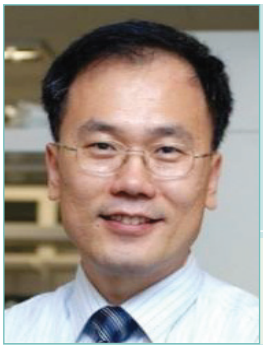

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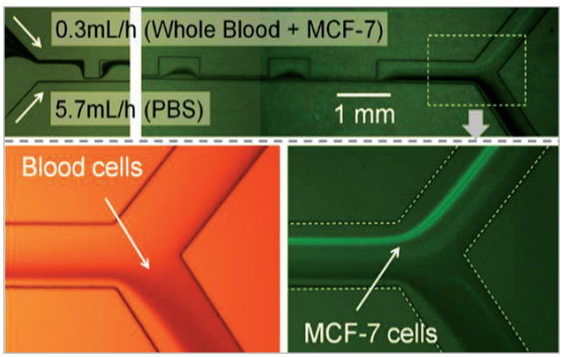
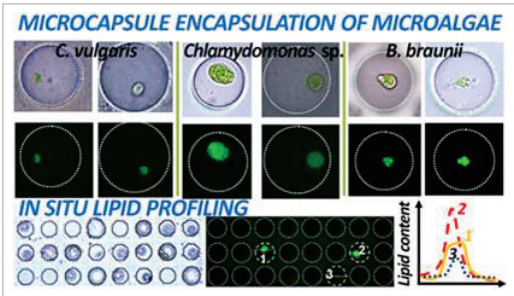
Recent progress of lab-on-a-chip technology is challenging for the development of nanobiotechnology and integrative bioengineering. Particularly, micro/nano fluidics has been a key technology for the realization of micro total analysis systems (μTAS) or lab-on-a-chip as well as the next generation bio-tools 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).

Inertial microfluidics for rare cell separation: The isolation of the circulating tumor cells (CTCs) from the blood is a great challenge because these cells are extremely rare in the peripheral blood. With the recent development of bioMEMS and nanotechnology, traditional cell separation and analytical methods are oriented toward applying their principles to lab-on-a-chip devices or finding a new physical principle for cell separation and detection. Recently, inertial microfluidic separation is of great interest due to its continuous and high throughput separation of cells without chemical cell damages. To take advantages of high throughput, simple fabrication and high separation resolution, a new strategy for microfluidic CTC separation was reported using the force balance between inertial lift and Dean drag forces in a contraction-expansion array microchannel [1]. From this modulation of force balance, the cutoff size value for cell separation can be tuned into proper value according to target cell size.

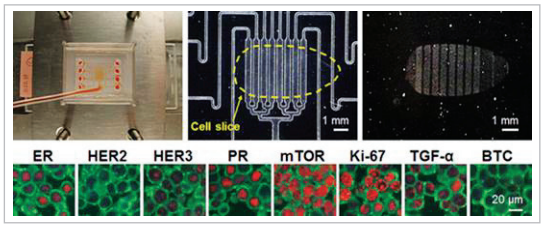


Hydrogel microcapsule array for microalgae screening: Droplet-based microfluidics has recently been applied to a wide range of applications, including biological assay, combinatorial synthesis, and high-throughput screening. Unlike solid-well based systems, microdroplets enables to move or stop, split or merge with others, and select different paths for sorting at timed intervals. However, a precise temporal control of microdroplets such as storage, synchronization and combinatorial pairing of droplets is required to achieve a variety range of chemical and biochemical reactions

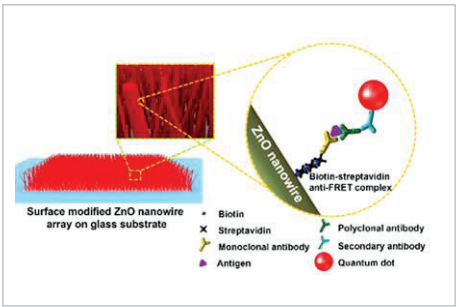


inside microfluidic networks. We developed alginate hydrogel microcapsules containing a green microalga to provide a quantitative analysis of the lipid content of individual alga within the microcapsule [2]. With further development, this device may provide a novel screening platform, especially for various microbes directly harvested from a natural environment.

Microfluidic Immunohistochemistry for breast cancer biomarkers: Immunochemical assay using an antibody-based molecular detection technology can provide information on both cellular morphology and the quantities of molecules within cells (immunocytochemistry) or tissues (immunohistochemistry). In this field, multiplexed protein quantification remains difficult using conventional methods. Recently, we demonstrate a new analytical concept that integrates a microfluidic multiplexing platform and a quantum dot (QD) double-staining method [3]. The microfluidic double-staining method enabled accurate quantification by normalization of biomarker levels to that of β-actin as an internal reference. This novel molecular profiling method will accelerate cancer cell studies and the development of diagnostic tools for personalized medicine.



Quantum dot-based immunoassay: We report an efficient and high-performance immunoassay platform by combining high-density vertical ZnO nanowire array with photostable quantum dot (QD) labeling [4]. The ZnO nanowire array provides a large surface area for the immobilization of biomolecules, which makes it an efficient substrate for the immunoreaction of biomolecules. When a sandwich immunoassay with QD label was conducted on various substrates, the ZnO nanowire substrate showed stronger fluorescence signal than ZnO thin film and bare glass substrates by 3.8 and 8.5 times, respectively. We found that the fluorescence resonance energy transfer (FRET) from QD to ZnO nanowire could be suppressed by extending their distance with multilayer biotin-streptavidin complex. In addition, we demonstrated the QD-based immunoassay of carcinoembryonic antigen on a ZnO nanowire substrate, showing an excellent immunoassay performance with a very low detection limit (0.001 ng/mL) and a large detection range up to 100 ng/mL.



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 2013/2014

1. M. G. Lee, J. H. Shin, C. Y. Bae, S. Choi, J.-K. Park, "Label-free cancer cell separation from human whole blood using inertial microfluidics at low shear stress," Analytical Chemistry, 85 (13): 6213-6218, 2013.
2. D.-H. Lee, C. Y. Bae, J.-I. Han, J.-K. Park, "In situ analysis of heterogeneity in the lipid content of single green microalgae in alginate hydrogel microcapsules," Analytical Chemistry, 85 (18): 8749-8756, 2013.
3. S. Kwon, M. S. Kim, E. S. Lee, J. S. Sohn, J.-K. Park, "A quantum dot-based microfluidic multi-window platform for quantifying the biomarkers of breast cancer cells," Integrative Biology, 6, 430-437, 2014.
4. J. Kim, S. Kwon, J.-K. Park, I. Park, "Quantum dot-based immunoassay enhanced by high-density vertical ZnO nanowire array," Biosensors and Bioelectronics, 55, 209-215, 2014.