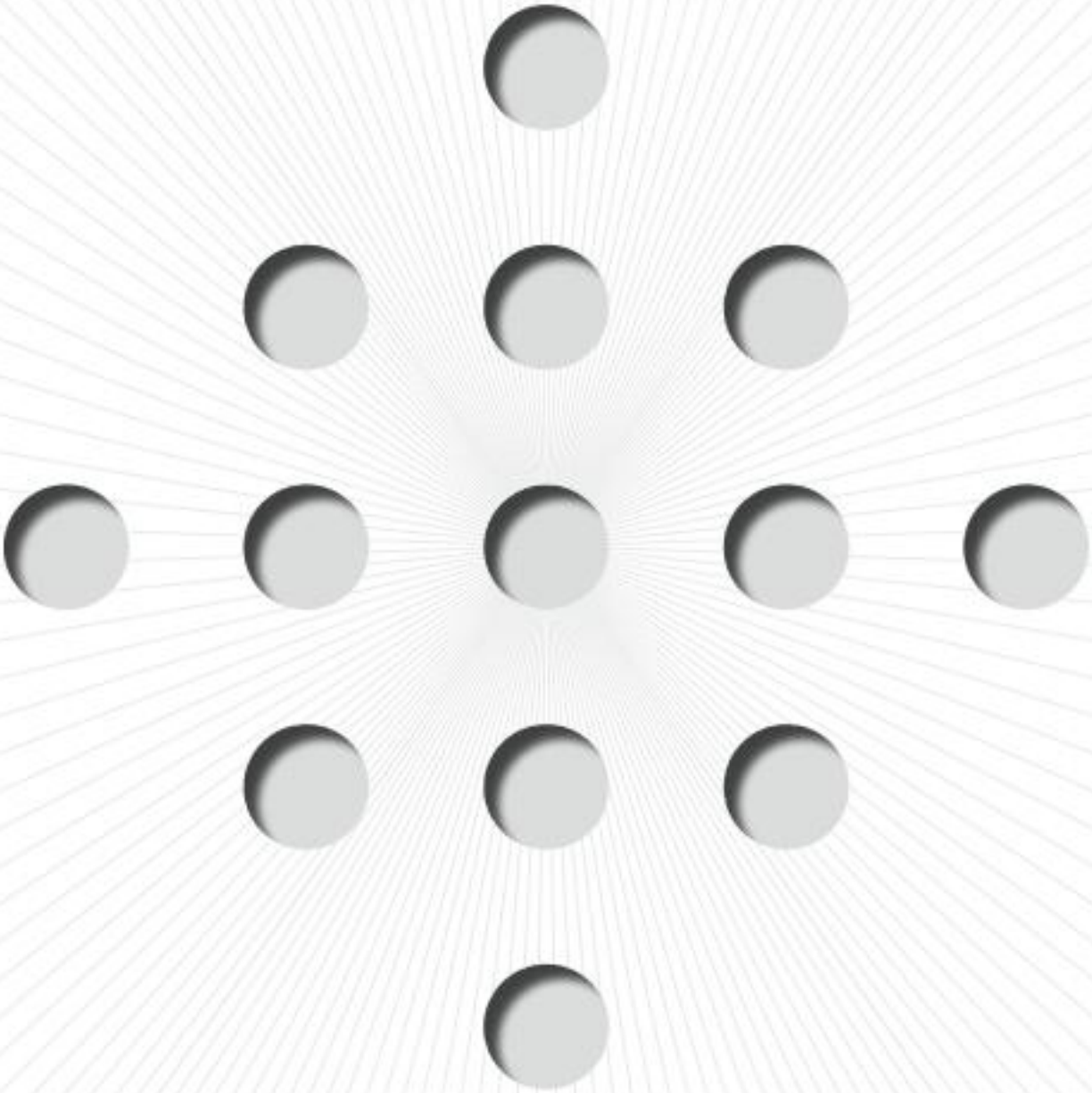
FemtoFAB

Femtosecond laser micromachining system

Workshop of Photonics



Konstitucijos ave. 23C
LT-08105 Vilnius, Lithuania

tel. +370 5 272 57 38
fax +370 5 272 37 04

info@wophotonics.com
www.wophotonics.com

Workshop of Photonics

INTRODUCTION

FemtoFAB is designed for micromachining research and production with femtosecond laser for fast and precise microfabrication in 3D space for industrial applications. Feasibility studies can be carried out to solve your unique micromachining needs.

CONTENTS

I. SYSTEM FEATURES

Femtosecond technology

Femtosecond pulses offer great advantages over the nanosecond and picosecond pulses in their ability to deposit energy into a material and remove or modify it in a very short time period, before thermal processes can occur. As a result – the heat affected zone can be reduced significantly. Also the high peak intensities of femtosecond pulses make new kinds of laser-matter interactions possible. Smaller feature sizes, greater spatial resolution, and better aspect ratios can hence be achieved.

High speed

High power (up to 10 W) Yb:KGW (1030 nm) femtosecond laser system with variable pulse repetition rate from 1 to 1000 kHz in combination with galvanometer scanners offers significant advantages in high speed micro fabrication.

Nanometer resolution

High resolution object positioning system (XYZ Aerotech linear stages) synchronized with laser beam positioning system (galvanometer scanners) and pulse picker gives full control in space, time and energy domains, allowing to fabricate difficult objects with sub-micron resolution and repeatability.

Machine vision

Machine vision system composed of high resolution camera which is calibrated with Aerotech linear stages.

System Control Application (SCA)

The main SCA software idea is to provide the ability to control different technological processes and their sequences. Main SCA software advantage is the ability to integrate and control various hardware (different manufacturers) using unified technological parameter systems.

II. LASER SOURCE

PHAROS laser source has these advantages in comparison with other commercially available femtosecond laser systems: shorter pulse duration both from oscillator (<80fs) and amplifier (<280fs); higher average power from oscillator (up to 2W on special request) and amplifier (6W); easily tunable repetition rate; laser control and monitoring from a PC including control of a pulse duration; laser is designed according to industrial standards, which assures higher stability and reliability.

Laser with amplifier specifications:

- Wavelength 1030 nm
- Average power 6 W
- Tunability of pulse repetition rate – 1 to 1 MHz
- Computer controllable pulse duration in the range of <280 fs – 10 ps
- Max pulse energy – 1 mJ (pulse repetition rate dependant)
- Output stability < 1% rms
- Beam quality M2<1.2
- Pulse Picker
- Broad range of frequency conversion options: harmonic generators (SH, TH, FH)

Laser oscillator specifications:

- Power >1W (with scaling possibility up to 2W on special request)
- Pulse duration <80 fs
- Repetition rate 76MHz

III. POSITIONING SCANNING SYSTEM

Flexible positioning scanning system provides 6 axis of freedom for fast and precise fabrication. It enables to use advantages of femtosecond laser with maximum efficiency. System consists of 3 axis for object positioning, 2 axis for laser beam scanning and another z axis for focusing lens positioning.

Open frame architecture of FemtoLab system provides high flexibility for easy configuration and upgrade. This is advantageous for scientific and R&D activities, where it is necessary to add some additional components and modify the system. Scanning positioning system is coupled with the laser in such a way that it enables to change laser source easily.

Laser and scanning positioning system requires vibration isolated optical table with minimal dimensions of 1000 x 2000 mm.

XYZ stages for object positioning are mounted on a granite base. Beam delivery and XYZ scanning system is assembled on optical mounting plate, situated on top of the granite base.

Three axis system

- Three axis system for object positioning is based on Aerotech linear stages with Npaq controllers, which will fit in a 19” rack together with the laser power supply. Linear stages have a long travel range, high positioning accuracy speed:

Axis	**X**	**Y**	**Z**
Total Travel	150 mm	150 mm	4 mm
Resolution	0,005 µm – 1,0 µm	0,005 µm – 1,0 µm	2 nm (60 pm with A3200)
Maximum Travel Speed	300 mm/s	300 mm/s	50 mm/s
Maximum Load	12 kg	12 kg	4 kg
Accuracy	±0,3 µm	±0,3 µm	±0,2 µm
Repeatability	±0,1 µm	±0,1 µm	±50 nm
Axis orthogonal	5 arcs	5 arcs	5 arcs
Nominal Stage Weight	4,6 kg	4,6 kg	1,4 kg

- Two axis for fast and precise laser beam scanning, based on GSI Lumonics galvanometer scanners:

Clear aperture	9,5 mm
Max Scan Angle	±25° degrees, optical
Non-linearity (max)	0.08%
Operating Temperature	0-50°C
Bandwidth	>2500 Hz
Small Step Time	<300 μs
Full Step Time	<1.5 m

- Z axis for beam scanning system realized by Physik Instrumente piezo-driven microscope objective nanofocusing/scanning device. Objective is easily accessible and replaceable.

Max objective diameter	39 mm
Closed loop travel	250 μm
Closed loop resolution	0,75 nm
Closed loop linearity	0,03%
Full-range repeatability	±3 nm
Tilt (ΘX,ΘY)	6 μrad, 45 μrad
Resonant frequency	330 Hz ±20% @ 0 g 180 Hz ±20% @ 120g 140 Hz ±20% @ 200g

- Intel Pentium dual core PC with additional PCI slot for Aerotech SSAM controler.

IV. SOFTWARE

For convenient operation of the system, SCA software hides different device integration from the end user. SCA software integrates design (CAD), manufacturing (CAM) and device control functionality. We have implemented WYSIWYG (What You See Is What You Get) principle for convenient fabrication preview. The software is of modular type, so it is easy to insert new modules for new tasks and/or additional devices.

Hardware Support

SCA software supports the following hardware:

- Linear stages from Aerotech Co.Ltd. (For example ALS130-150 XY with NLdrive/Npaq controllers).
- Rotary stages from Aerotech Co.Ltd.
- Galvo scanners (GSI Group, Inc.; ScanLab AG) controlled through RTC4 (ScanLab AG) interface board via XY100 protocol. patikslinkit su Titu
- Piezo actuators from Physik Instrumente (PI) GmbH & Co. (For Ex.: P-725 with E-750 controller).
- Motorized attenuators (Altechna).

Necessary knowledge

SCA software requires different computer programming knowledge for particular operation:

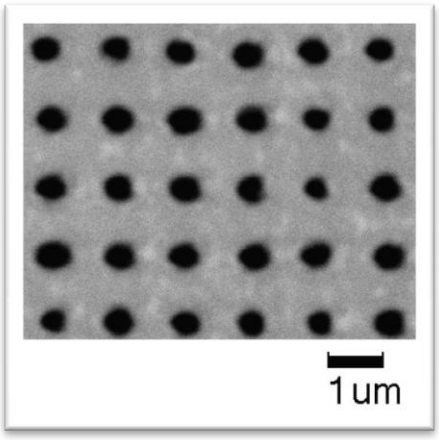
1 level - (highest knowledge) – creating, editing and updating fabrication “letters” using C++, Delfi, C#.

2 level – fabrication algorithm construction from “letters”, “words” or “sentences” created earlier, – simple fabrication algorithm creation and hardware configuration (requires knowledge in hardware used).

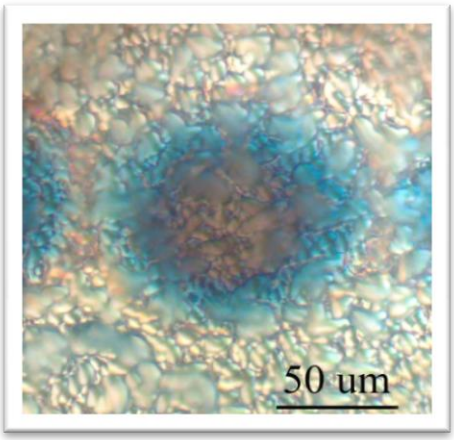
3 level – load saved fabrication and hardware parameters - requires only basic PC knowledge.

V. EXAMPLES

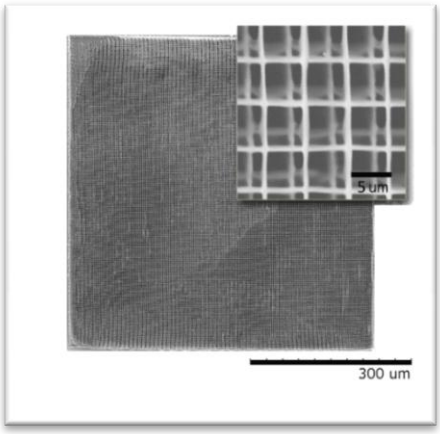
Sapphire bulk machining



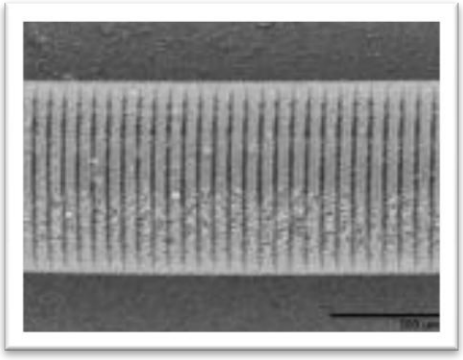
Submicron patterning



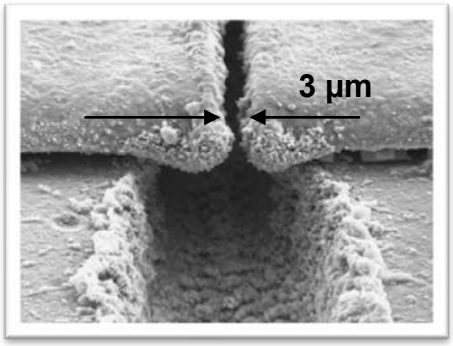
SiNx, SiO2 selective ablation



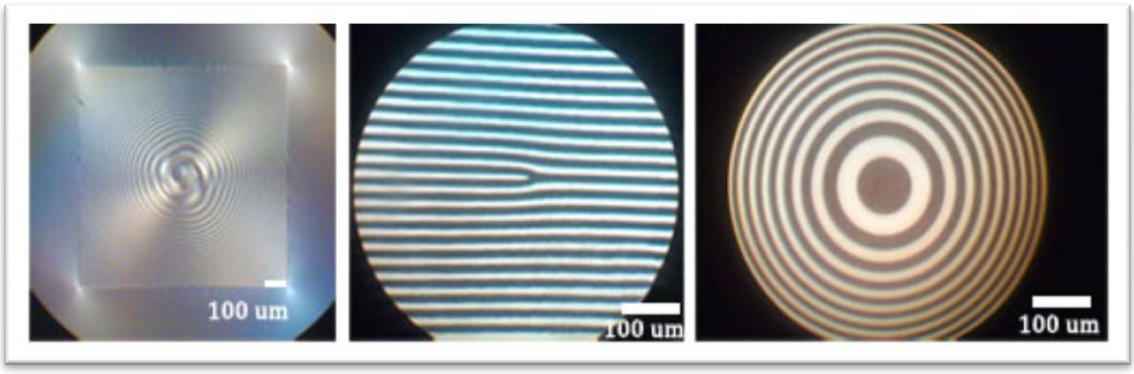
Micro- and nano-
structuring using mPP



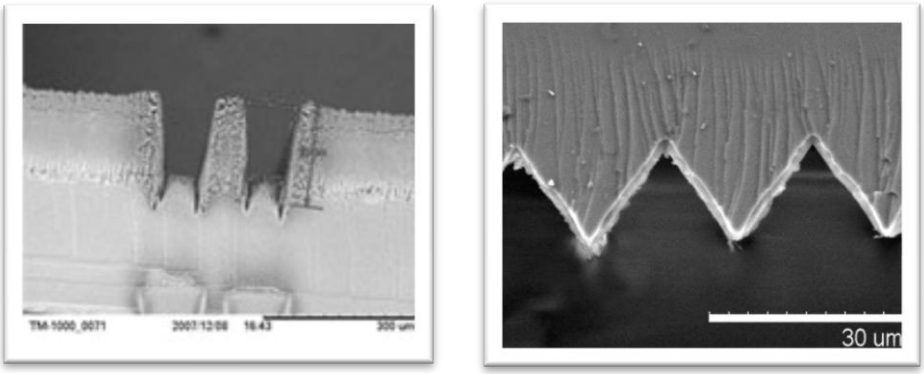
Writing of Bragg gratings
and waveguides



Precise cutting



Diffractive Optical Elements (DOE) fabrication



Silicon cutting for selective etching

VI. MAINTENANCE COST

- Power consumption < 3 kW.
- Laser cooling water exchange approx. once in 3 months.
- Laser water filter exchange once per year.
- Laser diode bar warranty of manufacturer 20000 hours.

VII. OPERATING CONDITIONS

- Micromachining system requires vibration isolated optical table with minimal dimensions of 1000 x 2000 mm. It can be provided by Altechna on separate request.
- Electric requirements: 220 VAC, 60 / 50 Hz, 20 A.
- Operating temperature: 22±5°C,
- Humidity - non condensing.
- Typical laboratory environment (clean room not required), indoor avoiding direct sunlight.

VIII. TECHNICAL ASSISTANCE AND SERVICE

- Altechna will provide specialists for system installation and three day training for two people.
- One additional two-day visit for system testing and adjustment during first year.
- Full technical service including technical consultations will be provided, which will be available by e-mail tech@altechna.com or telephone +370-5-2725738 during working hours.
- Remote connection to the PC of FemtoFAB system available for testing and adjustment.
- In case of technical consultation or system modification required in place, visit cost of 800 € euro per day per person shall be covered by customer.

IX. WARRANTY AND TERMS

- System carries 12 months warranty after provisional acceptance under conditions of each component manufacturer (listed below).
- If the failure cannot be solved remotely, technicians will arrive in two weeks after the problem is agreed (free of charge during warranty period).
- In case of necessity, customer must return the system or its components for repair or replacement (free of charge during warranty period).

*There is a possibility to extend warranty for a laser source.

Konstitucijos ave. 23C
LT-08105 Vilnius, Lithuania

tel. +370 5 272 57 38
fax +370 5 272 37 04

info@wophotonics.com
www.wophotonics.com