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Surface and Extended-Nano / Micro Fluidic Phenomena and Control for Chemistry and Bio-Clinical Applications

Micro chemical and biological systems on microchips are promising to next generation experimental tools for chemistry and biology related science and technologies. Our concept of chemical and biological microchip is quite similar to electronics. Those devices are the same as central processing units of analytical, synthesis and biological instrumentations. The structure and the function of the microchips are also the same as the electronic devices. Unit operations in chemical engineering, such as mixing and reaction, extraction, phase separation, and so on, are realized by simple Y-shape microchannels, and they become as integrated parts of IC like diodes, capacitors, and resisters. They are named as micro unit operations (MUO). MUOs can be freely combined in parallel and in serial, and the microfluidic circuits are composed. They have advanced functions of chemical and biological processes, and named as continuous flow chemical processing (CFCP).

Their rapidity, simplicity, and compactness will provide evolutional convenience. Those are also the same as electronics, and they have been proved by variety of analytical and biological instruments like medical diagnosis. This technology is now going into the phase of making them into practical and industrial use. And also, another direction of this technology is going into much smaller size. Actually, we have been developing the similar technological platform for extended nano size area, and unique characteristics of extended-nano fluidics and ultimate applications like single cell single molecule analysis are becoming realistic.

In such progress of micro and extended-nano fluidics, surface control is one of the most important factors. In micro space, the effect of wall is dominant for fluidic behavior, chemical characteristics, biological properties, and so on. Those effects are more dominant in smaller space like extended-nano space. Therefore, we have developed many kinds of surface modification methods, and applied them for one of the key components of micro and extended-nano chemical/biological systems. One of the typical examples is fluidic control by hydrophilic and hydrophobic modification. Mechanical controlling devices are very difficult to insert into the channels, so this kind of affinity control to the liquid is alternative and useful methodology of fluid control. Some examples as droplet-parallel flow conversion, phase separation, a stop valve, and others will be introduced in the lecture. And also, chemical and biological functions will be introduced.

In the final part, unique surface and fluidic interaction in the extended-nano channels will be introduced. Surface chemical groups dominate the characteristics and structure of the fluid, although they are negligible in micro and macro space. The proton migration layer in water/glass interface will be introduced and some application of the extended-nano space for pico to atto little analytical chemistry.

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