University of Ljubljana
Faculty of electrical engineering

LMSE

LABORYTORY FOR MICROSENSOR STRUCTURES AND ELECTRONICS

ADVANCED MICROFLUIDIC SYSTEMS

LMSE

In the laboratory of microsensor structures and electronics (LMSE) we are the leading partner in Slovenia in the field of development and fabrication of advanced microstructures and micro-electro-mechanical-fluidics systems for use in biomedicine, pharmaceutics, chemical process engineering and energetics. We have many years of experiance in micromachining and bonding of various materials such as silicon, glass, PZT, SU8, elastomers, metals and plastics. Prototyping and microsystems optimization is supported by advanced 3D fully-coupled numerical modeling based on finite element method (FEM).

INFORMATION:

danilo.vrtacnik@fe.uni-lj.si
drago.resnik@fe.uni-lj.si

Laboratory of Microsensor Structures and Electronics LMSE

Faculty of Electrical Engineering

University of Ljubljana
Trzaska 25
1000 Ljubljana
SLOVENIA

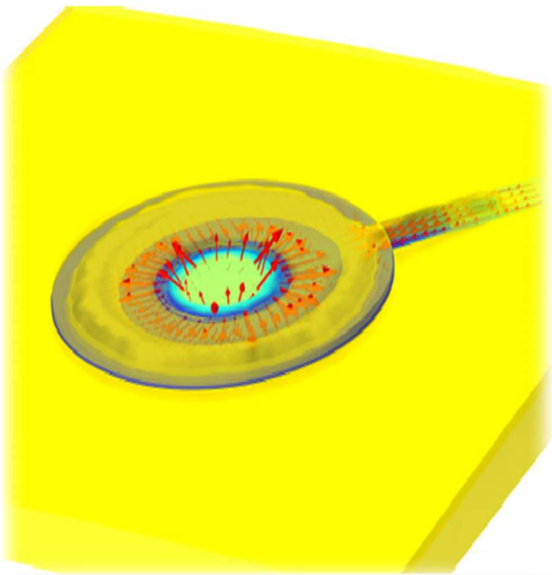
Phone: (+386 1) 4768 303
Fax: (+386 1) 4264 630
URL: http://lmse.fe.uni-lj.si

POWERFUL AND RELIABLE MICROPUMPS

Micropumps are the microfluidic system's basic elements. Due to small size, energy efficiency, low cost, high performance and reliability they are steadily spreading in all significant areas of human activities. They are being extensively used in lubrication microsystems to deliver lubricants to sensitive micromechanical parts, in cooling systems to run the coolant through hot electronic integrated circuits, in energetics to supply fuel in portable fuel cells, in medicine for subcutaneous injection of therapeutic substances, in biomedicine for manipulation of biological media in LOCS (Labs-on-chip), in chemical engineering and pharmaceutics for controlled dosing of various reagents, etc.

In LMSE, we have recently developed new types of micropumps, whose advantages lies in greater functionality, lower fabrication costs and higher performance and reliability according to the competition. Micropumps are upgraded with advanced integration of other fluidic, sensing and heating microelements to meet the requirements of dedicated applications.

Developed **mikrocylinder™ pump** features high back-pressure and flow-rate performance, bubble tolerance and self-priming capability. Innovative patented implementation offers novelties in the field of piezoelectric micropumps: **bi-directional pumping,** electrically controlled **valve regime** and **biomode operation**. In the latter case, the pump is non-destructive to sensitive biological media and suspensions of microcapsules. **Monoactuator peristaltic piezoelectric micropump (MAP™)** enables control with less expensive and simpler **single-phase controllers,** while maintaining all superior properties of conventional peristaltic micropumps (**robustness, simplicity** and **purity** due to the absence of valves).



University of Ljubljana
Faculty of electrical engineering

LMSE

LABORATORY OF MICROSENSOR STRUCTURES AND ELECTRONICS

ADVANCED MICROFUIDIC SYSTEMS

LABORATORY ACTIVITIES

Laboratory of microsensor structures and electronics (**LMSE**) is engaged in the development and investigation of silicon semiconductor devices, sensors, actuators and microelectromechanical systems (MEMS). Technological equipment in LMSE allows us to study basic semiconductor processes as well as development of active and passive discrete semiconductor devices (fotosensors, piezoresistive pressure sensors, temperature sensors, radiation sensors, 3D microstructures, etc.).

INFORMATION:

danilo.vrtacnik@fe.uni-lj.si
drago.resnik@fe.uni-lj.si

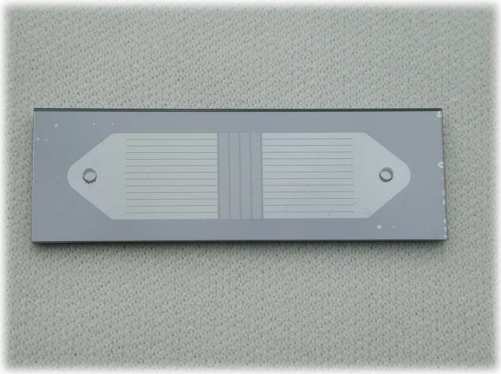
Laboratory of Microsensor Structures and Electronics LMSE

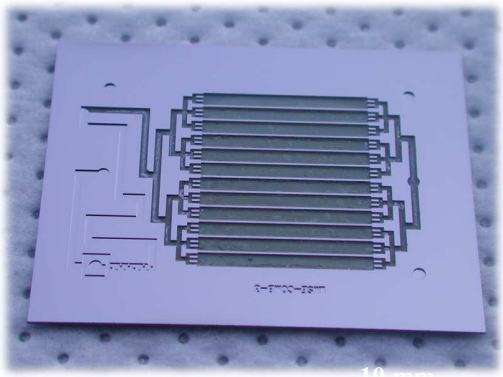
Faculty of Electrical Engineering

University of Ljubljana
Trzaska 25
1000 Ljubljana
SLOVENIA

Phone: (+386 1) 4768 303
Fax: (+386 1) 4264 630
URL: http://lmse.fe.uni-lj.si

ADVANCED BIOLOGICAL MICROFLUIDIC SYSTEMS AND CATALYTIC MICROREACTORS

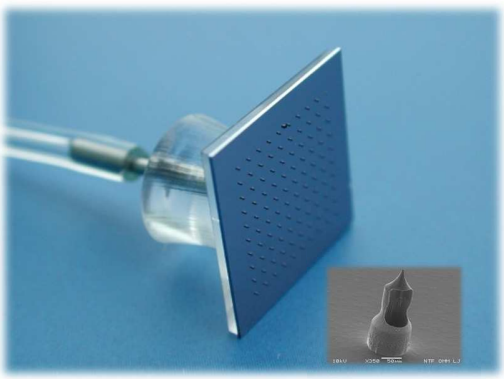




Microfluidic platforms, designed and fabricated in LMSE, are the result of many years of experience in the field of microfluidics and constant development and introduction of new technologies. Microfluidic systems consist of microfluidic elements such as mixers, separators, tanks, inlet and outlet connectors, fluid assemblies for media manipulation etc. They can also be integrated with micropumps, thin-film Pt heaters to allow temperature-controlled processes in microchannels and with thermal, optical or chemical sensors. Also uniform catalytic layers can be deposited in microchannels when required. Scope of application includes chemical engineering, biotechnology, biomedicine, pharmaceutics, etc. Microchannels are usually etched in silicon and covalently sealed with glass, allowing certain phenomena observation by optical microscopy or camera. Depending on media compatibility and operating temperature range, alternative materials such as PDMS or PMMA can be employed.

MICRONEEDLES SYSTEMS FOR MEDICAL APPLICATIONS

Administration of substances through array of microneedles is an effective alternative to the conventional administration of drugs or vaccines into the tissues (eg orally or through a hypodermic needle). Stitches are shallow (typically 100-200 µm) and painless, since the needles does not penetrate the nerve endings. Arrays of hollow microneedles have many uses in diagnostic extraction and sampling of biological media.



University of Ljubljana
Faculty of electrical engineering

LMSE
LABORATORY OF MICROSENSOR STRUCTURES AND ELECTRONICS

ADVANCED MICROFLUIDICS SYSTEMS

Technological research is supported by the measurement equipment and characterization methods. Investigations of physical phenomena and elements output characteristics are supported with analytical and computational models. LMSE offers comprehensive research and development services in the field of silicon semiconductor devices and MEMS, from theoretical analysis to the development of test structures, their characterization and optimization.

INFORMATION:

danilo.vrtacnik@fe.uni-lj.si
drago.resnik@fe.uni-lj.si

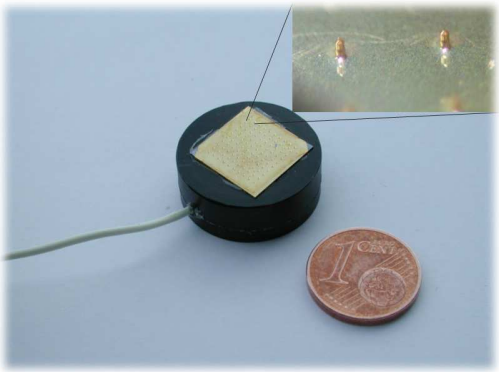
Laboratory of Microsensor Structures and Electronics
LMSE

Faculty of Electrical Engineering

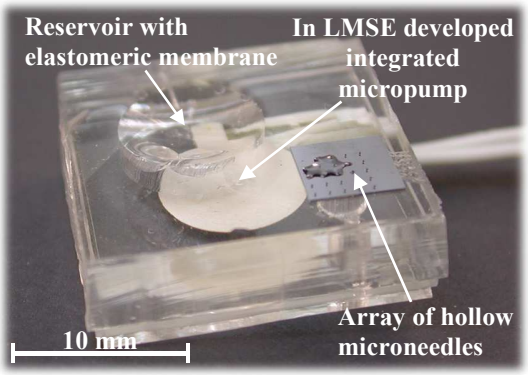
University of Ljubljana
Trzaska 25
1000 Ljubljana
SLOVENIA

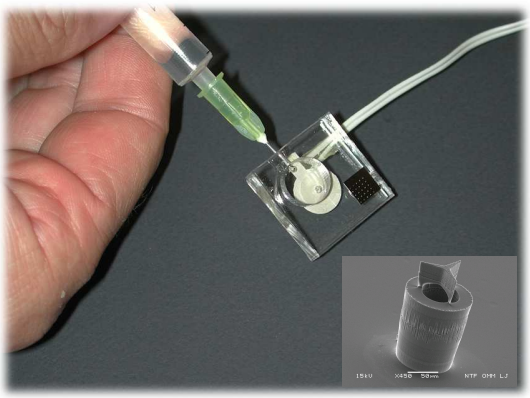
Phone: (+386 1) 4768 303
Fax: (+386 1) 4264 630
URL: http://lmse.fe.uni-lj.si

Microneedles, fabricated during DRIE process, coated with thin metallic coating (gold or platinum), may serve as electrodes for bio-impedance measurements, as they reduce contact resistance between the electrode and the tissue and improve stability during measurements. With appropriate modifications, such types of needles are appropriate for tissues activities capturing or for tissues stimulation.



MICRODOSING WEARABLE SYSTEMS FOR CONTROLED DRUGS ADMINISTRATION





Worldwide development in the field of drug administration points towards wearable, low-cost, compact and reliable disposable microdosing systems.

In LMSE, we have developed processes and innovative approaches for integration of individual microfluidic components in a compact microdosing system. Approaches are also suitable for the development of similar applications.

Presented wearable microdosing system with integrated array of hollow microneedles offers a painless, discreet, compact and easy-to-use administration of active substances. It is simply secured on the skin by a patch. For proper and accurate dosing, dedicated micropump with corresponding electronic control unit and integrated microprocessor is adopted.

University of Ljubljana
Faculty of electrical engineering

LMSE
LABORATORY OF MICROSENSOR STRUCTURES AND ELECTRONICS

ADVANCED MICROFLUIDICS SYSTEMS

We also provide a partial research and development services such as process steps modeling, semiconductor devices and microfluidics systems modeling, measurement and characterization as well as individual technological process steps (photolithography, diffusion, metallization, micromachining, etc.).

INFORMATION:

danilo.vrtacnik@fe.uni-lj.si
drago.resnik@fe.uni-lj.si

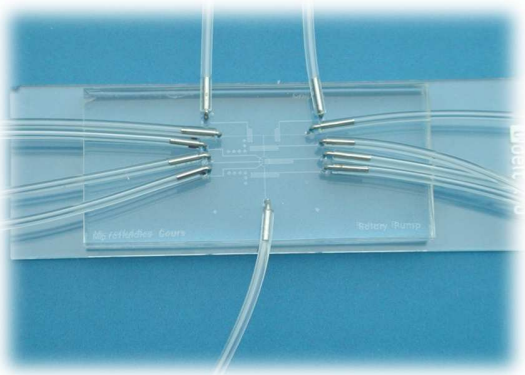
Laboratory of Microsensor Structures and Electronics LMSE

Faculty of Electrical Engineering

University of Ljubljana
Trzaska 25
1000 Ljubljana
SLOVENIA

Phone: (+386 1) 4768 303
Fax: (+386 1) 4264 630
URL: http://lmse.fe.uni-lj.si

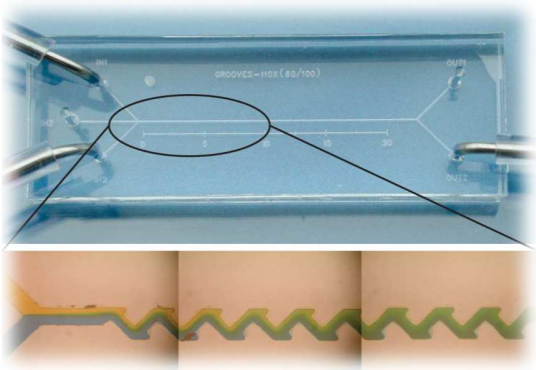
LAB-ON-A CHIP (LOC) - TEST CHIP



Over the last 10–20 years, LOC devices have demonstrated their potential and benefits for many applications, including point-of-care (POC) diagnostics, genomic and proteomic research, analytical chemistry, environmental monitoring, and the detection of biohazards. These miniaturized systems offer many advantages compared to bulkier and "historical" analytical instruments: they support precise control of liquids flowing usually under laminar regime, minimize consumption of reagents and samples, favor short reaction times, enable highly parallel and multiplexed analysis, require little or less power to operate, are portable, and potentially have low cost of production.

Application:
- Chemical and biomedical field
- Global health
- Point-of-care testing (POCT)
- Diagnostic tests (immunoassays, nucleic acid assays…)
- Drug discovery
- Stem cell research

PLANAR CHAOTIC ZIGZAG MICROFLUIDIC MIXER



The aim of microfluidic mixing is to achieve a thorough and rapid mixing of multiple samples in microscale devices. Small-scale mixing is of uttermost importance in bio- and chemical analyses using micro TAS (total analysis systems) or lab-on-chips. Many microfluidic applications involve chemical reactions where, most often, the fluid diffusivity is very low so that without the help of chaotic advection the reaction time can be extremely long.

Application:
- Chemical engineering (crystallization, extraction process, polymerization, organic synthesis…)
- Biological engineering (enzyme assay, biological screening, protein folding, bio-analytical processes…)
- Detection/analytical process (NMR, Raman, FTIR…)

University of Ljubljana
Faculty of electrical engineering

LMSE
LABORATORY OF MICROSENSOR STRUCTURES AND ELECTRONICS

ADVANCED MICROFLUIDICS SYSTEMS

LMSE colaborates with number of international research groups, universities, laboratories, and industrial partners both at home and abroad, mostly under the auspices of international projects, sponsored by the European Union.

INFORMATION:

danilo.vrtacnik@fe.uni-lj.si
drago.resnik@fe.uni-lj.si

Laboratory of Microsensor Structures and Electronics LMSE

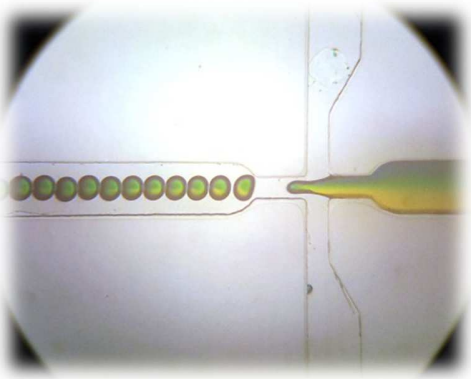
Faculty of Electrical Engineering

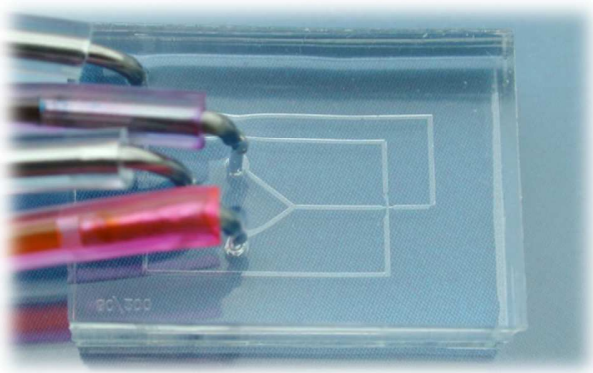
University of Ljubljana
Trzaska 25
1000 Ljubljana
SLOVENIA

Phone: (+386 1) 4768 303
Fax: (+386 1) 4264 630
URL: http://lmse.fe.uni-lj.si

MICROFLUIDIC DROPLET GENERATOR

The droplet format has several advantages compared to single phase microfluidics: it provides physical and chemical isolation eliminating the risk of cross-contamination, reagents are quickly and efficiently mixed inside droplets, droplets are very stable and can be incubated or thermocycled off-chip before being re-injected and droplets can be manipulated at very high throughput.





Applications :
- Chemical reactions
- Therapeutic agent delivery (e.g. controlled drug release)
- Biomolecule synthesis
- Diagnostic chips
- Drug discovery (e.g. cell culturing)