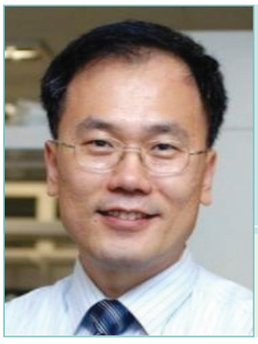

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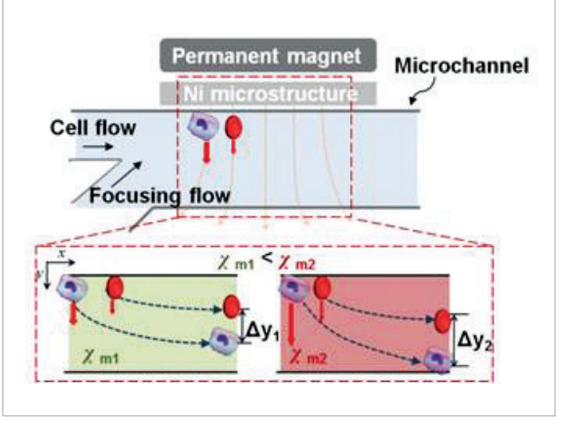
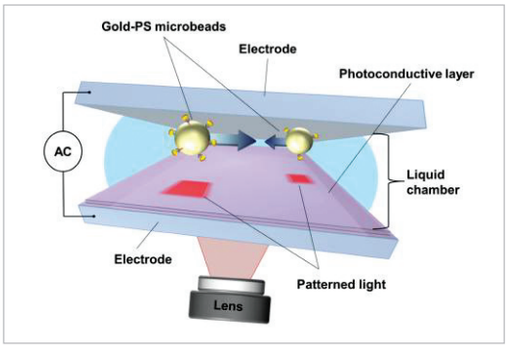
Recent progress of lab-on-a-chip technology is challenging for the development of nanobiotechnology and integrative bioengineering. Particularly, micro/nano fluidics has been a key technology for the realization of micro total analysis systems (μTAS) or lab-on-a-chip as well as the next generation bio-tools for drug discovery, diagnostics, and tissue engineering. This research area covers the design and development of miniaturized devices that manipulate liquid samples at nanoliter volumes, allowing biological assays to be integrated and accomplished on a small scale with minimum time and cost. Prof. Park's research focuses on the development of a nanobiosensor, microfluidic device and lab-on-a-chip as a new platform for biological sample processing, separation, and detection, including optoelectrofluidics, hydrophoretic separation, magnetophoretic assay, and cell-based assay. From June 2008, his laboratory has been selected to receive a National Research Laboratory (NRL) Program grant through the National Research Foundation of Korea funded by the Ministry of Education, Science and Technology (MEST).

Label-free cell separation using magnetophoresis: We developed a new label-free cell separation using a magnetic repulsion force resulting from the magnetic susceptibility difference between cells and paramagnetic buffer solution in a microchannel [1]. The difference in the magnetic forces acting on different sized cells is enhanced by adjusting the magnetic susceptibility of surrounding medium, which depends on the concentration of paramagnetic salts such as biocompatible gadolinium-diethylenetriamine pentaacetic acid (Gd-DTPA) dissolved in the medium. On the basis of this new separation scheme, we demonstrated a label-free separation of U937 cells from red blood cells with > 90% purity and 1 × 10^5 cells/h throughput using a 40 mM Gd-DTPA solution. This work was highlighted in Chemical & Engineering News, entitled "Microfluidic Device Separates Unlabeled Cells (March 12, 2012)"

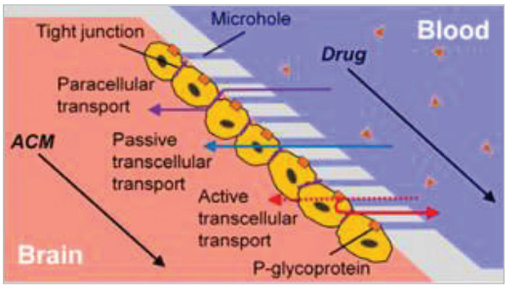


Optoelectrofluidic analysis of colloid particles: Optoelectrofluidic technology allows programmable manipulation of particles or fluids in microenvironments based on optically induced electrokinetics resulted from photochemical, photoconductive, and photothermal effects. Recently, we reported the behavior of metal-polymer hybrid particles in an optoelectrofluidic device [2]. In the application of hundreds of kHz ac voltage, a variety of optically-induced electrokinetic and electrostatic mechanisms affect the movement of gold-coated polystyrene microspheres in concert.



The particles repel from the light pattern and their mobility increases as the amount of gold increases. We apply this model to develop a novel optoelectrofluidic immunoassay, in which the corresponding metal-polymer microparticles are formed by a reaction of antibody-coated gold nanoparticles, antigens, and antibody-coated polystyrene microspheres.

Cell-based assays in a microchannel: An in vivo-like microenvironment may play an important role for drug screening and development. As orally administered drugs must be absorbed from the intestine into the blood circulation, permeability and cytotoxicity assays of drug candidates have been widely used in the early screening stages of drug discovery. To realize the drug permeability assay in a microchannel, a microhole array structure for cell trapping was exploited by mimicking the intestinal epithelial cell membrane, considering the in vivo delivery path of drugs in humans [3]. With the use of trapped cells, the integrated system including toxicity assay could be used as a valuable tool in drug discovery, and its applicability will be extended to include ADME/Tox drug properties.



Cellular hydrogel biopaper: We reported "microarchitectured freestanding cellular hydrogel biopaper" as a novel 3D cell culture or tissue reconstruction module [4]. The biopapers are thin enough to allow adequate diffusion, and they feature both the desired hydrogel microarchitectures and the organized cellular arrangements that can duplicate the native cellular environment. We also developed facile new harvest, transfer, and assembly techniques of the construction of laminated tissue composites of the biopaper with on-demand timing. Using these techniques, we were able to construct stratified 3D hepatic tissue modules with increased liver function. The cellular hydrogel biopaper will provide unprecedented tools to study cell?ECM interaction s, structure?function relationships, tissue morphogenesis, and modular tissue reconstructions.

Key Achievements

1. Y. K. Hahn, J.-K. Park, "Versatile immunoassays based on isomagnetophoresis," Lab on a Chip, 11 (12), 2045-2048, 2011.
2. M. S. Kim, T. Kim, S.-Y. Kong, S. Kwon, C. Y. Bae, J. Choi, C. H. Kim, E. S. Lee, J.-K. Park, "Breast cancer diagnosis using a microfluidic multiplexed immunohistochemistry platform," PLoS One, 5, e10441, 2010.
3. H. Hwang, J.-K. Park, "Rapid and selective concentration of microparticles in an optoelectrofluidic platform," Lab on a Chip, 9 (2), 199-206, 2009.
4. J. H. Kang, S. Choi, W. Lee, J.-K. Park, "Isomagnetophoresis to discriminate subtle difference in magnetic susceptibility," Journal of the American Chemical Society, 130 (2), 396-397, 2008.

Achievements 2012/2013

1. F. Shen, H. Hwang, Y. K. Hahn, J.-K. Park, "Label-free cell separation using a tunable magnetophoretic repulsion force," Analytical Chemistry, 84 (7): 3075-3081, 2012.
2. D. Han, H. Hwang, J.-K. Park, "Optoelectrofluidic behavior of metal-polymer hybrid colloidal particles," Applied Physics Letters, 102 (5), 054105, 2013.
3. J. H. Yeon, D. Na, K. Choi, S.-W. Ryu, C. Choi, J.-K. Park, "Reliable permeability assay system in a microfluidic device mimicking cerebral vasculatures," Biomedical Microdevices, 14 (6), 1141-1148, 2012.
4. W. Lee, C. Y. Bae, S. Kwon, J. Son, J. Kim, Y. Jeong, S.-S. Yoo, J.-K. Park, "Cellular hydrogel biopaper for patterned 3D cell culture and modular tissue reconstruction," Advanced Healthcare Materials, 1 (5): 635-639, 2012.