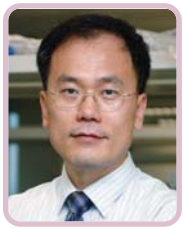
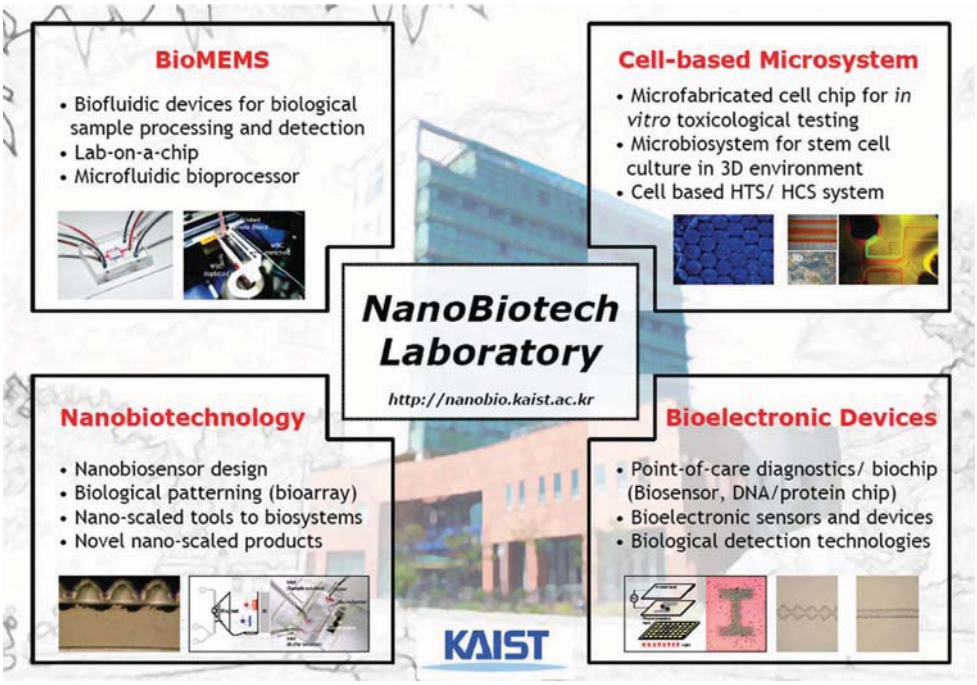


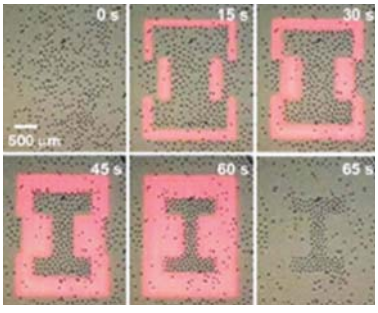
3.1.3. NanoBiotech Laboratory
(Prof. Je-Kyun Park, http://nanobio.kaist.ac.kr)

The aim of NanoBiotech Laboratory (NBL) lies in conducting research and development on the nanobiotechnology as well as microsystems technology. During the last 4 years, NBL has interested in developing a novel biomicrofluidic devices for biotechnology and bioengineering, based on the synergetic integration of miniaturization technology to biology, chemistry, and medicine. Currently, NBL focuses on the development of a nanobiosensor, microfluidic device and lab-on-a-chip as a new platform for biological sample processing and detection. The main application areas include biomolecular diagnostics, micro total analysis system (μTAS), cell-based high-throughput screening, and nanobio device.



Dielectrophoretic Separation Platform

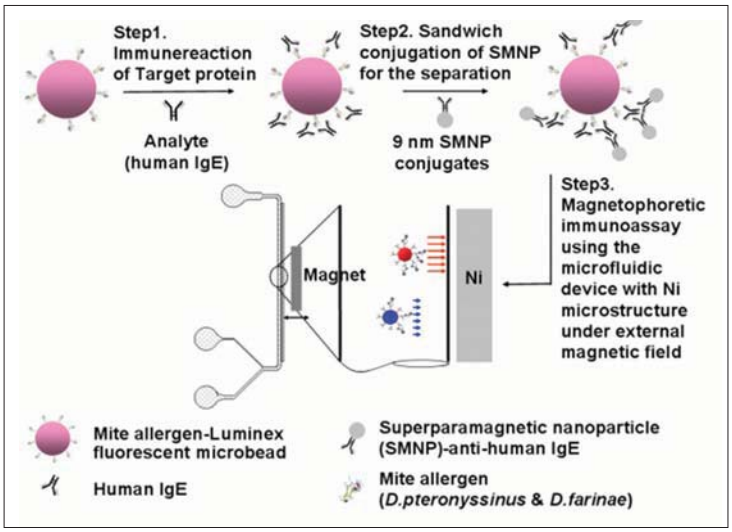
We recently report a new portable microfluidic platform, "lab-on-a-display", that microparticles are manipulated by dielectrophoretic force generated from the optoelectronic tweezers (OET) on a liquid crystal display (LCD). It was successfully applied to the programmable manipulation of 45μm polystyrene beads; more than 100 particles were transported with an optical image-driven control, following the moving edge of the image at every moment. Due to the portability and compatibility for disposable applications, this new platform has potential for programmable particle manipulation or chip-based bioprocessing including cell separation and bead-based analysis [1].



LCD driven optical manipulation of microbeads with a diameter of 45μm

Magnetophoretic Assay Platform

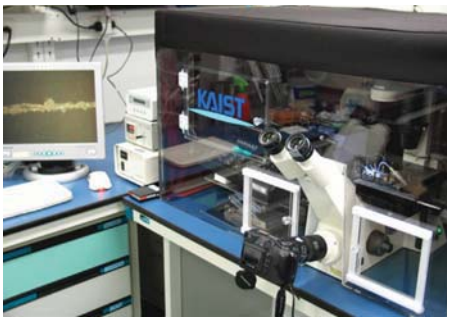
A new detection system based on the magnetophoretic mobility of a microbead, depending on the amount of associated superparamagnetic nanoparticles under magnetic field gradient in a microfluidic channel, was developed [2]. By measuring the magnetophoretic deflection velocity of microbeads as the signal for the presence of analytes, the multiple analytes (rabbit IgG and mouse IgG) in a microchannel were simultaneously quantified by conjugated nanoparticles as a label. Because the magnetophoretic deflection velocity was also decided by the magnetic field gradient, the detection sensitivity of this assay system can be improved to the femtomolar concentration range. Currently, we are applying this technology to detect allergen-specific IgE in patient samples [3] and to purify single-walled carbon nanotubes (SWCNTs) from the superparamagnetic iron impurities in a microfluidic device without any influence on inherent SWCNT properties.



Magnetophoretic immunoassays

Microfluidic Cell-based Assay Platform

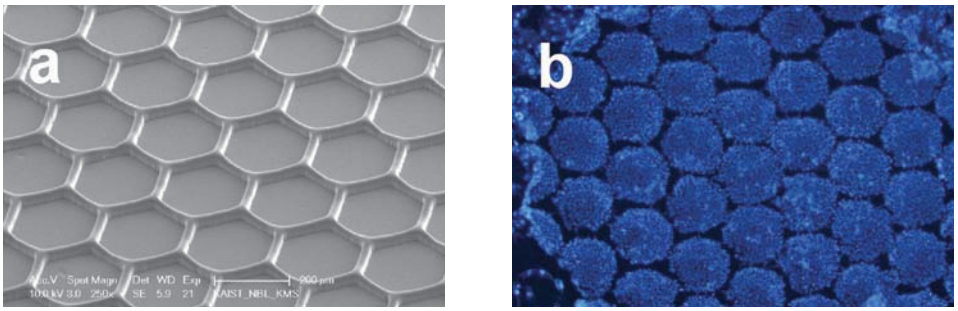
We report a novel cell culture platform for 3D cell immobilization as well as a dose-dependant cell-based assay by forming linear concentration gradient inside a peptide scaffold of a microchannel. A sol-gel transition peptide hydrogel, Puramatrix™, was first adopted in microfluidics. As the mixture of the peptide hydrogel and human hepatocellular carcinoma cells (HepG2) was flowed and gelled in the middle of a main channel by diffusion of media, we could simply fabricate a stripe-shaped peptide scaffold. Encapsulated HepG2 were cultivated in the 3D microenvironment and applied to cytotoxicity assays using Triton X-100. This platform also could be applied to co-cultures, angiological research, cytotoxicity tests, cell viability monitoring, and continuous dose-response assays as well as drug-drug interaction studies [4].



Microfluidic 3D cell culture system for in-vitro cell-based assays

Microfabricated Embryonic Stem Cell Divider (ESCD)

Microtechnology has supported innovative tools enabling micro-scale control so that a variety of tools have been applied for biological and medical applications. Recently, microwell-based human ESC culture has been used to control cluster size and cell differentiation. However, applications of microtechnology have rarely been studied for a large expansion of undifferentiated human ESCs and precise control of ESC clump size under intact culture



(a) SEM image of the PDMS replica (b) DAPI-stained image of a human ESC colony after pressing with ESCD with a hexagonal pattern (×100)

conditions. We propose a simple cell dissociation method using an embryonic stem cell divider (ESCD) to support large-scale expansion with high efficiency and minimization of damage to human ESCs. The ESCD was constructed from a poly(dimethylsiloxane) (PDMS) replica with a square or hexagonal pattern. Using the ESCD, human ESC colonies can be easily and efficiently dissociated into regular-sized ESC clumps without enzymatic treatment. Its quality and reliability were confirmed by maintaining undifferentiated ESCs up to the 15th passage. The ESCD will contribute to the advance quality control of in vitro ESC cultures and allow large-scale production of qualified ESCs with tremendous time- and work-saving [5].

References

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