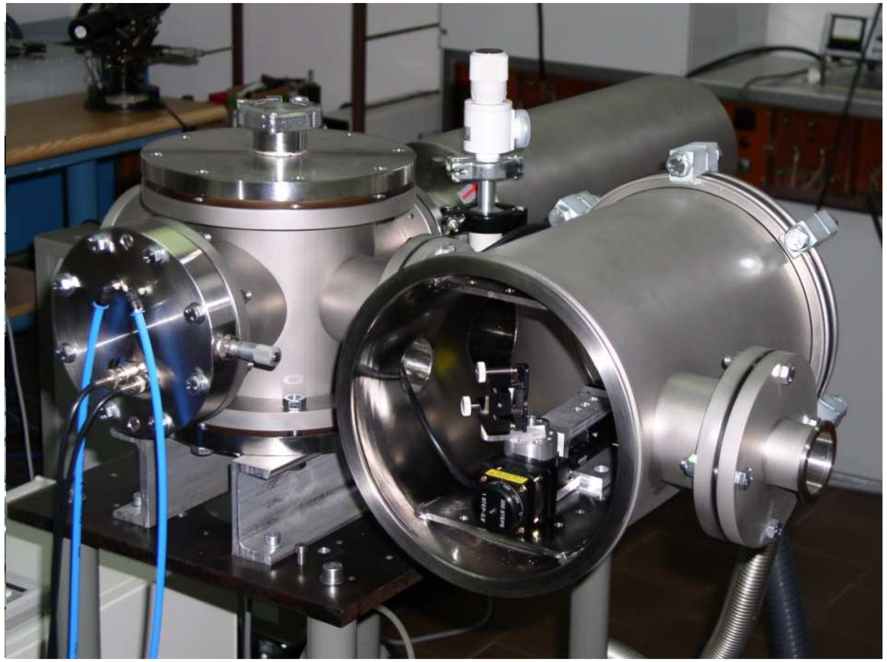


Soft X-ray ablation with multiple exposition



H. Fiedorowicz *et al. Microelectronic Engineering* **73-74**, 336 (2004)

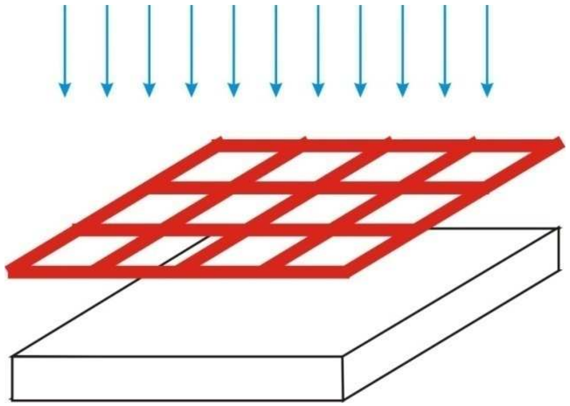
PROCESSING OF POLYMERS USING A COMPACT LASER PLASMA EUV SOURCE



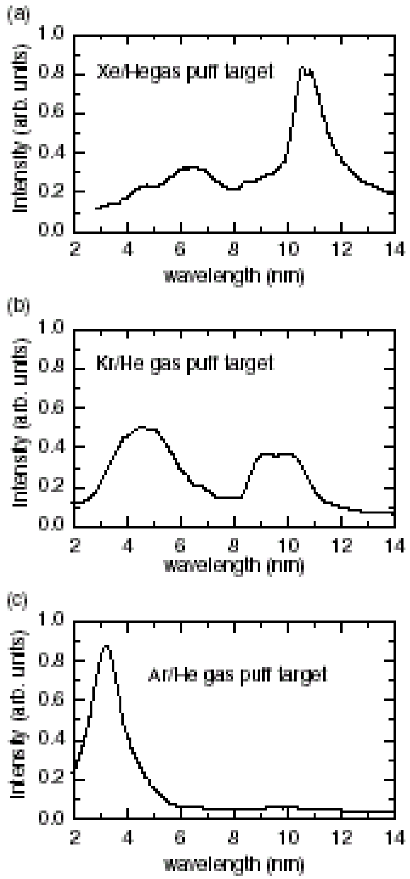
EUV

Micro-grid

Polymer sample



EUV spectra



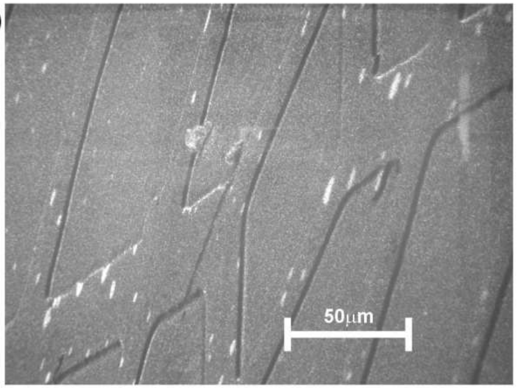
EUV PHOTO-ETCHING POLYMERS

- micromachining of organic polymers by direct photo-etching using a compact laser-plasma EUV source

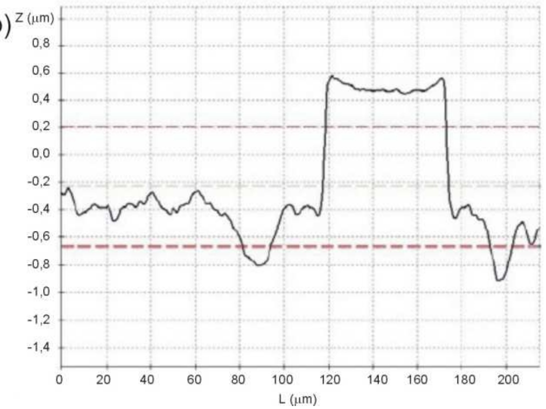
EUV fluence ~2-3 mJ/cm2/shot

1000 pulses

a)



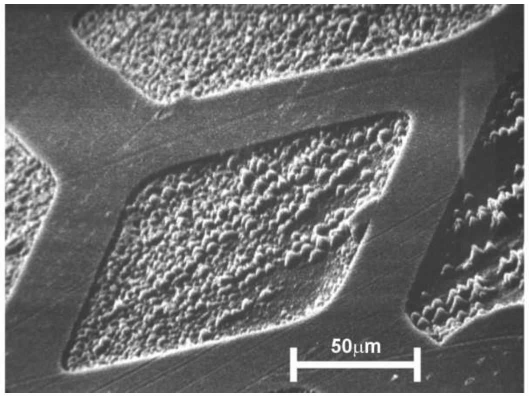
b)



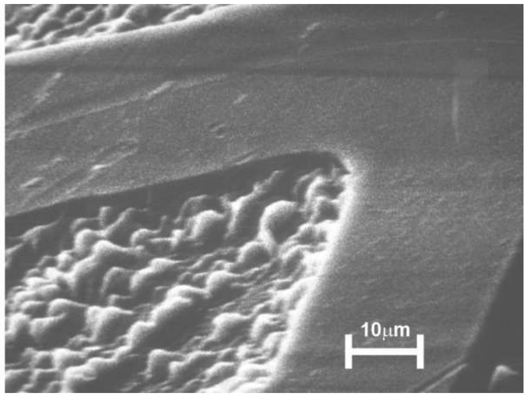
~1µm

SEM microphotograph of microstructures in PMMA

a)



b)



~2µm

SEM microphotographs of microstructures in PTFE

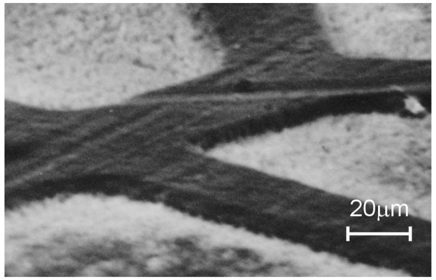
Bartnik *et al*. *Microelectronic Engineering* **78-79** (2005) 452

EUV PHOTO-ETCHING POLYMERS

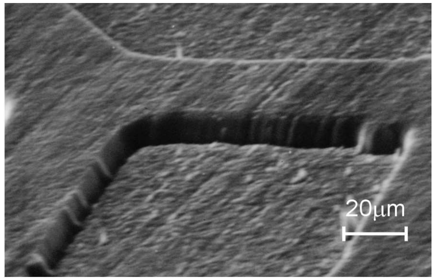
PTFE

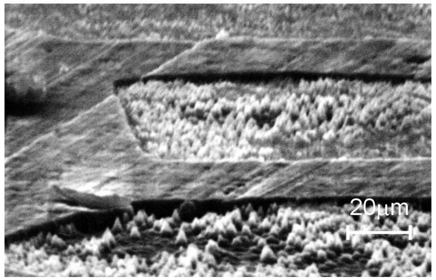
EUV fluence ~2-3 mJ/cm^2/shot,
10 min exposition time,

Kr/Ar gas puff target, T=200^{0}C

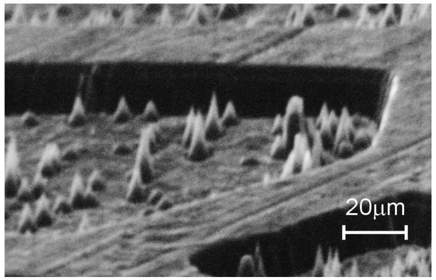


Xe/Ar gas puff target, T=200^{0}C



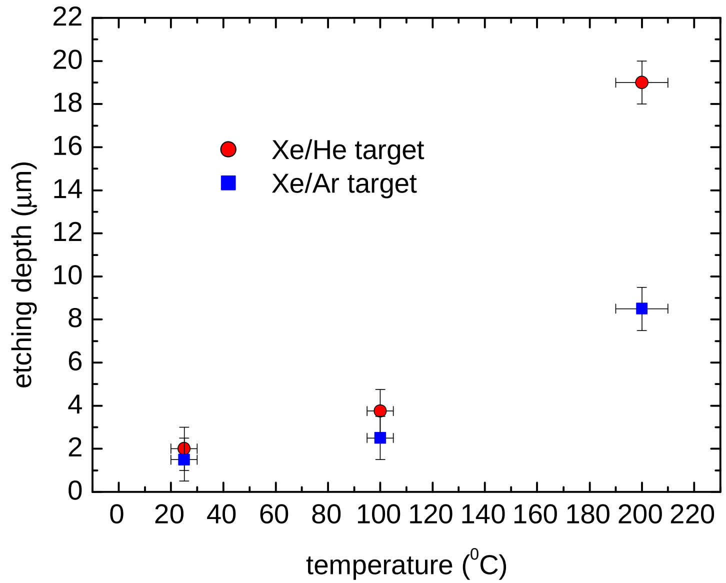


Xe/He gas puff target, T=100^{0}C



Xe/He gas puff target, T=200^{0}C

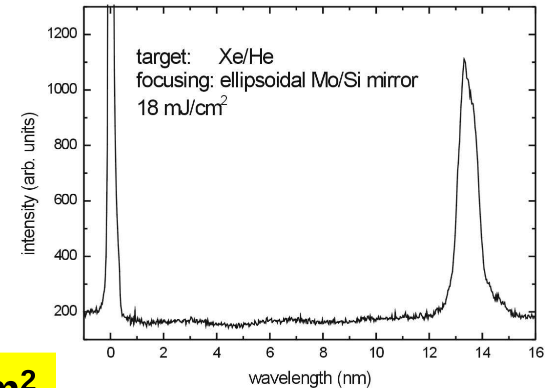
Strong dependence of the EUV photo-etching depth on the sample temperature



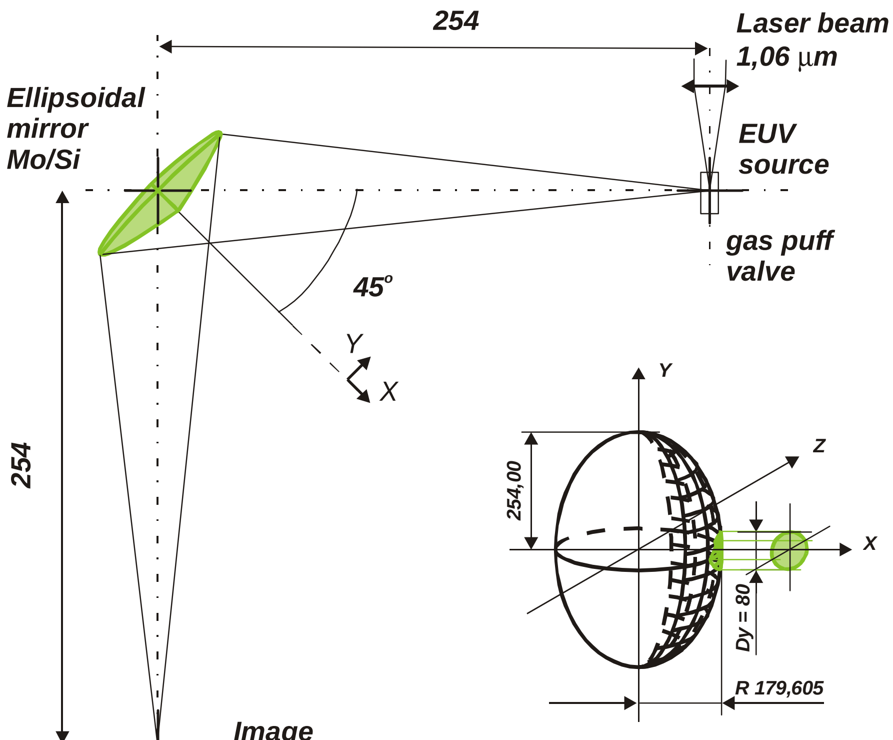
A. Bartnik *et al. Microelectronic Engineering* ***78-79*** *(2005) 452*
A. Bartnik *et al. Appl.Phys. B* ***82*** *(2006) 529*

EUV OPTICAL SYSTEM

Ellipsoidal mirror with Mo/Si coating



18 mJ/cm²



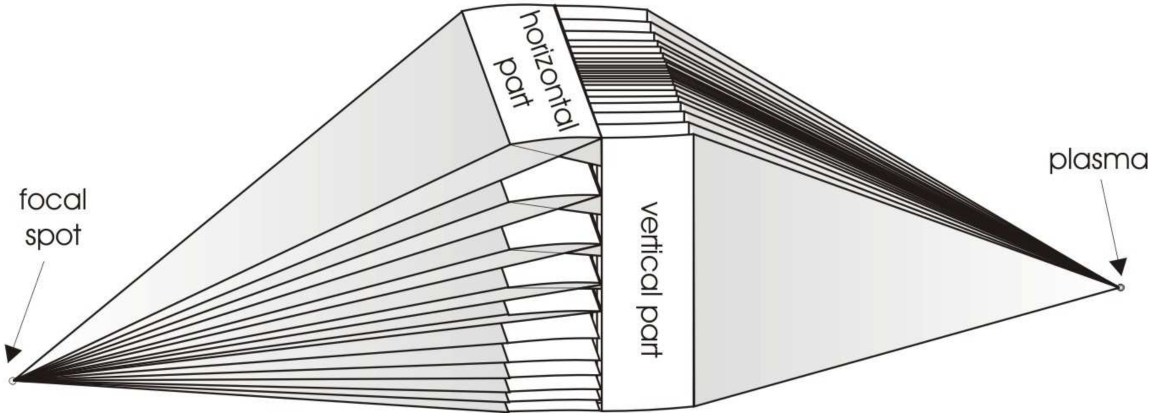
Ellipsoidal surface of mirror is formed by rotating ellipse: $\frac{x^2}{(179{,}605)^2} + \frac{y^2}{(254)^2} = 1$ *around Y axis*

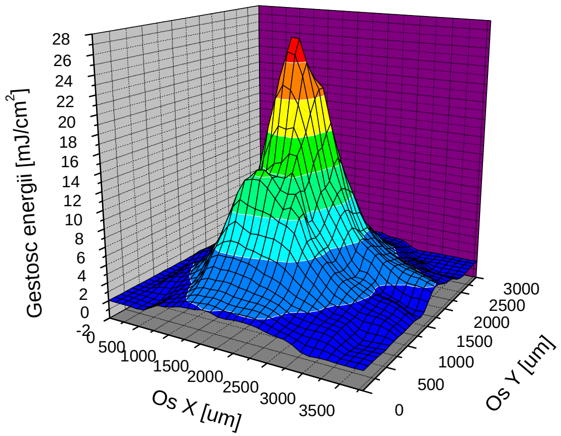
Collaboration with REFLEX s.r.o. Prague, Czech Republic (substrate) and IOF, Jena, Germany (multilayers)

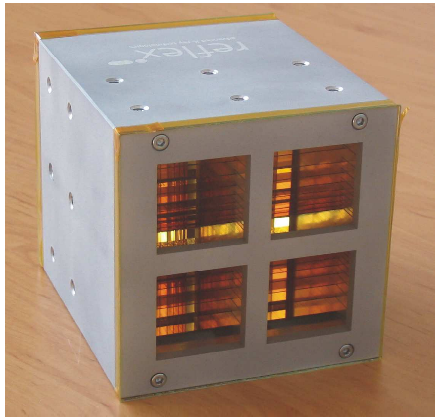
EUV OPTICAL SYSTEM

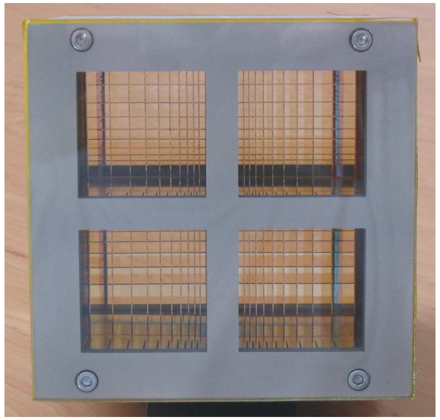
Grazing incidence „lobster eye" multifoil mirror system

Two orthogonal stacks of ellipsoidal mirrors forming a double-focusing device. The ellipsoidal surfaces are covered by a layer of gold that has relatively high reflectivity at the wavelength range between 8-20 nm up to about 10 degrees of an incidence angle.









> 20 mJ/cm^2 for xenon

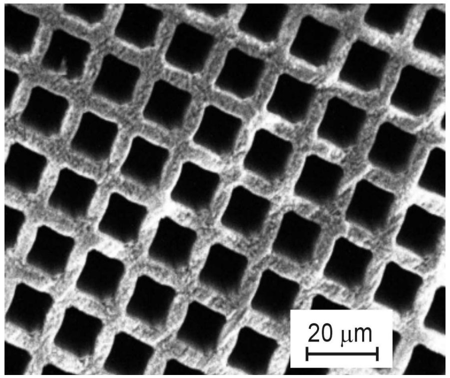
Collaboration with the Czech Technical University and Reflex s.r.o., Praha

EUV PROCESSING POLYMERS WITH OPTICS

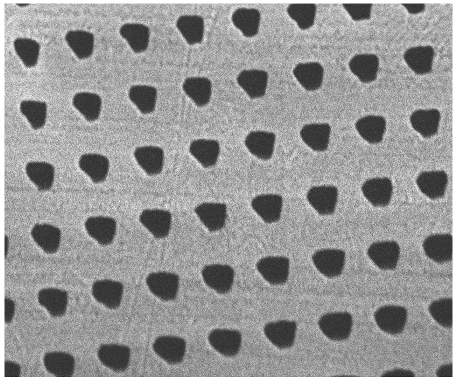
High-aspect microstructuring polymers with the use of the „lobster eye” mirror system

50 µm PTFE foil

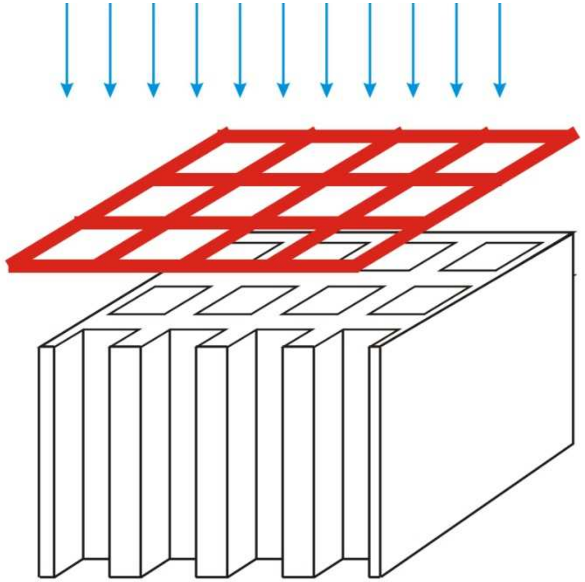
Exposition time 4 min. **(40µm/h for CAMD)**



front side

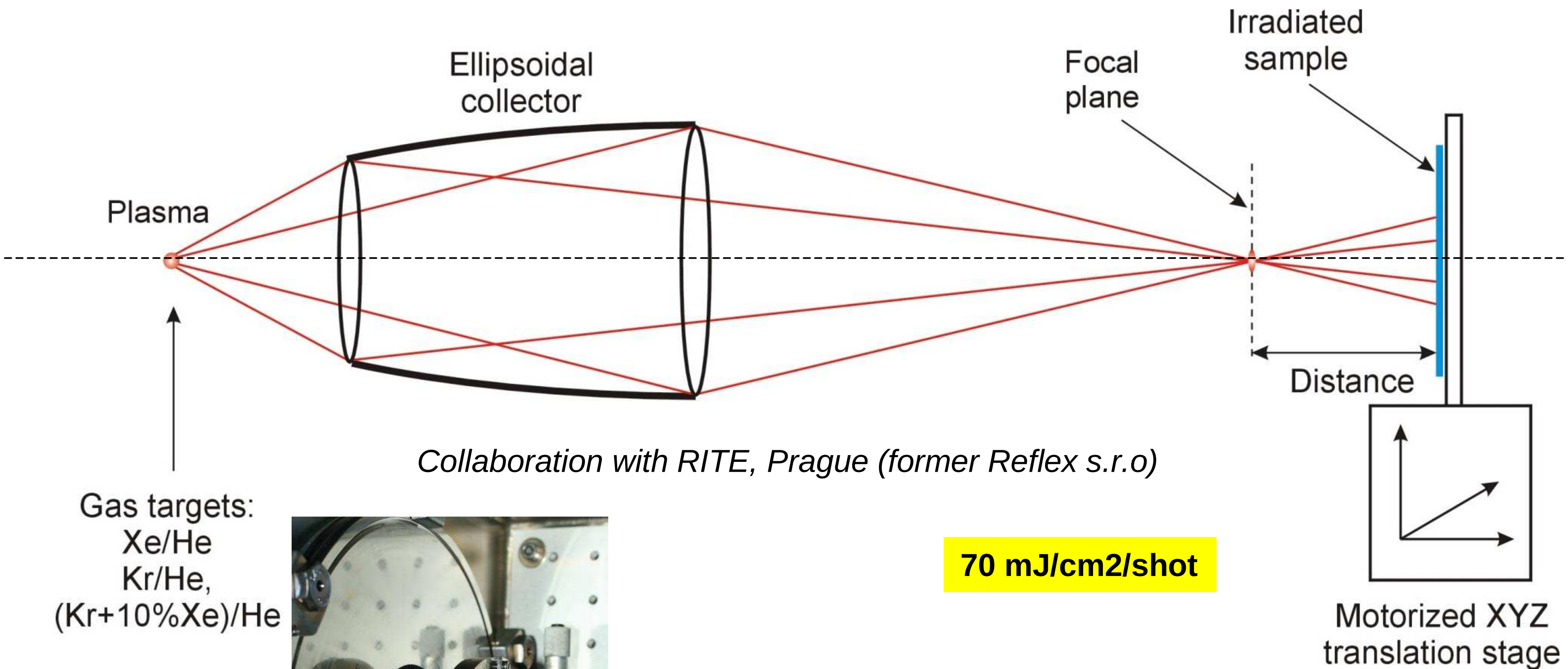


back side



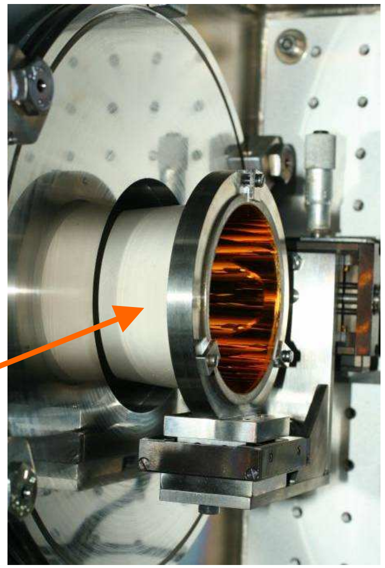
X-ray fluence ~20-30 mJ/cm^2/shot

EUV OPTICAL SETUP

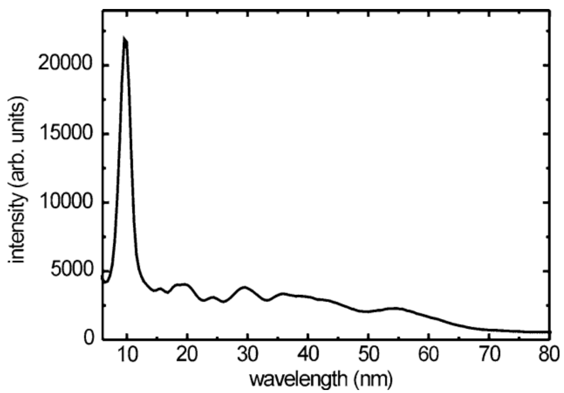


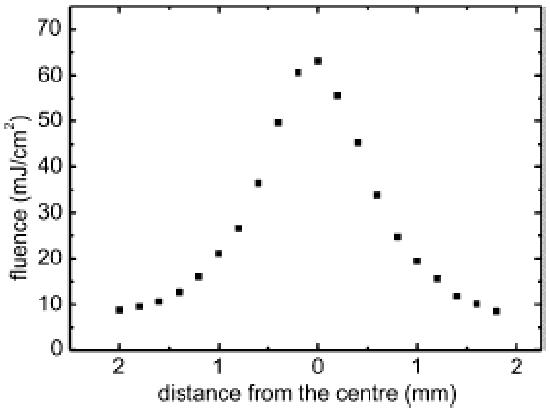
Collaboration with RITE, Prague (former Reflex s.r.o)

70 mJ/cm2/shot

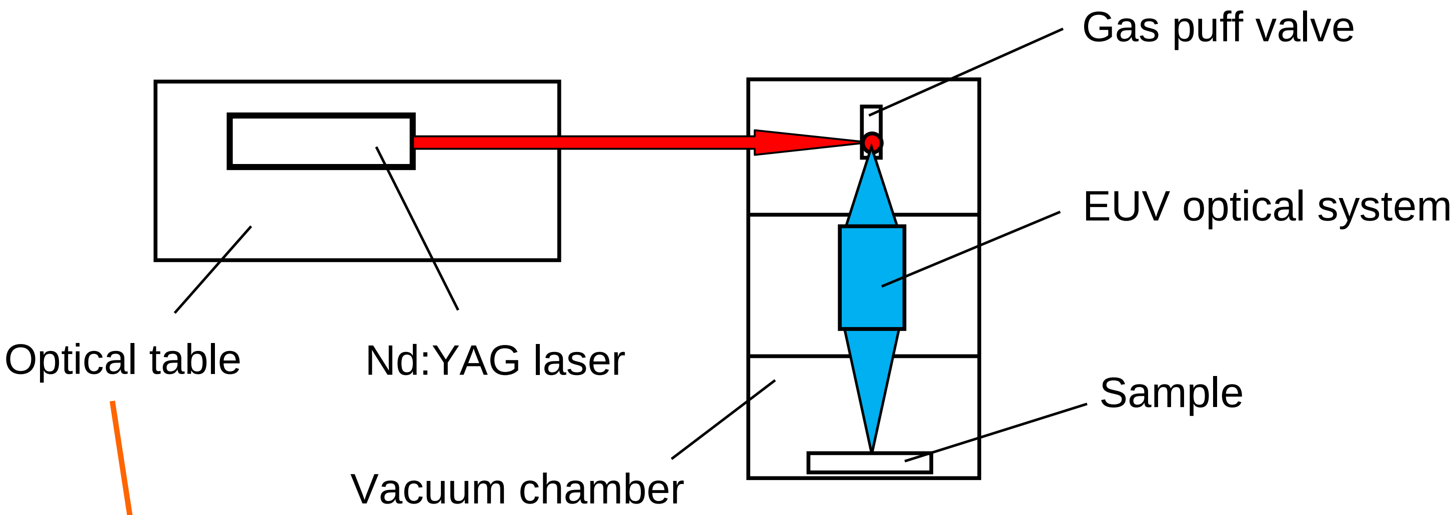


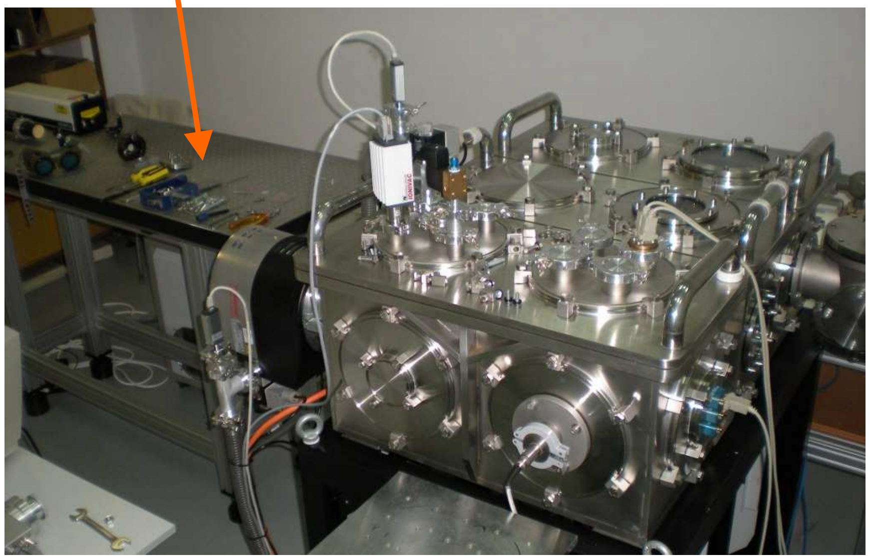
Ellipsoidal EUV collector

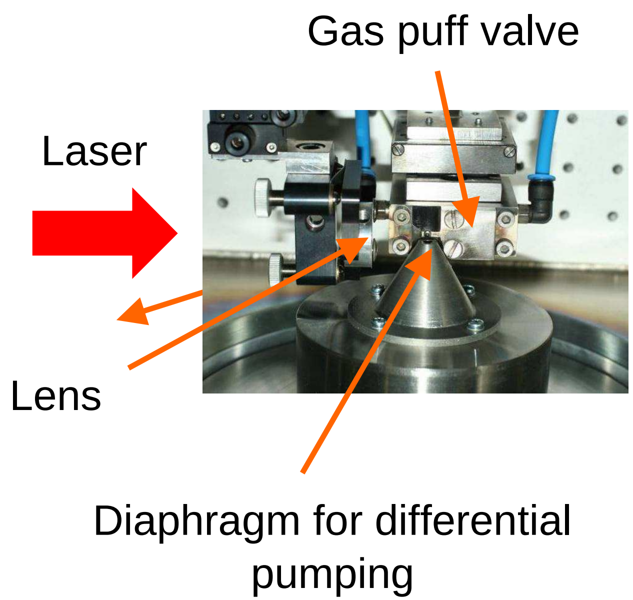




LASER PLASMA EUV SOURCE







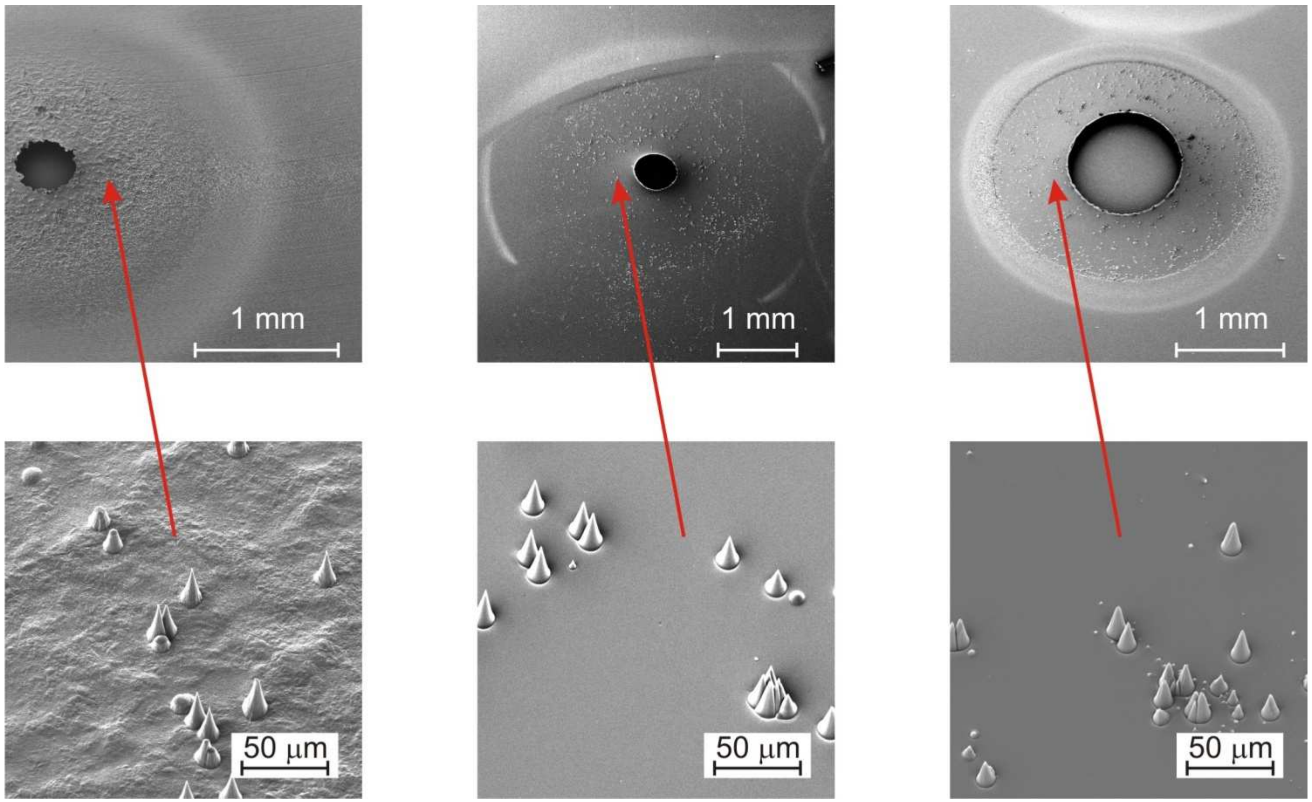
EUV PHOTO-ETCHING POLYMERS WITH OPTICS

50 µm thick polymer foils, 2 min irradiation, 10 Hz operation rate, GI mirror

Ablation acompanied by cones formation

Suggested explanations for cones formation:

- shielding by impurities,
- carbon enrichment
- local shift of the ablation threshold,



Polytetrafluoroethylene, PTFE

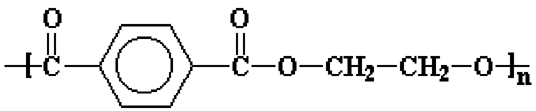
Fluorinated ethylene – propylene, FEP

Poly (methyl methacrylate), PMMA

CONICAL STRUCTURES FORMATION

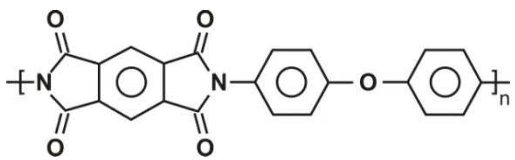
SEM images of strongly modified surfaces with conical structures, 10 Hz EUV irradiation. Dashed yellow lines indicate borders between zones of different structures

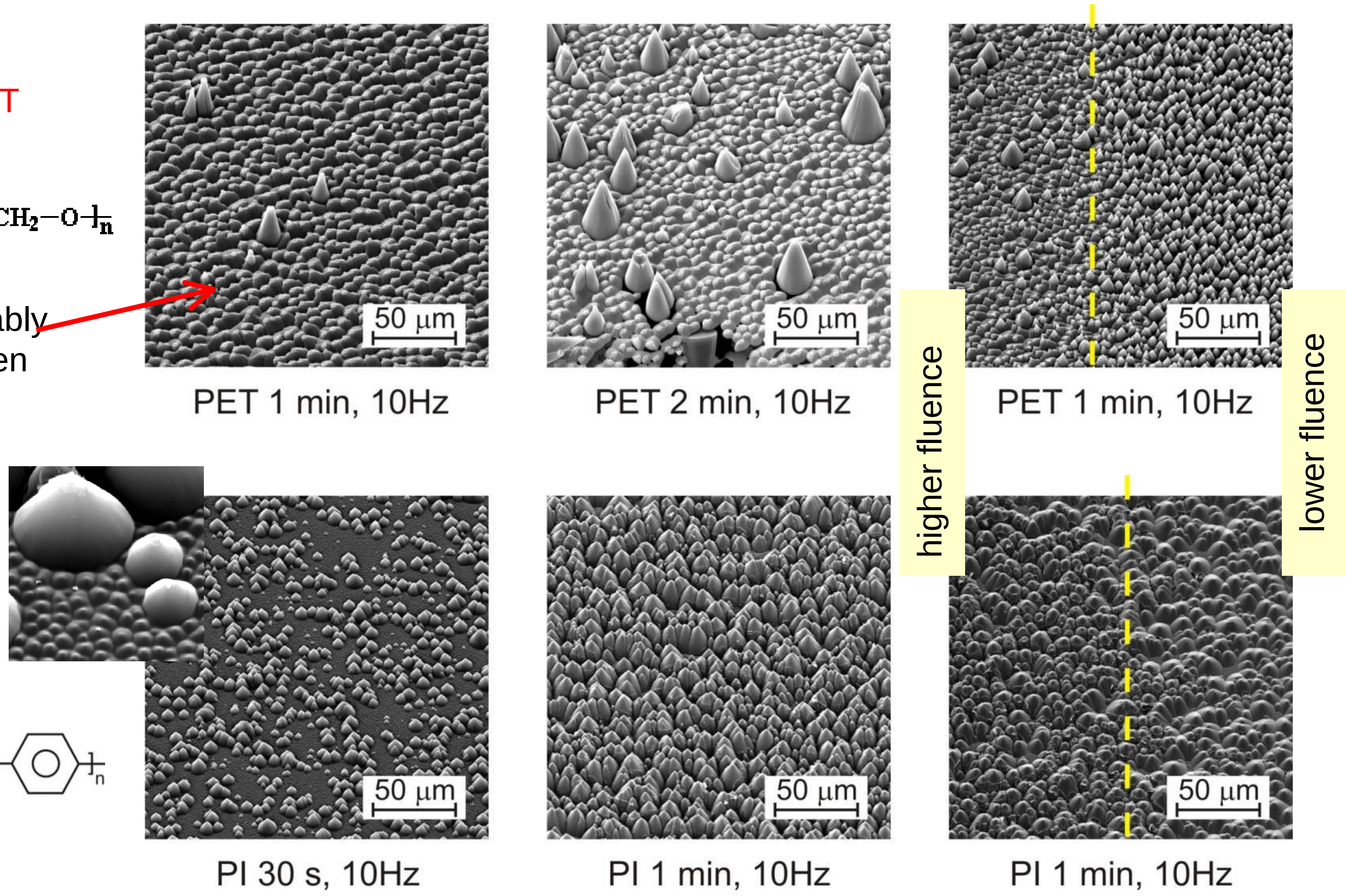
poly(ethylene terephthalate), PET



Structure coming probably from relaxation of frozen stress fields

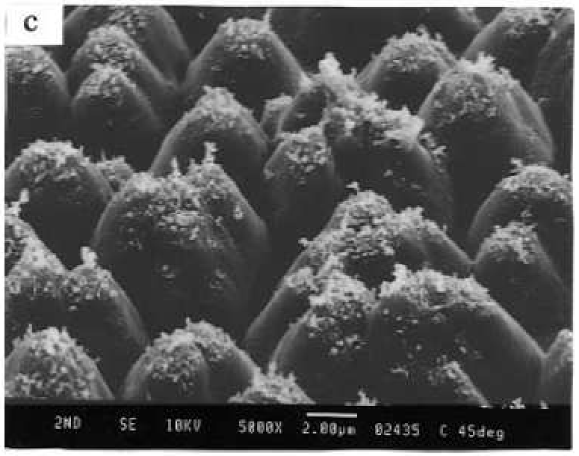
Polyimide, PI



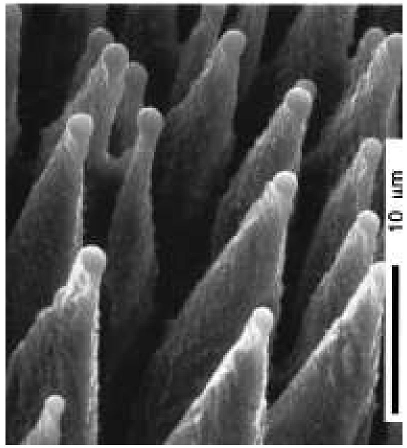


SURFACE MODIFICATION WITH LASERS

Polymer -KrF laser



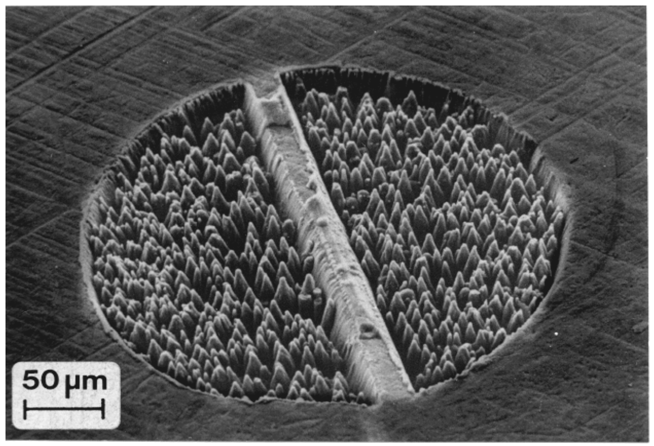
T. Lippert et al. *Macromolecules* **29** (1996) 6301



Si-fs laser

E. Mazur et al. *Appl. Phys*. **A 65**, 259 (1997)

Si_3N_4 Ceramics – ArF laser



J. Heitz et al. *Appl. Phys*. **A 65**, 259 (1997)

Applications:

- biomedicine
- photovoltaics
- ………….

RESEARCH PROJECT

EUREKA PROJECT E!3892- EULASNET II MODPOLEUV

1. General description

Project	E! 3892- EULASNET II MODPOLEUV	**Status**	Announced- 14-Jun-2007
Title	**Modification Of Polymer Foils With Euv (Extreme-Ultra-Violet) Radiation For Applications In Biomedical Technology**		
Class	Sub-Umbrella	**Technological area**	Lasers
Start date	01-Jul-2006	**End date**	01-Jan-2009
Duration	30months	**Total cost**	0.58Meuro
Partner sought	No		
Summary	New Methods And Techniques For Modifying Polymer Foils To Improve Their Bio-Functions Using Extreme Ultraviolet (Euv) Radiation From Laser Plasma Light Sources Which Will Be Developed During The Project For Biomedical Technology.		

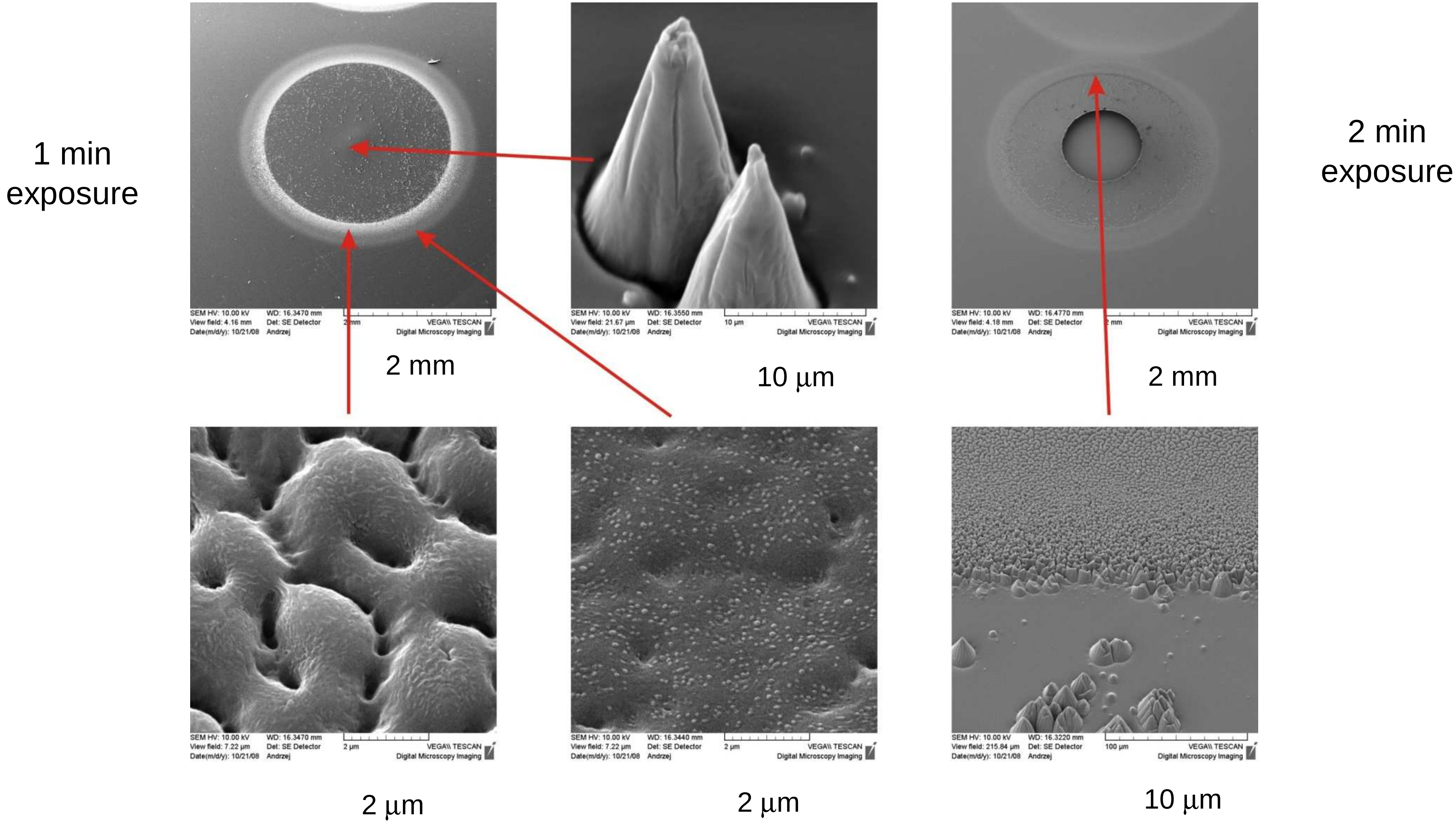
Institute of Applied Physics, Linz
Institute of Optoelectronics, Warsaw
Institute of Biophysics, Linz
REFLEX s.r.o, Prague

Start date 23-Aug-2007
End date 22-Feb-2010

Motivation

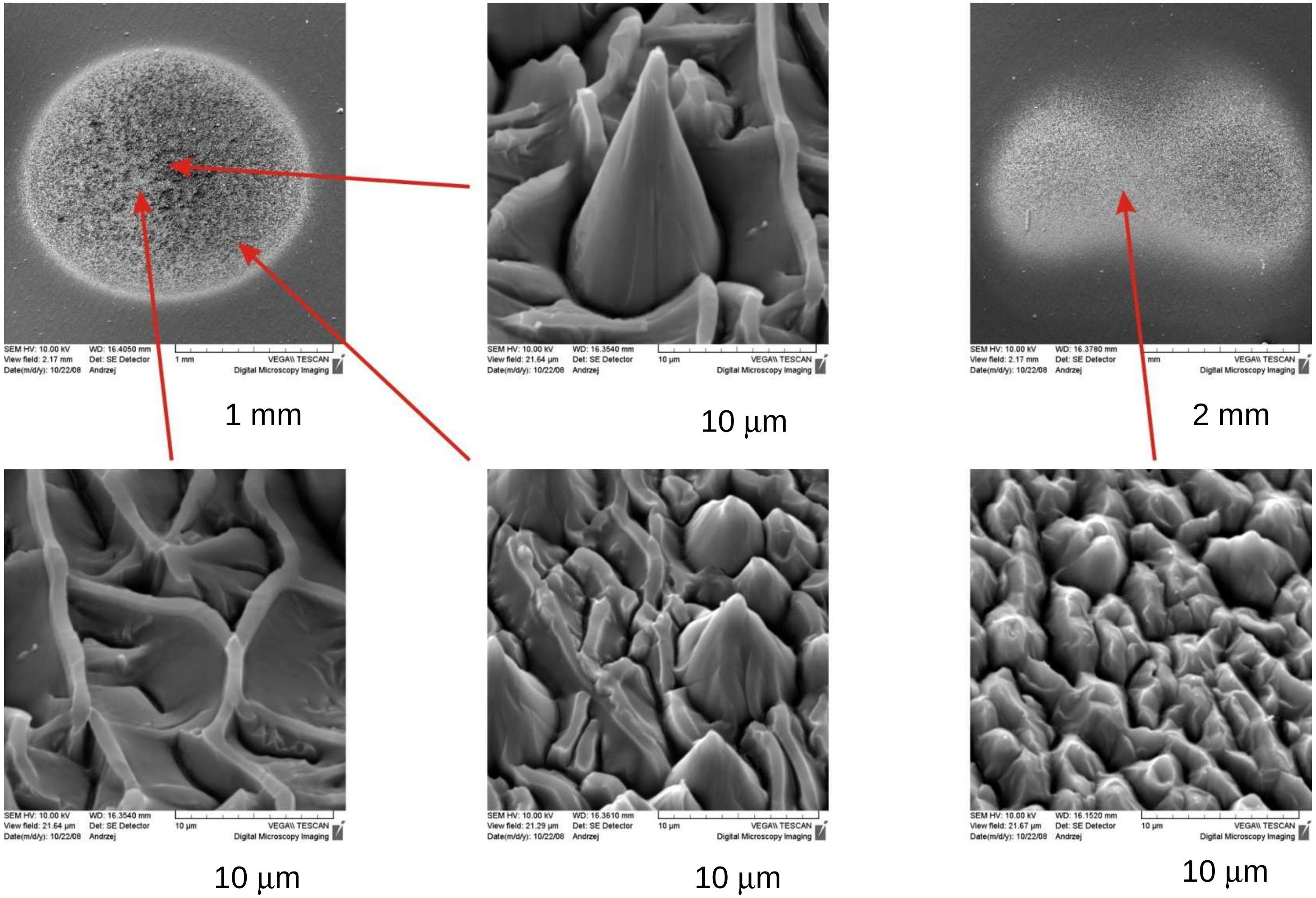
Polymethyl methacrylate (PMMA)

SEM images of PMMA irradiated in the focal plane of Mo coated ellipsoidal collector, Xe plasma radiation, repetition rate 10 Hz



Polyvinyl fluoride (PVF)

SEM images of PVF irradiated in and out of the focal plane of Mo coated ellipsoidal collector, Xe plasma radiation, 1 min exposure, repetition rate 10 Hz

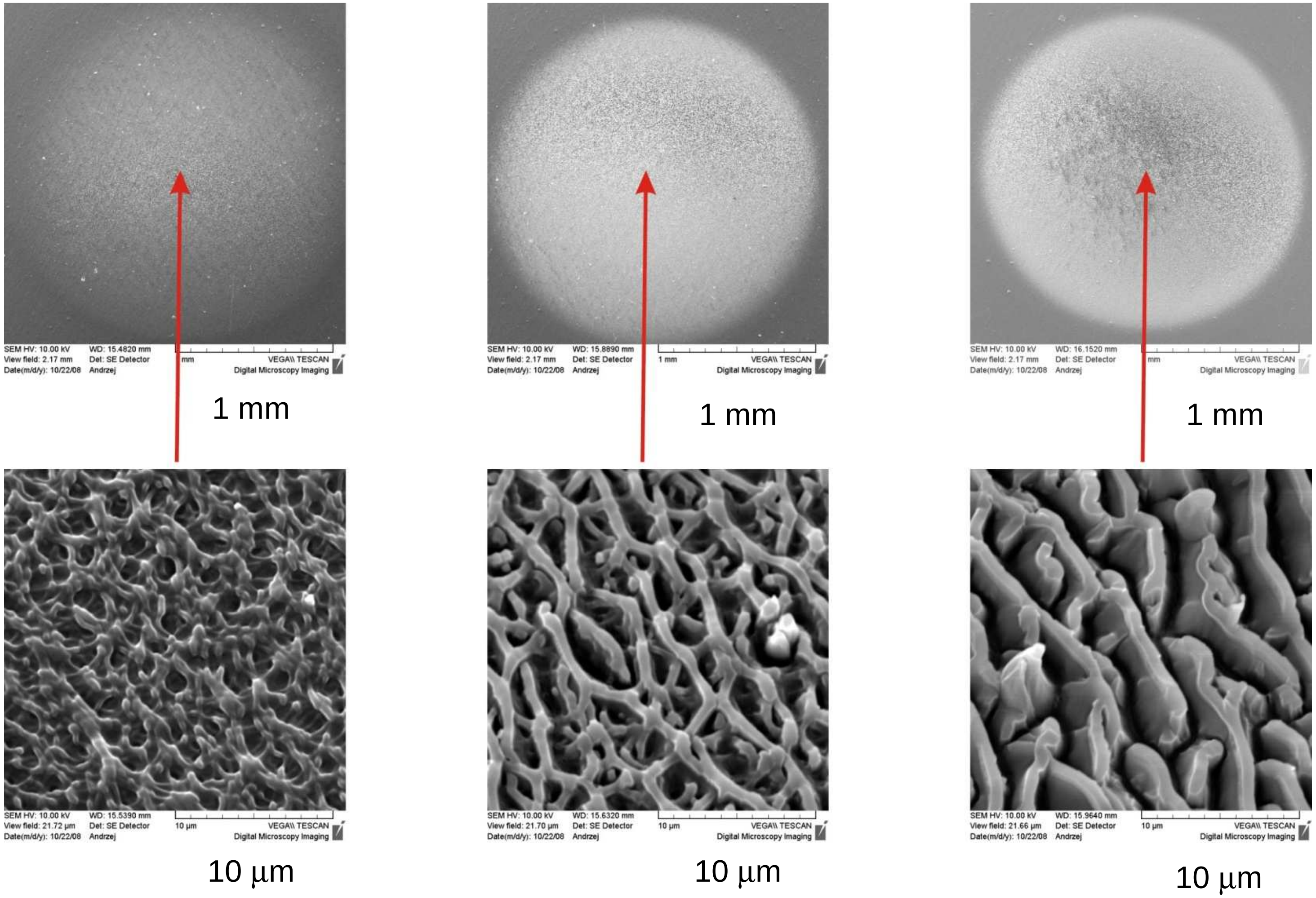


Irradiation in a focal plane

Irradiation 6 mm behind a focal plane

Polyvinyl fluoride (PVF)

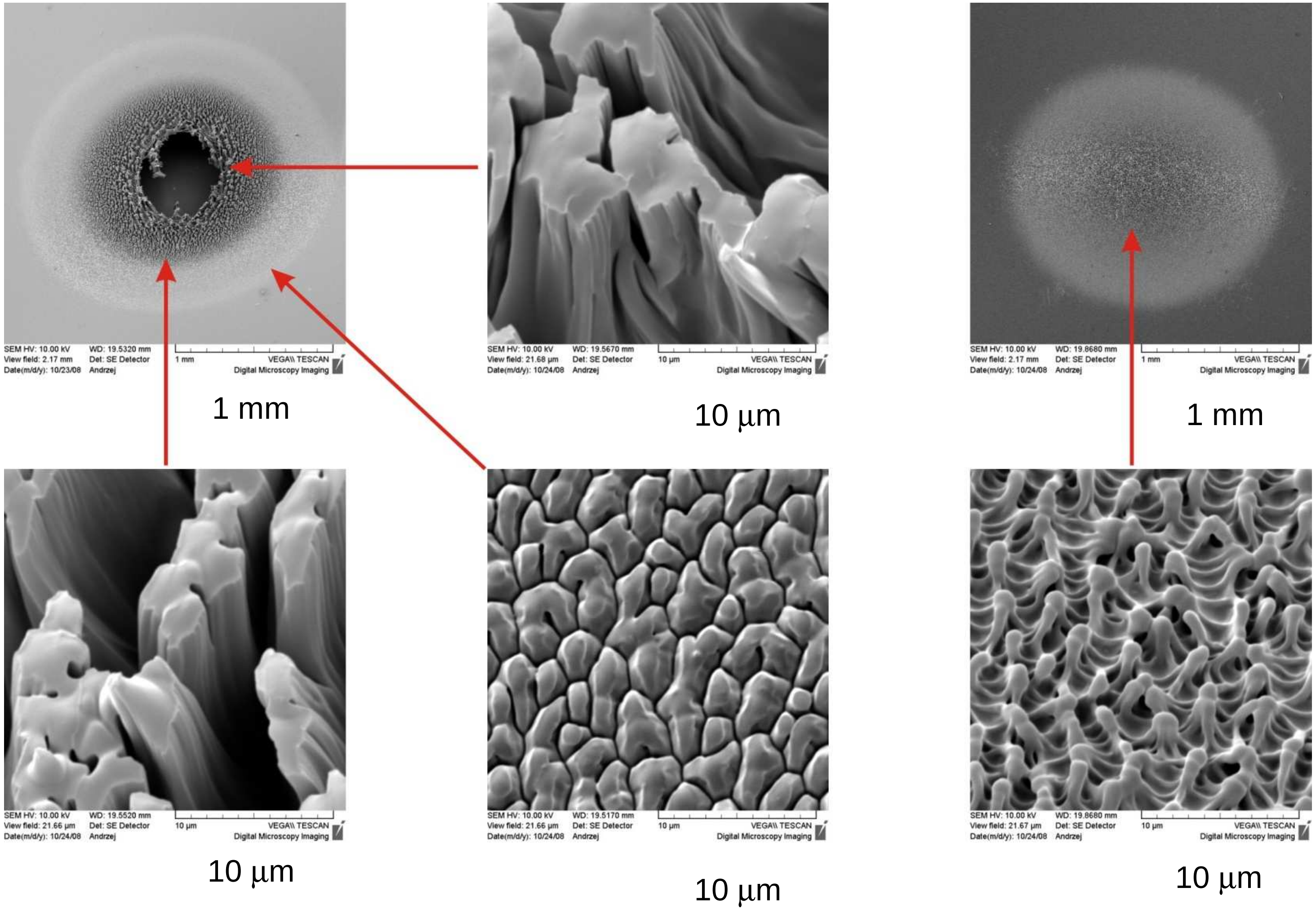
SEM images of PVF irradiated 3 mm behind the focal plane of Mo coated ellipsoidal collector, Xe plasma radiation, repetition rate 10 Hz



5 s exposure | 10 s exposure | 30 s exposure

Polystyrene (PS)

SEM images of PS irradiated in the focal plane of Mo coated ellipsoidal collector, Xe plasma radiation, repetition rate 10 Hz

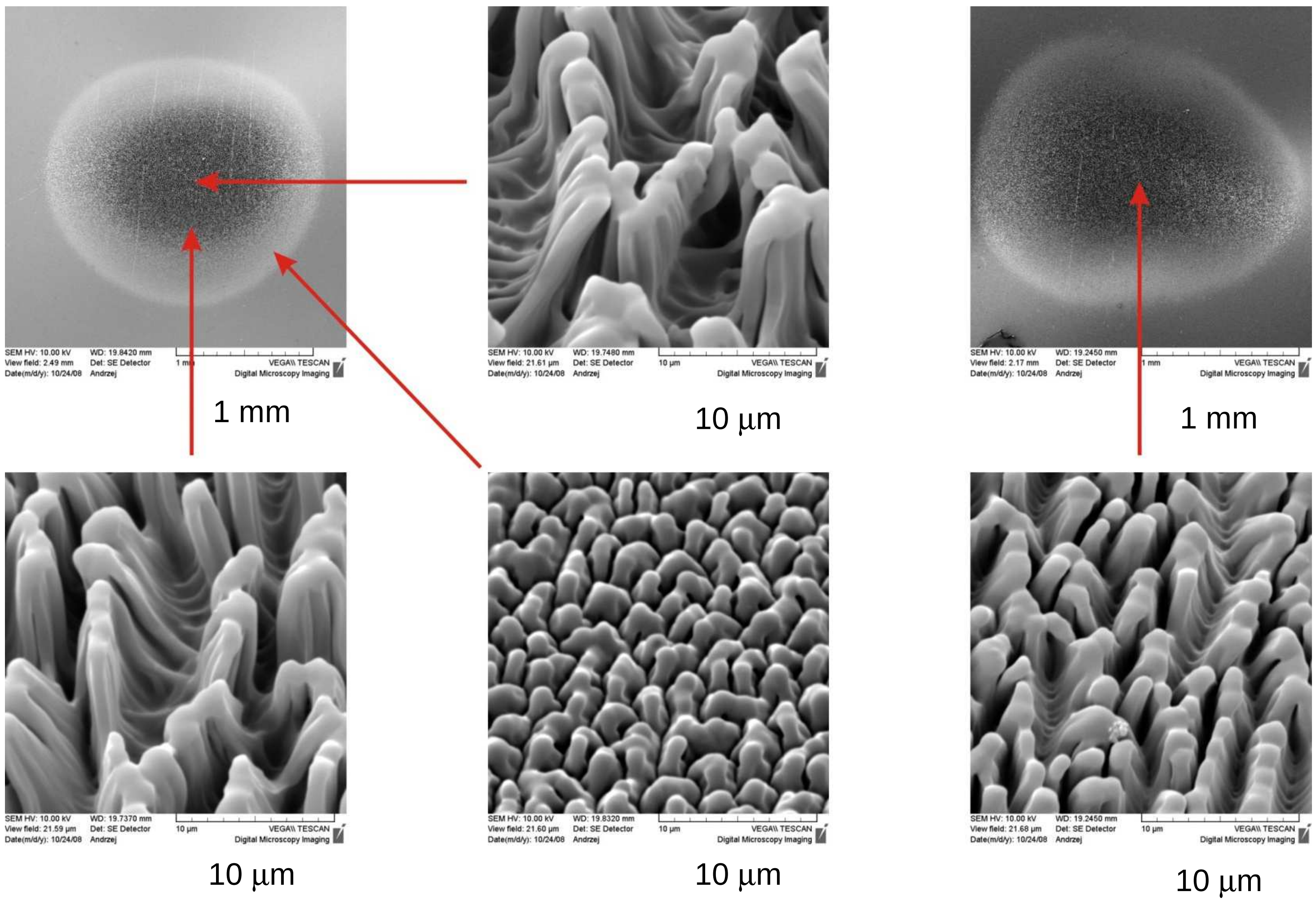


1 min exposure

2,5 s exposure

Polystyrene (PS)

SEM images of PS irradiated behind the focal plane of Mo coated ellipsoidal collector, Xe plasma radiation, 10 s exposure, repetition rate 10 Hz

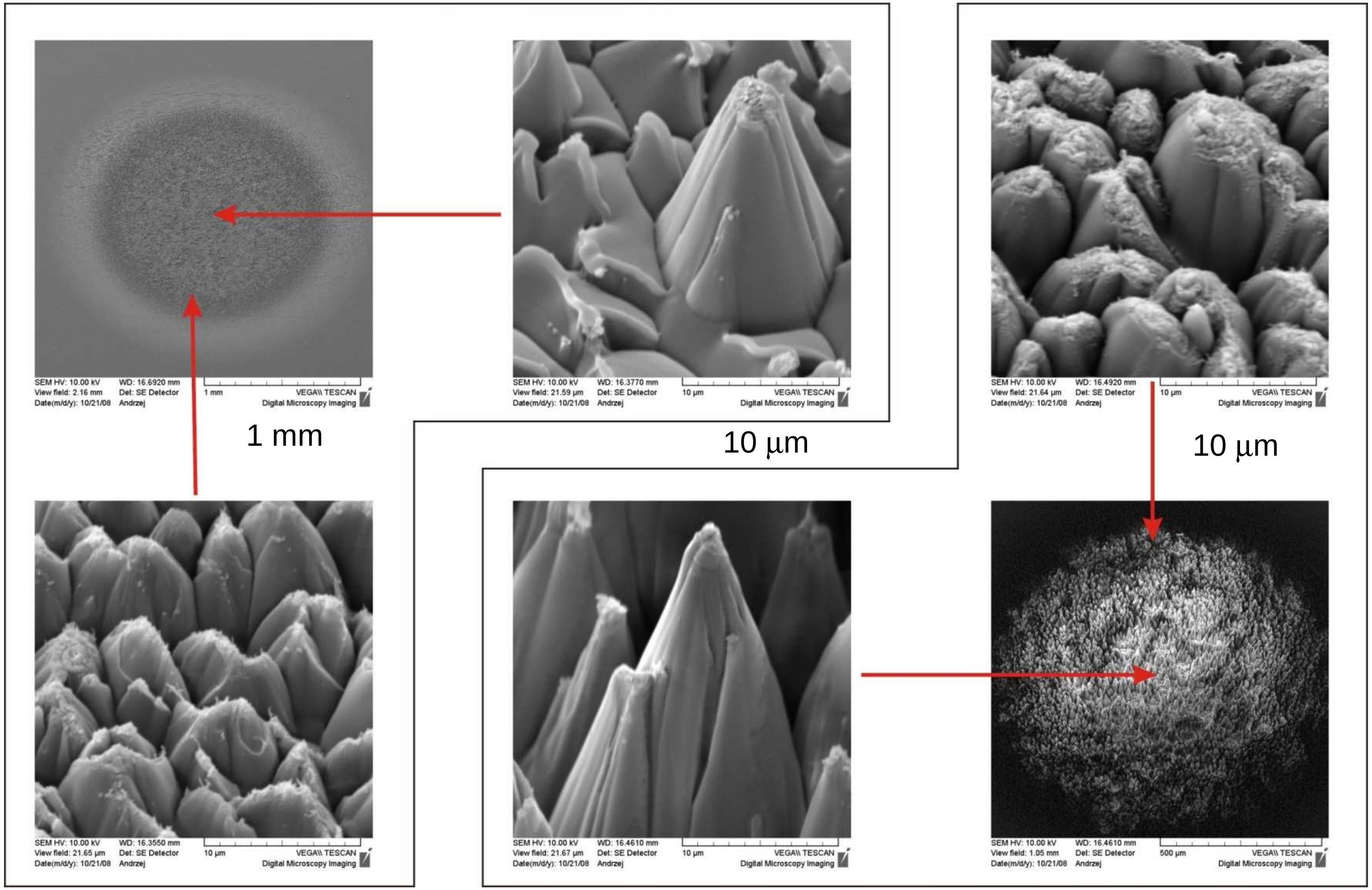


3 mm behind a focal plane

5 mm behind a focal plane

Polyethylene terephthalate (PET)

SEM images of PET irradiated in the focal plane of Mo coated ellipsoidal collector, Xe plasma radiation, repetition rate 10 Hz



10 μm
1 min exposure

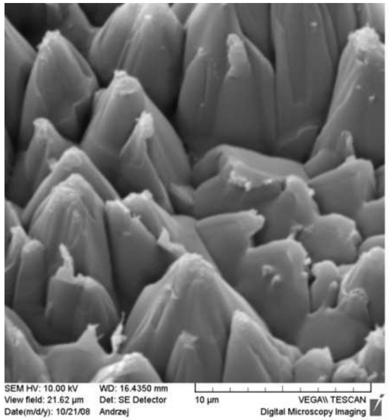
10 μm
2 min exposure

500 μm

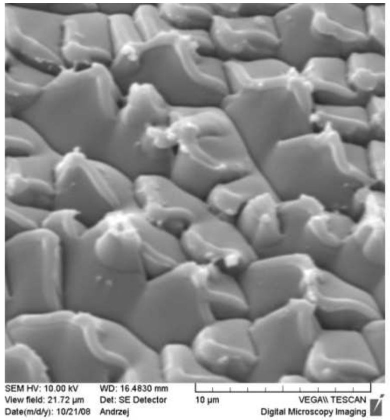
Polyethylene terephthalate (PET)

SEM images of PET irradiated behind the focal plane of Mo coated ellipsoidal collector, Xe plasma radiation, repetition rate 10 Hz

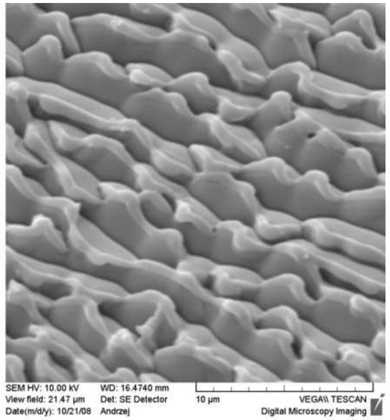
Central part



10 µm

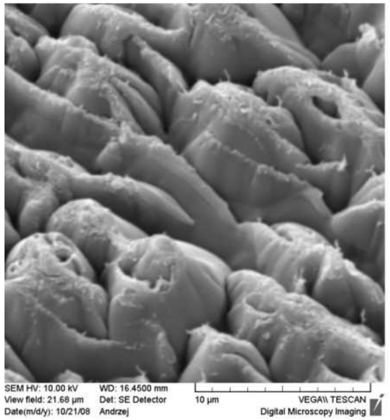


10 µm



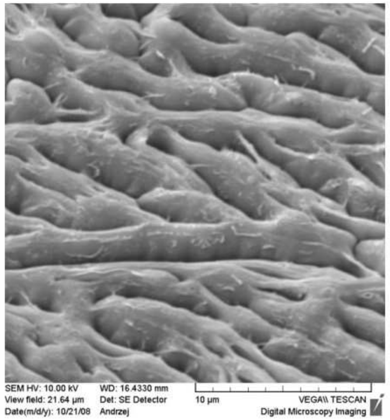
10 µm

Close to an edge of the focal spot



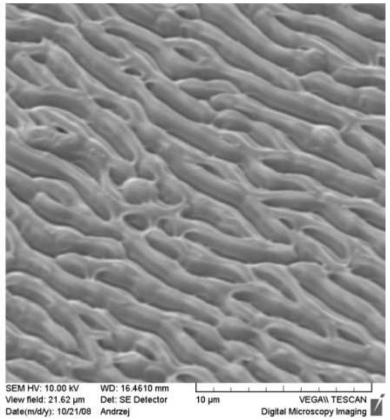
10 µm

1 min exposure



10 µm

30 s exposure

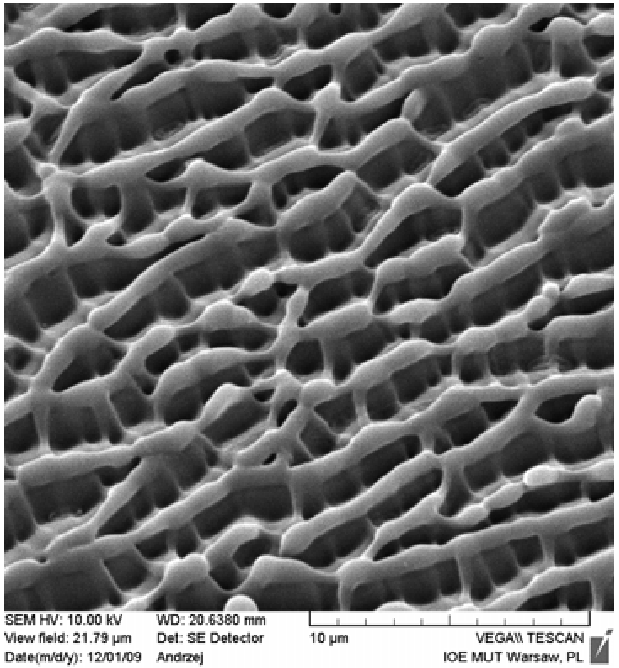


10 µm

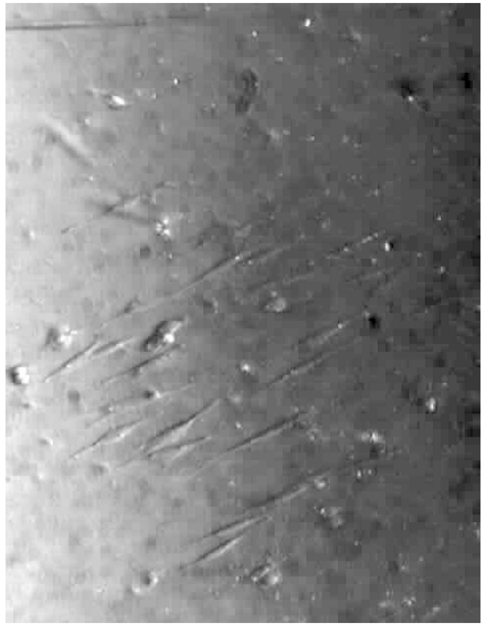
10 s exposure

CHO cells at EUV irradiated PET

SEM



Phase Contrast Microscope

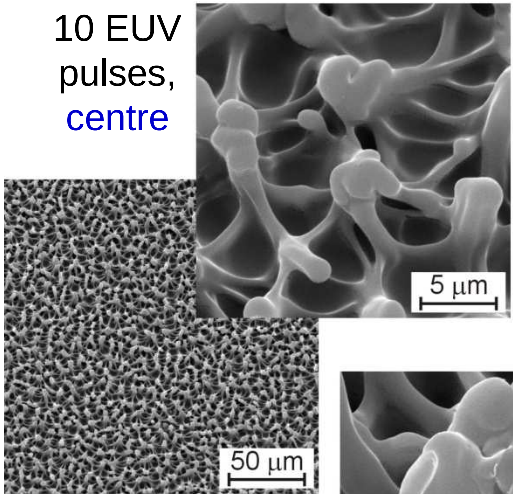


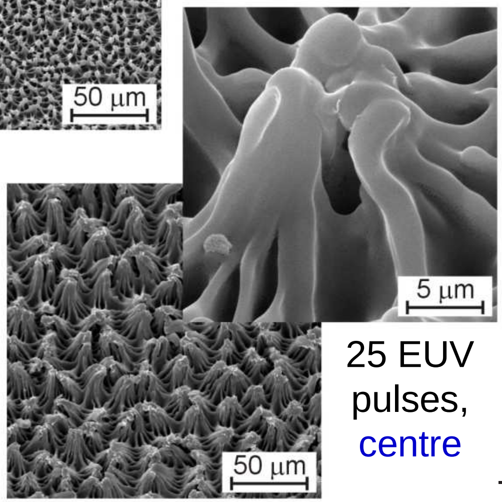
- EUV-induced wall- type structures at PET with dimension in the micrometer range were observed,
- good alignment of Chinese hamster ovary (CHO) cells along the direction of the walls was found,
- CHO cells showed only bad adhesion at the irradiated surfaces and no alignment for samples irradiated with UV laser at 193 nm,
- chemical surface modification is more pronounced for EUV irradiation.

Self-organized microstructures

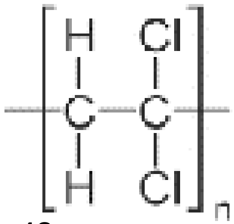
Polyvinylidene chloride, PVDC

10 EUV pulses, centre



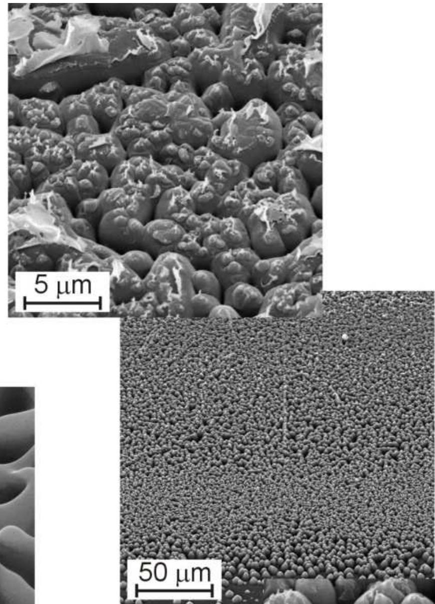


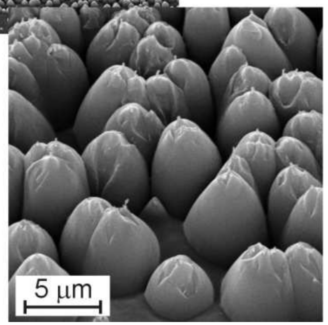
25 EUV pulses, centre

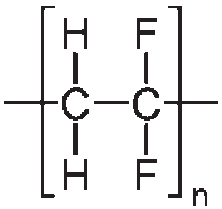


Polyvinylidene fluoride, PVDF

300 EUV pulses, 1 mm from the centre



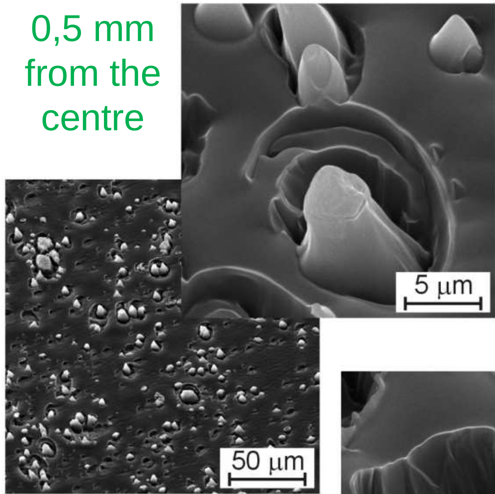




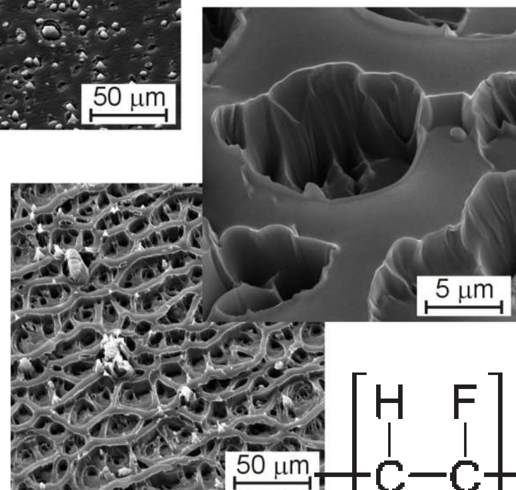
Polyvinyl fluoride, PVF

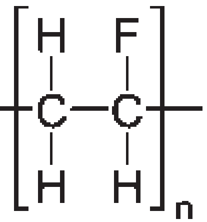
300 EUV pulses,

0,5 mm from the centre

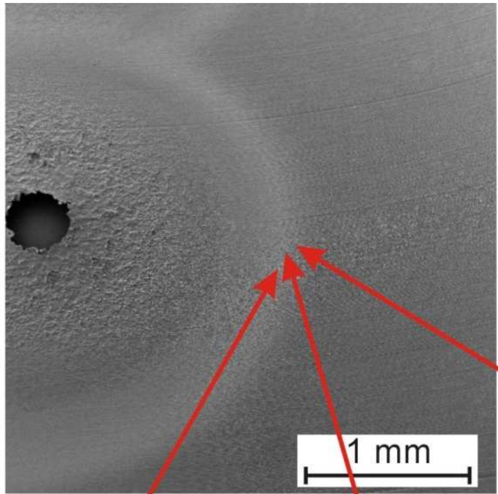


centre



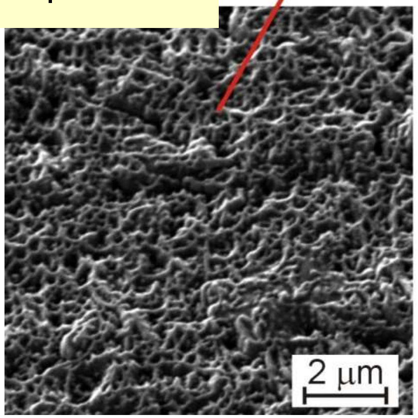


Self-organized nanostructures, PTFE

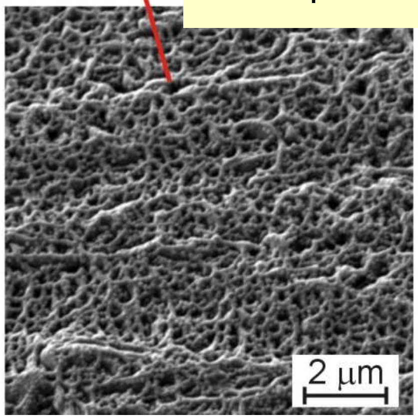


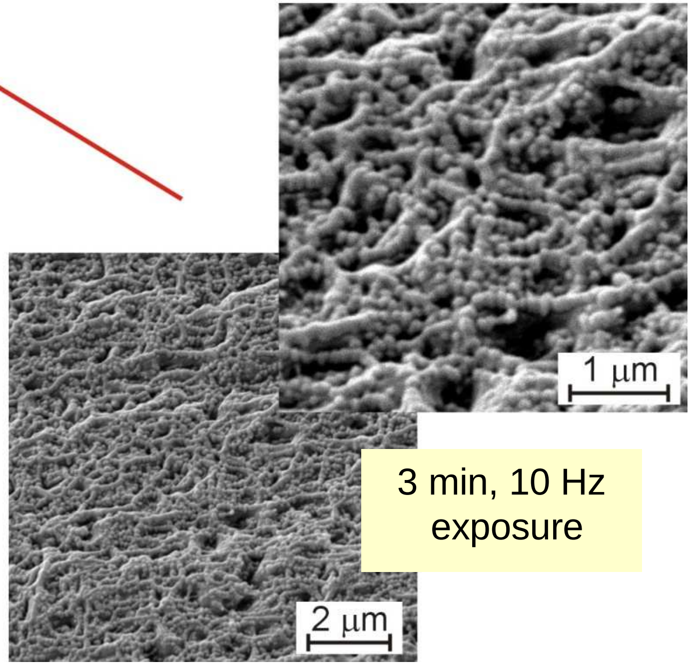
Nanostructures are formed 1.5 mm from the centre of the interaction region for fluence below 10 mJ/cm^2. No signs of melting, probably preferential dry etching leading to formation of nanofibres with variable diameter.

2 min, 10 Hz exposure



2,5 min, 10 Hz exposure

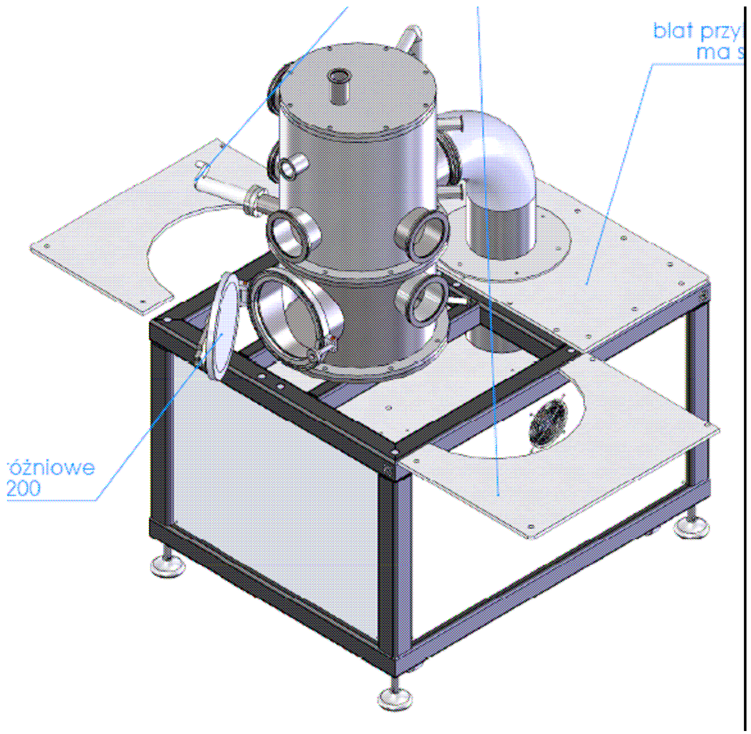




3 min, 10 Hz exposure

Laser plasma EUV source for modification polymers

The instrument designed at the **Institute of Optoelectronics MUT** has been built in co-operation with **PREVAC** – leading in Europe producer of vacuum instruments

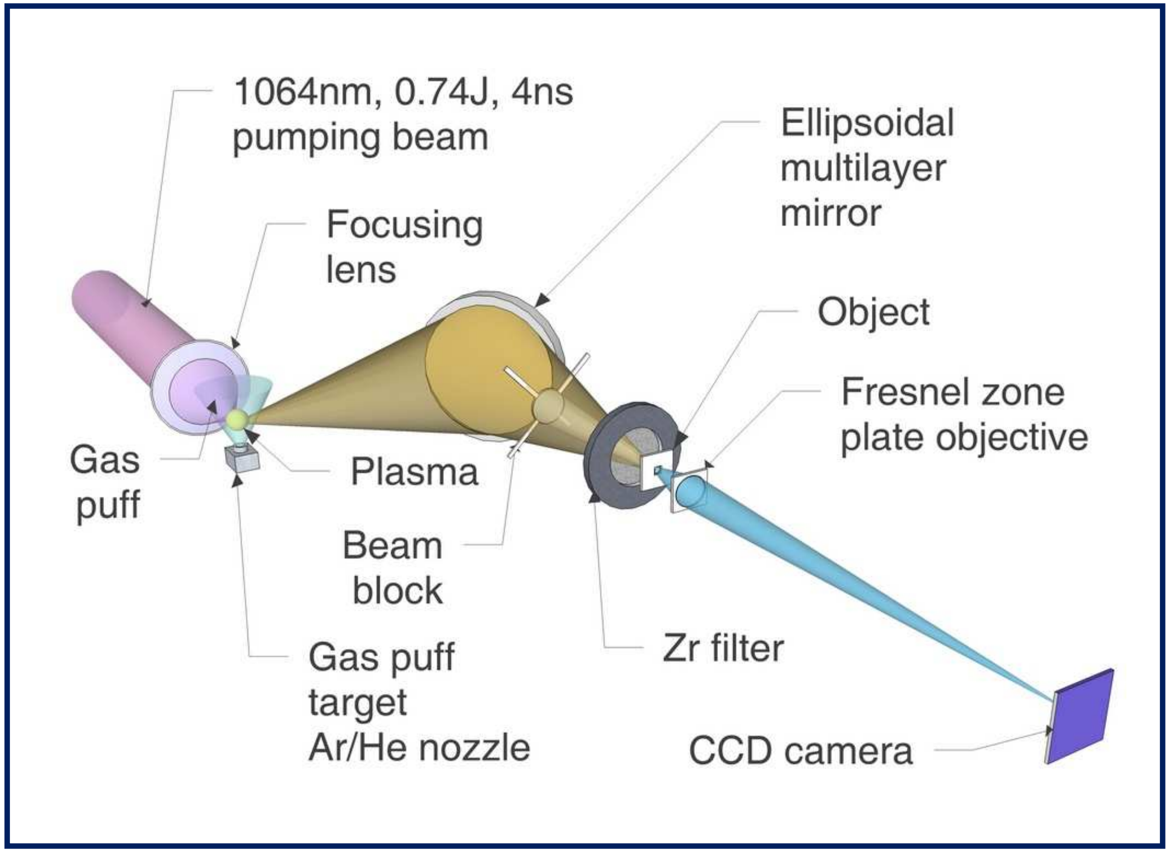


PREVAC PRECISION & VACUUM

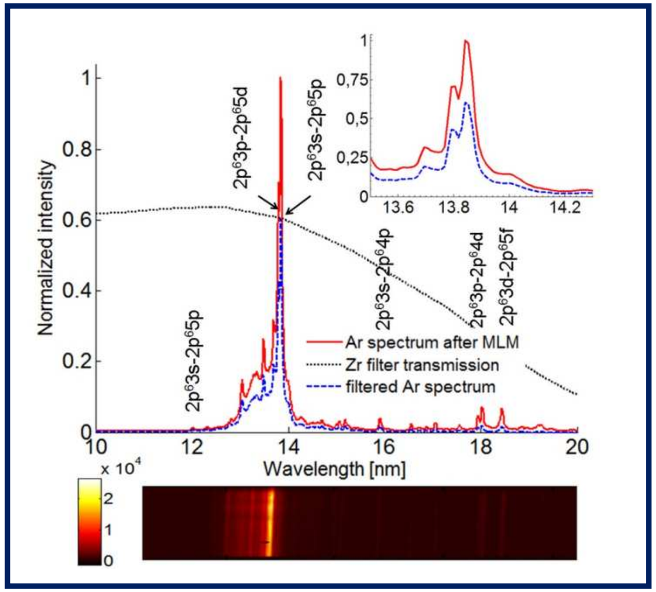
EUREKA

NANOIMAGING USING LASER PLASMA EUV SOURCE

Scheme of the EUV microscope based on a Fresnel optics



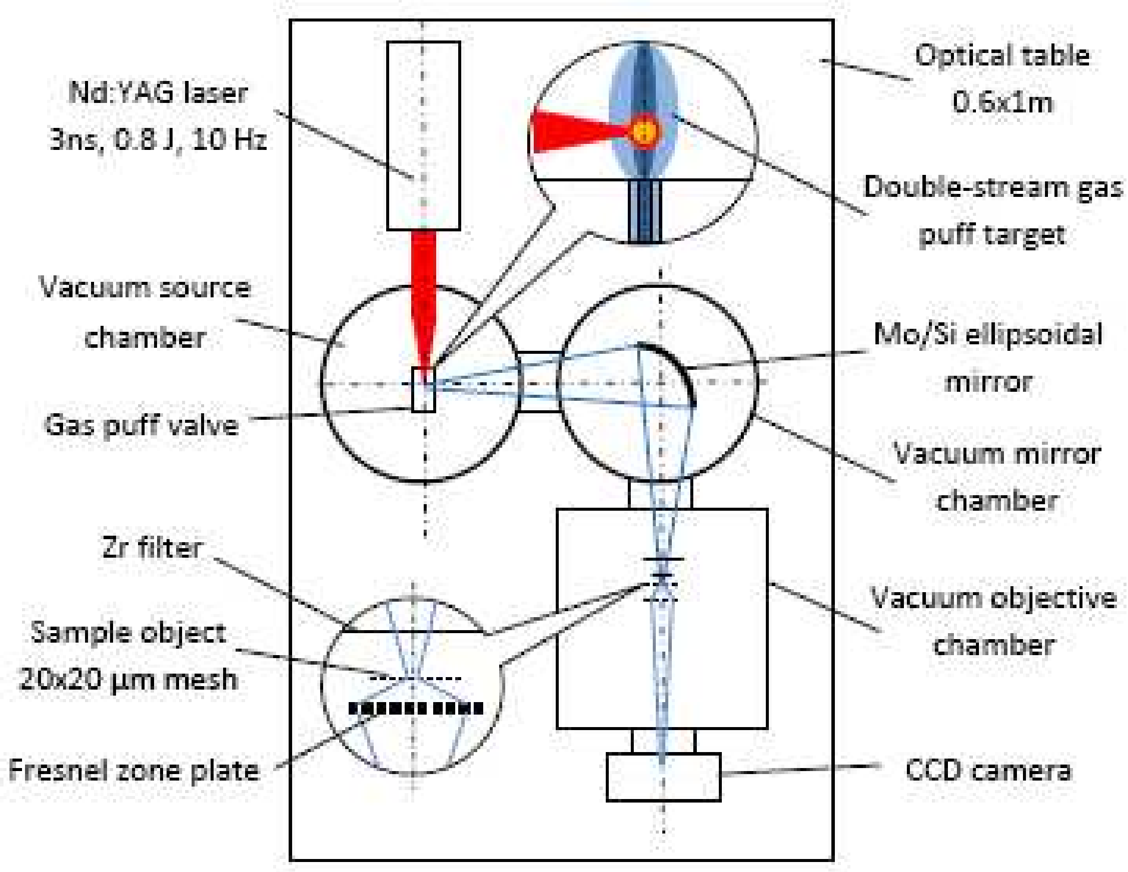
Quasi-monochromatic EUV emission



Photon flux ~8.8 x 10^{10} photons at λ=13.84nm.

NANOIMAGING USING LASER PLASMA EUV SOURCE

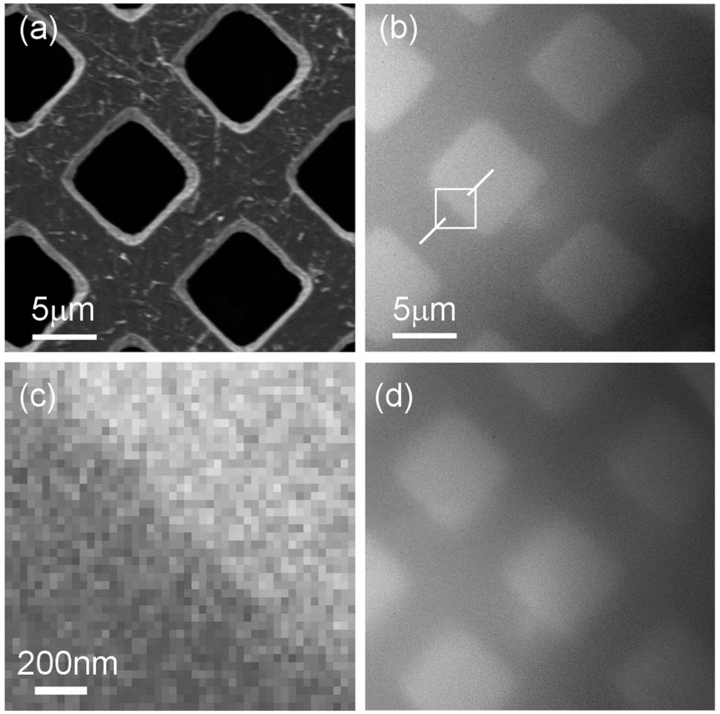
Experimental setup of the table-top EUV microscope



NANOIMAGING USING LASER PLASMA EUV SOURCE

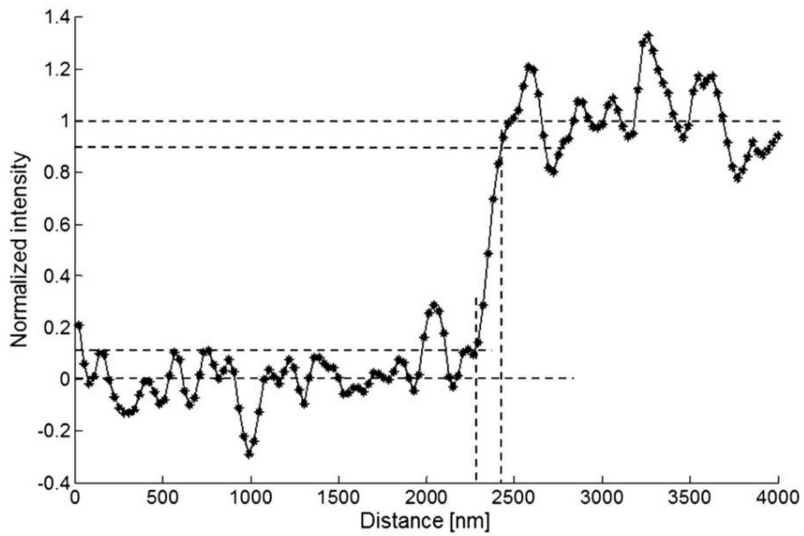
Sub-70nm resolution table-top microscopy at 13.8 nm using a compact laser-plasma EUV source

(a) SEM image of the copper mesh
(b) EUV microscope image of the mesh



(c) magnified EUV image
(d) defocused EUV microscope image

Knife-edge test for EUV image



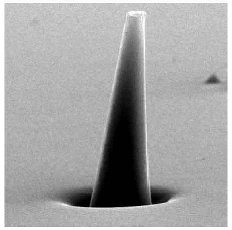
The estimated 10 to 90% intensity transition across the sharp edge is equal to 138.5nm (5 image pixels).

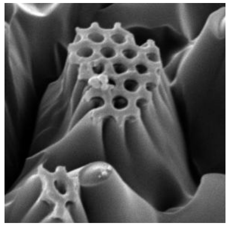
This corresponds to a half-pitch spatial resolution of the microscope equal to 69.4+/-4.0nm.

P. Wachulak et al. *Optics Letters* – submitted (2010)

CONCLUSIONS

- a compact **laser plasma EUV source** based on a gas puff target was introduced,
- **micro- and nanoprocessing polymers** using the laser plasma EUV source was demonstrated
- preliminary investigations on **modification of polymer surfaces** using EUV have been performed,
- laser plasma **EUV source dedicated for processing polymers** was developed,
- **EUV microscope at 13.8 nm** based on a Fresnel optics have been proposed,
- **sub-70nm resolution** was demonstrated.





ACKNOWLEDGEMENTS

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Laser-Matter Interaction Group

http://www.ztl.wat.edu.pl/zoplzm

Laser-Matter Interaction Group
Institute of Optoelectronics
Military University of Technology

Military University of Technology
Institute of Optoelectronics
Laser Technology Section

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IOE WAT 49 budynek

Laser-Matter Interaction Group

The goal of the Laser-Matter Interaction Group is to develop short wavelength sources based on laser-matter interactions for applications in nanotechnology, solid state physics and material science among others.

Currently LMI group consists of nine researchers including one professor, six doctors and one master of science.

The group develops new methods of generating a short wavelength (soft X-ray and EUV) radiation based on the interaction of a laser light with the matter. Such a radiation is emitted from high temperature plasma generated by exciting the medium by a focused laser light.

As a result of research, conducted over many years by the LMI group, an appropriate medium for efficient EUV generation - gas puff target, was developed.

The efficient EUV/SXR generation at different wavelengths with different intensities is possible by changing the parameters of the gas puff target, especially changing the gasses used as a medium and the parameters of the laser pulse. As a result of the previous projects a laser-plasma EUV source based on a double stream gas puff target was developed which is capable of operating with a repetition rate of 10Hz.

Monday
April 12, 2010

Students!

FNP
International Doctoral Studies under the Foundation for Polish Science MPD Programme (under evaluation)

Visitors:
02162
Since March 24th, 2009

International PhD Program ALTech

The Institute of Optoelectronics, Military University of Technology in Warsaw has established the **International PhD Program "Advanced Laser Technologies for Material Science and Engineering, Health and the Environment (ALTech)"** to offer an unique interdisciplinary platform for PhD training at the IOE and its foreign partners. The Program will be funded by the **Foundation for Polish Science.** The ALTech Program will start in September 2010 and finish in June 2015.

Under the Program 20 PhD projects will be realized.

- Tunable, mid-infrared lasers based on transition metals (Cr , Fe) doped semiconductor crystals.
- High peak power holmium laser based on hybrid technology.
- Ceramic lasers based on yttrium aluminum garnets.
- Near and mid-infrared photonic fiber lasers.
- Resonantly pumped, 'eye-safe' erbium lasers.
- Tunable mid-IR a ZGP optical parametric oscillator.
- Pulsed fiber laser sources operating in the "eye-safe" wavelength range.
- High repetition rate, Q-switched Er-doped laser operating at 3 μm wavelength range.
- Investigation of the interaction of the middle infrared pulsed lasers with biological-like media.
- **X-ray contact and projection microscopy using a compact laser plasma X-ray source.**
- **Imaging with nanometer resolution using a compact laser plasma EUV source based on a gas puff target.**
- **Nanoengineering of diffractive optics for soft X-rays and EUV.**
- **Micro- and nanomachining of polymers using wide band EUV radiation and UV lasers.**
- **Modification of physical and chemical properties of polymer surfaces by extreme ultraviolet (EUV), ultraviolet (UV) and laser plasma treatment.**
- **Analysis of decomposition process of polymers irradiated with EUV pulses using mass spectrometry.**
- **Generation of coherent EUV radiation using high-intensity femtosecond lasers.**
- **Generation of ultra-short X-ray pulses for pulsed diffractometry using high-intensity femtosecond lasers.**
- Numerical simulation and experimental studies of laser shock processing materials.
- Deposition of silicon carbide (SiC) thin films by hybrid pulsed laser deposition (PLD).
- Fabrication of a membrane-electrode assembly for fuel cells using the hybrid pulsed laser deposition method.

Short-term Training in Laser Plasma Soft X-ray and EUV Sources

Training in Laser Plasma Short Wavelength (Soft X-rays and EUV) Sources

Call for applications for short-term training visits at the Institute of Optoelectronics, Military University of Technology, Warsaw, Poland

Local Organizer: Institute of Optoelectronics (IOE)
Research Group: Laser-Matter Interaction (LMI) Group
Number of participants: 1 researcher at the time
Training duration: 1 to 4 weeks

Detailed programme and aim of the Training:

This short-term scientific visit is intended to teach or to increase the experience of the potential User on the laser plasma extreme ultraviolet (EUV) and soft X-ray (SXR) sources based on a gas puff target. The aim of the Training is to improve the experimental skills and competencies of the European PhD students and young scientists in the area related to the laser plasma EUV/SXR gas puff sources and their applications. The main goal is to increase the User's interest in the laser plasma gas puff type sources, start the domestic and international collaboration and develop a community of Users. Training action will cover seminars introducing to the topics prepared by the IOE staff and participation in the experiments performed at the LMI laboratories. It is possible for the Users to propose their own experiments with the use of the sources available at the IOE. It is also expected, that the User will give a short seminar presenting his/her research as well. During the Training we offer the scientific and technical assistance, access to the research infrastructure, accommodation and meals at the university guest house. The support for the Training will be granted on the basis of application which will be evaluated by internal and external experts. User applications should include a C.V. with a list of publications, short motivation and statement on how the Training will help to enhance User's own research programme, a recommendation letter and description of the experiment proposal, if applicable. Applications are accepted from researchers or teams located in the European countries.

How to apply: Please complete the application form (form) and create a single pdf-file. Please send this file to the following email address: wachulak@gmail.com

Remarks:

We would like to encourage to participate in the Training, since we already have the experience in organizing similar short-term scientific visits performed in the frame of bilateral international co-operations and under the COST Action MP 0601 Short Wavelength Laboratory Sources (Training School on "EUV Optics and Technology" and Short Term Scientific Missions).

For further details on the experimental capabilities and research opportunities please visit Institute of Optoelectronics website: http://www.ioe.wat.edu.pl/ and Laser Matter Interaction Group website: http://www.ztl.wat.edu.pl/zoplzm/index_eng.html. For more information regarding the Training and technical assistance in completing the application, please contact:

Contact:

Przemyslaw Wachulak, Ph.D.
e-mail address: wachulak@gmail.com
phone number: +48(22)6839540
fax number: +48(22)6668950

Andrzej Bartnik, Ph.D.
e-mail address: abartnik@wat.edu.pl
phone number: +48(22)6839612
fax number: +48(22)6668950

LASERLAB EUROPE: User application for Training in Laser Plasma Short Wavelength (Soft X-ray and EUV) Sources

PART 1: General information	
Family name:	
First name:	
Year of birth:	
Status: (engineer (ENG), PhD student (PhD), post-doctoral researcher (PDOC), experienced researcher (EXP)	
Affiliation (Name and address of home institution, web page):	
E-mail:	
Phone and fax numbers:	
Proposed term of the visit:	

PART 2: Information about the applicant's expertise and interests
Short CV of the applicant:
A list of 5 recent publications:
Motivations:

PART 3: Description of the proposed experiment (if applicable)
Give a brief summary of the proposed experiment with a list of objectives and goals. Present the proposed experimental method and working plan.