【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Engineering I)

Title of Project : Development of Micro/Nanoscale Thermofluid Multiple Sensing and Interface-Controlled Device

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Research Area : Thermal Engineering

Keyword : Micro/Nanoscale Heat Transfer, Convection, Mass Transfer

【Purpose and Background of the Research】

For the development of interface-controlled microdevice, which is a key component of the next generation of micro-TAS, it is strongly required to integrate the key elements of micro/nanoscale technologies, i.e., thermofluid engineering, MEMS/NEMS, cutting process and polymer technology. The present study focuses on the establishment of micro/nanoscale thermofluid multiple sensing and interface-controlled device, and to propose a novel methodology of the system integration in micro/nano technologies. The liquid-solid, liquid-liquid, gas-liquid and gas-solid interface will be formed in the microchannels by MEMS/NEMS combined with the ultra precision machining. The thermofluid dynamics at each interface will be investigated by the fluorescence imaging techniques combined with laser radiation pressure. The selective absorption of gas from the gas to solid (polymer) phase will be examined.

【Research Methods】

The interface-controlled microdevice will be proposed in the final fiscal year, whose concept is illustrated in Figure 1. The research methods are listed as follows:

(1) The chemically-modified pattern of the microchannel surface, i.e., the zeta-potential pattern, and the channel geometry will be optimized in order to form the stable interface between different phases.

(2) The evanescent wave will be generated at the liquid-liquid and the gas-liquid interface to excite the fluorescence dye in the liquid phase whose refractive index is lower and the gold nanoparticles in the gas phase, respectively. Moreover, the optical tweezers will be applied to the nanoparticles at the interface to measure the interfacial force acting on the nanoparticle on the order of piconewton.

(3) Polymer will be selected as the device material that has an ability to selectively absorb the gas at the gas-liquid interface.

【Expected Research Achievements and Scientific Significance】

The expected research achievement in the present study is to propose a novel methodology of the system integration to develop the microfluidic device in which the heat, mass and molecular transfer at the interface between different phases will be precisely controlled, taking into consideration for the dynamical, electrochemical and organic chemical parameters.

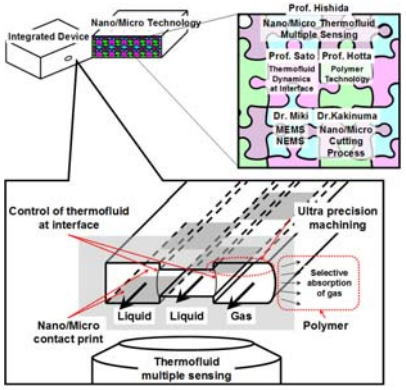

Figure 1. The concept of interface control microdevice proposed in the present study.

【Publications Relevant to the Project】

・ Ichiyanagi, M., Sasaki, S., Sato, Y. and Hishida, K., "Micro-PIV/LIF measurements on electrokinetically-driven flow in surface modified microchannel", Journal of Micromechanics and Microengineering, Vol. 19, 045021 (9 pages), (2009).

・ Kazoe, Y. and Sato, Y., "Effect of ion motion on zeta-potential distribution at microchannel wall obtained from nanoscale laser-induced fluorescence", Analytical Chemistry, Vol. 79, pp. 6727–6733 (2007).

【Term of Project】 FY2009-2013

【Budget Allocation】 137,500 Thousand Yen

【 Homepage Address and Other Contact Information】

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