MicroTAS 2021 Workshop 12 Information

WORKSHOP TITLE: MICROFLUIDIC FLOW VISUALIZATION

PRESENTER AFFILIATION:

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WORKSHOP DESCRIPTION:

The flow fields inside microfluidic devices are very important while designing these devices for gas sensing, bacteria culturing, and heat exchanging. In order to understand the flow inside the microfluidic devices, we present a non-intrusive experimental technique, known as pressure/temperature-sensitive paint (PSP/TSP), using luminescence molecules and fluorescence microscopes to provide global view of pressure/temperature contours in microfluidic devices. The experimental results obtained from PSP/TSP can provide quantitatively visualization in flow field and heat transfer analysis, which are essential for the operation and improvement of microfluidic devices with complex microchannel system.

The workshop will be divided in three lectures, as detailed in the following.

LECTURE 1 (Y. Egami) – Introduction of PSP/TSP

LECTURE DESCRIPTION:

・ PSP and TSP are molecular sensors that can measure the pressure and temperature distribution in a small region of interest with high spatial resolution, which is challenging to do with conventional sensors. The background and the measurement principle of PSP/TSP, such as oxygen and temperature quenching, are explained in the lecture.

• Then, the recipes and characteristics of several typical PSP/TSPs are presented. The hardware required for basic PSP/TSP experiments will also be described. In addition, post-image processing to obtain pressure and temperature distributions from the acquired data will be tested.

OVERVIEW OF MATERIAL TO BE COVERED AND WHAT ATTENDEES CAN EXPECT TO TAKE AWAY FROM THE LECTURE:
• In this lecture, we introduce the basic principles of PSP and TSP techniques. Typical recipes and sample preparation methods for sensors required for PSP/TSP measurement are discussed. We also present the experimental setup and post-image processing and discuss the factors that affect the measurement accuracy.

LECTURE 2 (Y. Matsuda) – PSP applications in microfluidic visualization

LECTURE DESCRIPTION:
• Fabrication methods of PSP for microfluidic visualization are introduced. We will review the applications of PSP in microflow measurements such as flows through different designs of microchannel (straight, constricted, and 90deg bend microchannel), various flow regimes like compressible flows, slip flows, and gas mixing in micromixers. Future aspects of PSP applications in microfluidics will be also discussed.

OVERVIEW OF MATERIAL TO BE COVERED AND WHAT ATTENDEES CAN EXPECT TO TAKE AWAY FROM THE LECTURE:
• The audience will learn how to prepare PSP sensors suitable for microscale applications. The lecture will provide several applications of PSP to micro-scale flows. It will also provide an understanding of the measurement systems that are important for micro-scale flow measurements. Current problems and future developments in PSP measurement will be also discussed.

LECTURE 3 (C.Y. Huang) –TSP applications in microfluidic visualization

LECTURE DESCRIPTION:
• TSP technique has been applied to microfluidic research for years, not only measuring the fluid temperature inside microfluidic devices but also provide detailed analysis of heat transfer characteristics in micro heat

exchangers. TSP sensors can be dissolved in DI water or solvents which can be injected inside microchannel for fluid temperature measurements. TSP sensors can also be prepared as paint and applied to the bottom wall of microfluidic devices for surface temperature measurements. Combining both fluid and surface temperature information, the heat transfer information, such as global Nusselt number contours, can be retrieved.

• Additionally, TSP technique uses excitation light and luminescence signal from the sensor and measures the temperature variation with images of luminescence. The instrumentation of TSP is similar to the experiment technique of Particle Image Velocimetry (PIV) which records the images with fluorescence tracer particles. The simultaneous temperature and velocity measurement become feasible by integrating TSP and PIV technique in one florescence microscope system. A brief discussion of integration with TSP and PIV will be also included in the lecture.

OVERVIEW OF MATERIAL TO BE COVERED AND WHAT ATTENDEES CAN EXPECT TO TAKE AWAY FROM THE LECTURE:

• In this lecture, we will talk about the preparation of TSP sensor for fluid and surface temperature measurements, as well as the instrumentation. A few examples of TSP sensor will be introduced. Recent advance of TSP application in microfluidics will be provided with heat transfer analysis in various microfluidic devices such as 90-degree elbow channel and serpentine microchannel with segmented flow. The experimental setup with integrated TSP/PIV will be illustrated and examples of simultaneous velocity and temperature measurements will be presented.

WHO SHOULD ATTEND:

PhD students, post-docs, and researchers who are interested in flow visualization in microfluidic devices should attend this workshop. People could learn the basic knowledge of PSP/TSP technique and their applications in microfluidic visualization.

PARTICIPANTS WILL NEED THE FOLLOWING:
For those attending in-person, a laptop or iPad with headphones are required.