Sensors and Materials, Vol. 7, No. 2 (1995) 131-146
MYU Tokyo

S & M 0195

Positioning and Manipulation of Cells and Microparticles Using Miniaturized Electric Field Traps and Travelling Waves

Günter Fuhr, Thomas Schnelle, Torsten Müller, Henning Glasser, Thomas Lisec[1] and Bernd Wagner[1]

Humboldt-University of Berlin, Biological Department, Invalidenstr. 43, 10115 Berlin, Germany
[1]Fraunhofer Institute for Silicon Technology (ISiT), Dillenburger Str. 53, 14199 Berlin, Germany

(Received February 14, 1994; accepted June 14, 1994)

Key words: cell polarization, semiconductor, microstructures, electric field forces, negative dielectrophoresis

Multielectrode systems consisting of two planar chips mounted by a hybrid technique in an LCC-68 ceramic carrier and spaced at a distance between 100 and 200 μm were used to create electric field cages and travelling waves in the micrometer range. It could be shown that at frequencies between 10 kHz and 400 MHz microscopic particles and various living cells show negative dielectrophoresis and are trapped, levitated and moved in weak electrolyte solutions as well as in culture media without any contact with a solid surface. Numerical calculations were carried out to determine the forces acting on complex structured particles such as cells, with consideration of distinct electrode configurations. The influence of thin dielectric layers coating the electrodes was studied. Changing the amplitude, frequency or phase at some of the electrodes was used for manipulation and insertion of particles and cells into the field cage. As a first application, a microfabricated electric field manipulator with three crossed channels was studied, applying travelling and rotating electric high-frequency waves.

1. Introduction

Many investigations characterizing charged and uncharged atomic and elementary particles followed the initial papers on quadrupole electric field cages of Paul et al.[(1)] On the other hand, Pohl[(2)] investigated ponderomotive forces acting on cells suspended in