



Centre for Natural Sciences and Technologies

J. E. Purkyně University in Ústí n. L. Faculty of Science Pasteurova 3632/15 400 96 Ústí nad Labem

Mgr. Jan Malý, Ph.D. E-mail: jan.maly@ujep.cz Tel.: +420 475 286 781 Room: 4.01

Mgr. Marcel Štofik, Ph.D. E-mail: marcel.stofik @ujep.cz Tel.: +420 475 286 786 Room: 4.04

> UNIVERZITA J. E. PURKYNĚ V ÚSTÍ NAD LABEM Přírodovědecká fakulta

BIOSENSORS AND MICROFLUIDIC CHIPS FOR MEDICAL DIAGNOSTICS

RESEARCH/TECHNOLOGY INTRODUCTION

The handling of a patient's cells in medical diagnostics by traditional procedures requires high volumes of chemicals, it is prone to operator errors, and the cells are examined in an unnatural in vitro environment. In addition, maintaining a stable experimental environment is the basis for successful experiments either with cell lines or in the creation of chemically modified surfaces.

Microfluidic chips are increasingly used in the field of medical diagnostics. Their use opens up new possibilities in the study of cell behavior, cell proliferation, cellular responses to various stimuli, separation of cells from liquid biopsies and alike. The rapid development of microfluidic technologies in the last twenty years has brought new possibilities in medical diagnostics, especially in the field of detection of various types of markers associated with specific diseases. Proteins, metabolites, subcellular organelles (e.g. exosomes) or even whole cells have been successfully captured and analyzed in microfluidic devices. Microfluidic chips allow to work only with small volumes of chemicals, so they are suitable for testing new drugs of which only a very limited amount is available. Thanks to their dimensions and design, microfluidic systems mimic blood vessels and body spaces. which is used in "organs on a chip" concepts. The use of microfluidic chips enables the automation of all testing processes and thus a large amount of data can be obtained in a very short time.

A large degree of automation of these experiments is also possible thanks to the development of specialized external incubators, environmental controllers and solutions for selective heating of microscope stage inserts. These solutions make it possible to create specific conditions for specific research applications. Such solutions can be easily constructed using programmable microcontrollers, sensors and PID control methods. These systems can operate both autonomously and connected to a computer, allowing the exact state of the controlled environment to be recorded during the experiment, making it easier to find errors in the event of a failed experiment.

POTENTIAL USERS

The technology is suitable **for biomedical applications**, where it is necessary to precisely control the environment, mimic real body spaces and perform analyzes at the protein, metabolic, subcellular and cellular levels.

ADVANCEMENT OF TECHNOLOGY AND MARKET APPLICATION

Microfluidic systems are a rapidly evolving technology ranging from routine pharmacy tests (such as a pregnancy test), to laboratory equipment consumables (such as single cell drop generators for cell sorters and cytometers) to highly specialized tests for hospital diagnostics (such as lung cancer detection lungs from blood samples).

DOPLŇUJÍCÍ INFORMACE



- **Figure 1:** use of microfluidic systems A: Microfluidic systems can be observed in real time under a microscope
- B: Suitable for droplet generation and single cell analysis
- C: Separation of cells and microparticles in flow
- D: Efficient mixing of microliter volumes of chemicals
- E: Cell culture, live / dead tests, time lapse of culture growth
- F: Simplicity and modularity



Figure 2: use of microcontrollers in practice

- A: Heated microscope stage insert
- B: Heated portable incubator
- C: Microcontroller for checking and dosing humid air