Understanding Microbubble Coalescence Using High-Speed Imaging and Lattice Boltzmann Method Simulation

Shuyi Zhou[1], Yuanzhi Cao[1], Rou Chen[1], Chuanyi Chen[1], Huidan (Whitney) Yu[1], Likun Zhu[1], Tao Sun[2]

[1]Mechanical Engineering Department, Indiana University -Purdue University Indianapolis (IUPUI),
[2]Advanced Photon Source, Argonne National Laboratory, Argonne, Illinois 60439, USA

Microbubble coalescence is one of the important research areas of bubble dynamics. The purpose of this research is to seek deeper understanding and relative mathematical relation on microbubble coalescence. To fulfill that, we conducted both experiments and simulations. For the part of experiment, we fabricated a microfluidic gas generator with better performance leading corresponding fluidic chemical reaction. After that we utilized ultrafast synchrotron X-ray imaging facility at the Advanced Photon Source of Argonne National Laboratory to capture the gas generating and microbubble merging phenomena using high speed imaging. These experiments show how the microbubbles with the same ratio contact and merge in the reaction channel and different concentration of reactants. As for the part of simulation, we lead the simulation basing on lattice Boltzmann method to simulate microbubble coalescence in water with unequal diameter ratio. Focuses are on the effects of size inequality of parent bubbles on the coalescence geometry and time. The “coalescence preference” of coalesced bubble closer to the larger parent bubble is well captured. A power-law relation between the preferential relative distance and size inequality is consistent to the recent experimental observations. Meanwhile, the coalescence time also exhibits power-law scaling, indicating that unequal bubbles coalesce faster than equal bubbles.

Mentors: Likun Zhu, Huidan (Whitney) Yu, Mechanical Engineering Department, Indiana University -Purdue University Indianapolis (IUPUI), IN