**Department of Mechanical Engineering Seminar**

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Steinman Hall Room 254 (Conference Room)

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**Confinement Effects on Drop Coalescence: An Experimental Study Using Hele-Shaw Cells**

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**ABSTRACT**

When an initial contact occurs between two drops, a liquid bridge is formed between them and grows rapidly. This phenomenon is known as drop coalescence. Although the evolution of the liquid bridge is driven by surface tension during the coalescence process, there exist regimes dominated by viscous or inertial force, which are identified by scaling relations of the temporal growth of the bridge. These scaling relations have been obtained by studying unconfined drops (i.e., spherical drops) or partially confined drops (i.e., drops resting on a plane). We experimentally investigated confined drop coalescence in Hele-Shaw cell devices, which were formed by two parallel hydrophobic surfaces with controllable spacing. Two aqueous drops were slowly grown in a Hele-Shaw cell that was pre-filled with a different continuous phase (CP), air for three-phase and mineral oil for two-phase drop coalescence, respectively. The growing bridge of drops coalescing in the Hele-Shaw cell was captured using high-speed video microscopy, and the time-dependent diameter of the liquid bridge was measured. The scaling exponent of the growth of the liquid bridge between drops at the early stage was identical (= 1) in both two-phase and three-phase confined drop coalescence studies, consistent with the scaling exponent of unconfined drop coalescence at the early stage. When the CP of drop coalescence in Hele-Shaw cells had high viscosity, the transition to the late stage of drop coalescence occurred before the diameter of the liquid bridge approached the gap width of the Hele-Shaw cell. It suggested that the effect of the confinement was diffused to drops through the surrounding fluid with high viscosity because of momentum diffusion. In addition, we studied the location and generation mechanism of entrapped air bubbles specific to the three-phase confined drop coalescence experimentally. These results from this study helped to unveil the effects of confinement on drop coalescence.

**BIO**

Haipeng Zhang is currently a Postdoctoral Research Associate in the Department of Pharmacology and Regenerative Medicine at the University of Illinois at Chicago. He received his Ph.D. degree and M.S. degree in Mechanical & Materials Engineering from the University of Nebraska-Lincoln in 2022 and in 2018, respectively, and his B.S. degree in Mechanical Engineering from the Kitami Institute of Technology, Japan in 2007. He also worked for the pump department at the Beijing Office (China) of the KUBOTA Corporation between 2009 to 2015. His previous work experimentally characterized the interfacial phenomena of liquid drop behaviors in multiphase systems, particularly the effects of the confining substrates on drop coalescence and pinch-off. He was the recipient of 2020-2021 Graduate Returning Scholarship Award, 2019-2020 Graduate Student Scholarship Award from the ASME Fluids Engineering Division, and 2022 Reviewers of the Year Award from ASME.