Development of a Lab-on-a-Chip for the Characterization of Human Cells

Richter, L., Stepper, C., Mak, A., Brückl, H. and Ertl, P.*

*ARC GmbH, Nano-System-Technologies, A-1220 Vienna, Austria

phone: +43 – 50550 – 4305. e-mail: peter.ertl@arc.ac.at

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Abstract

Microfabricated biochips are developed to continuously monitor cell behavior in a non-invasive manner. In the presented work we describe the recent realizations of cellular dielectric spectroscopy (CDS) using contact-less microdielectric sensors for quantitative cell vitality. The cell chip consists of a µIDC system comprising of a glass substrate coated with thin metallic elements and with high-permittivity passivation layers. An integrated flow and heating system allows simultaneous monitoring of different sample types. Conventional or standard cell culture substrates are comparable to biological samples. The cell chip is designed to provide an outlook on cell responses in pharmaceutical applications, such as drug testing or genotyping.

Introduction

In the past decade the miniaturization of analytical techniques by means of MEMS technology has become a dominant trend in research. The principle behind cell analysis is that a cellular phenotype represents the expression of a genotype, thus monitoring cell behavior under varying conditions and understanding genotype-phenotype interactions in the context of a living cell is expected to have considerable impact on medicine. The principle behind cell analysis is that a cellular phenotype represents the expression of a genotype. Microfabricated biochips are developed to continuously monitor cell behavior in a non-invasive manner. In the presented work we describe the novel application of cellular dielectric spectroscopy (CDS) using contact-less microdielectric sensors for quantitative cell analysis. The cell chip consists of a µIDC system comprising of a glass substrate coated with thin metallic elements and with high-permittivity passivation layers. An integrated flow and heating system allows simultaneous monitoring of different sample types. Conventional or standard cell culture substrates are comparable to biological samples. The cell chip is designed to provide an outlook on cell responses in pharmaceutical applications, such as drug testing or genotyping.

Microfluidic technology: Multiple phenotypes

- Cell viability
- Reproduction and metabolic activity over long periods of time using different sensors on a common chip platform

Cell Adhesion and Signaling

The cell plasma membrane allows a build up of charge thus acting as tiny capacitors. The principle of this approach is to agitate the nanoliter defined dielectric properties are a crucial component of a high sensitivity sensor. Particularly, calculations (conformal mapping technique) of electric field distribution in the presence of SiN/SOG passivation layers using air and DI water as the dielectric medium are performed. For instance, the ability to tune electric field distribution by controlling the space ratio between fingers, as well as the width and thickness of individual fingers. For microfabricated biochips to be used as a multipurpose platform for cell analysis, spatial and temporal control of cell growth is an essential requirement.