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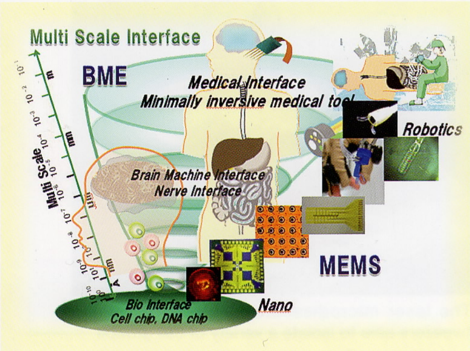
Medical treatment & health

[Research Project]
Fusion between MEMS and BME on Multiple-Scale

Creation of mircoscopic interfaces which revolutionize medical technology

Keywords

MEMS
µTAS
Multi-scale interfaces
micro-machines
BME



Taking on the challenge to develop multiscale interfaces for BME

As a result of dramatic advancements in semiconductor manufacturing technology, the field of microelectromechanical systems (MEMS) in which this technology is applied is also evolving spectacularly. It is well known that MEMS are used in a variety of devices in everyday use, such as mobile phones and automobiles. MEMS can be applied to a broad range of fields, from electrical and mechanical fields to chemistry, biotechnology and medicine. In recent years, there is particularly strong interest in the potential application of MEMS in biotechnology and medicine as an interface that is highly compatible with the living body.

Our research group has been conducting research into application of MEMS to biomedical engineering (BME). Living bodies handled in BME vary widely from large-scale bodies such as organs, tissue, and cells (and constituents), to those in the milli-, micro- and nanoscales; and MEMS have the potential to be applied to whichever scale necessary. In our project, we are building upon our achievements so far in our aims to develop an interface for a new technology that combines MEMS and BME.

Development of minimally invasive medical tools

So far, our research team has developed medical tools and devices of various scales. An instance of our achievements in the milliscale, is the development of pressure-driven actuators that move in a bending motion. An example is a 7mm-long, approx. 1mm-thick robotic microfinger made of silicone rubber. Based on the same technology a pressure-driven tool, in the form of an end scope device for insertion into the body for securing an operative field, was also jointly developed with medical institutions.

Another joint development with medical institutions involved that of a transplant tool for transplanting cell sheets into the eye. The sheet is initially flat with dimensions of 2.5mm × 2.5mm × 350µm, but can be transformed through application of pressure into a cylindrical body with a diameter of 1.3mm. A cylindrical body can be accommodated within a hypodermic needle which is used to inject it into the eye. The cylinder leaves the needle (with a diameter of about 2mm) at the back of the eye and opens up into a sheet form, allowing the cell sheet to be transplanted onto the affected area from a horizontal direction.

Realization of cellular sub-micro scale size scale medical devices

We have also successfully developed many tools and devices in relation to smaller microscale interfaces. One of these is the study of nerve interfaces. We have developed electrodes and the consequent device in which measurement electrodes of about 200µm attached to a nerve measures nerve signals from the brain, and stimuli electrodes directly controls muscular contraction.

On an even smaller nanoscale, we are developing a MEMS chip able to manipulate cells, or measure and analyze cellular signals. A microchannel array with 64 holes of several µm traps cells in the channel sections using suction, and can apply stimuli to cells or measure cellular signals via electrodes built into the channels. The ability to organize a large number of cells is crucial for the process of tissue formation in regenerative medicine.

More than 10 years of research has resulted in ever-expanding potential for interaction with the living body using multiscale interfaces in the fields of biotechnology, neurology, and medicine; and materialization of various applications in the form of tools which meet the requirements of clinical practice. We intend to continue working on laying the foundations for new groundbreaking technologies while keeping a close eye to keep up-to-date with the changing requirements. R

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