Contact Time of Bouncing Molten Ceramic Droplet on Nonwetting Surfaces

Yang XU*, Stéphane VINCENT, Qi-Chang HE, Hung LE-QUANG

Université Paris-Est, Laboratoire de Modélisation et Simulation Multi Echelle, UMR 8208 CNRS, 5 Bd Descartes, F-77454 Marne-la-Vallée Cedex 2, France

**E-mail:* yang.xu@u-pem.fr

The normal impact of liquid droplets onto dry solid surfaces with various wettabilities has been studied with a small scale simulation approach using the Volume Of Fluid (VOF-PLIC), an interface tracking method with a single set of mass and momentum conservation equations. The wetting effect is taken into account by applying the liquid/solid contact angle as a boundary condition by the Smooth VOF algorithm [1]. This model has been validated with experimental and numerical studies in literature [2,3,4] in terms of the time-evolving spread factor and energy distribution inside the droplet. The results are shown with varying major parameters in a systematic manner. Based on the results, we find the dimensionless jetting time t_j^* $(= t_j/(\rho D_0^3/\sigma)^{1/2})$ is inversely proportional to the square root of Weber number and show that t_j^* does not depend on the contact angle (Fig.2-a). Also within the regime a droplet spreads and rebounds completely, the dimensionless contact time t_c^* $(= t_c V_0/D_0)$ scales proportional to the square root of Weber number. The influence of contact angle on t_c^* varies slightly in a small range, which might be ignored in industry (Fig.2-b).

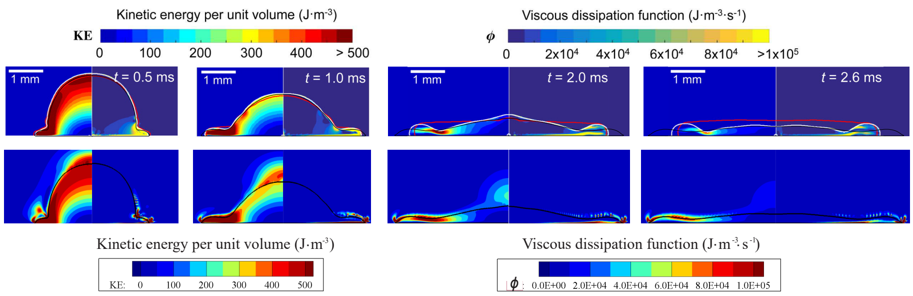

Figure 1: Time evolution of water droplet impact on a steel surface ($D_0 = 2mm$, $V_0 = 1.1m/s$). The first row present experimental images (white line), numerical results (red line) [4] and the second row show the ones from our simulations. The contour map on the left side depicts the kinetic energy per unit volume KE, and the right side shows the viscous energy dissipation function.

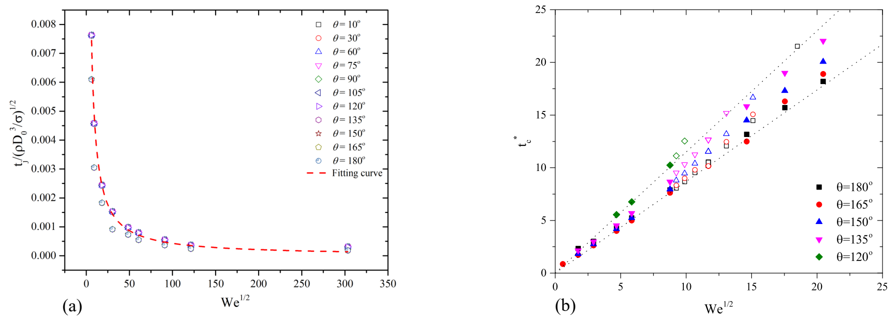

Figure 2: (a) The variations of t_j^* on $We^{1/2}$ on different solid surfaces ($10° \leq \theta \leq 180°$); (b) The variations of t_c^* on $We^{1/2}$ on hydrophobic surfaces ($120° \leq \theta \leq 180°$). The dot lines have slopes 1 ± 0.15.

References

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