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ON THE SIMULATION OF BINARY DROPLET COLLISION WITH SURFACTANT

Yu-Hau Tseng[1], Kuo-Long Pan[2], and Ming-Chih Lai[1]

[1] Department of Applied Mathematics,
National Chiao Tung University, Hsinchu 30013, Taiwan
yhtseng@math.nctu.edu.tw
[2] Department of Mechanical Engineering,
National Taiwan University, Taipei 10617, Taiwan
panpeter@ntu.edu.tw

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The collision between aqueous drops in air typically leads to coalescence after impact [1,2]. In a prior study [3], we demonstrated experimentally the creation of a non-coalescent regime through addition of a small amount of water-soluble surfactant. Here we perform a direct simulation to account for the continuum and short-range flow dynamics of the approaching interfaces, as affected by the soluble surfactant. Based on the immersed boundary formulation, a conservative scheme is developed for solving the coupled surface-bulk convection-diffusion concentration equations, which presents excellent mass preservation in the solvent as well as conservation of total surfactant mass. We show that the Marangoni effect, caused by the dynamic gradient of surface tension, induces stresses that oppose the draining of gas in the interstitial gap, and hence prohibits merging of the interfaces. In such gas-liquid systems, the repulsion caused by the addition of surfactant, as frequently observed in liquid-liquid systems such as emulsions, in the form of an electric double-layer force, was found to be too weak to dominate in the attainable range of interfacial separation. These results thus identify the key mechanisms governing the impact dynamics of surfactant-coated droplets in air and imply the potential of using little surfactant to manipulate impact outcomes, for example, to prevent coalescence, between droplets or interfaces in gases.

E-mail: *panpeter@ntu.edu.tw*

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