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Photo-induced flows relevant to laser-based droplet manipulations

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Non-invasive and non-contact manipulation of micro-scale droplet in air/liquid pool, which is relevant to Medical or Biological Engineering applications and chemical processes using lab-on-chip technology, has increasingly attracted attention in the field of microfluidics. Several techniques were proposed by utilizing a local variation of interfacial tension, because the effects of interfacial phenomena are dominant in microfluidics relative to the inertia and buoyancy forces. In particular, laser-induced optical force may be used as a non-invasive and precise tool for droplet-based controls, but its force magnitude is limited on the order of a pico newton. Compared to the optical force, an optically-induced thermal Marangoni convection may provide a larger resultant force that provides the nano-newton order force. Therefore, the photothermal Marangoni convection can be a powerful technique of on-demand bubble/droplet handling in a micro-channel liquid. If allowed to change physical properties of surfactant solution liquid (e.g., azobenzene) in response to light, the cis-trans photoisomerization can be alternative non-invasive fluid manipulation without adding heat. The cis-trans photoisomerization is a property that the cis and trans isomers are reversibly changed by light of a specific wavelength such as ultraviolet light. As the isomers of different molecular structures are switched by light irradiation, physical properties such as the contact angle and interfacial tension are varied. We have performed direct numerical simulation of multi-phase flows of droplets that are accompanied by either photo-induced thermal Marangoni convection or cis-trans photoisomerization, in order to study quantitatively the force and mechanisms relevant to the laser-based droplet manipulation.

Biography

Takahiro Tsukahara has completed his PhD in the year 2007 from Tokyo University of Science. He is an Associate Professor of Department of Mechanical Engineering, Faculty of Science and Technology, Tokyo University of Science. He has published more than 37 papers in journal publications and 44 peer-reviewed proceeding papers. He has been serving as an Editorial Board Member of *Advances in Mechanical Engineering*. He has his expertise in Thermo-fluid Dynamics, especially in Turbulent Transition and Flow Instability, and Computational Fluid Dynamics.

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