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Coalescence-induced jumping motion on non-wetting surfaces: The mechanism of low energy conversion efficiency FANGJIE LIU, Department of Mechanical Engineering and Materials Science, Duke University, Durham, NC 27708, GIOVANNI GHIGLIOTTI , JAMES J. FENG, Department of Mathematics, University of British Columbia, Vancouver, BC, Canada V6T 1Z2, CHUAN-HUA CHEN, Department of Mechanical Engineering and Materials Science, Duke University, Durham, NC 27708 — When two drops coalesce on a non-wetting substrate such as a superhydrophobic surface, the merged drop spontaneously jumps away from the surface. The self-propelled jumping is powered by the surface energy released upon drop coalescence. However, the translational kinetic energy associated with the jumping is much smaller than the released surface energy. The mechanism of this low energy conversion efficiency is elucidated with 3D phase field simulations which have been experimentally validated. The coalescing drops can be viewed as a two-lobed perturbation to the merged drop with a larger equilibrium radius. The large-amplitude perturbation induces the capillary-inertial oscillation of the merged drop, and the symmetry of the oscillation is broken by the non-wetting substrate. Since the substrate intercepts only a small fraction of the merged drop, a small translational momentum is imparted by the symmetry-breaking substrate, giving rise to the low jumping velocity of 0.2 when nondimensionalized by the capillary-inertial velocity and consequently a low energy conversion efficiency of less than 4%. Other than this small fraction of translational kinetic energy, the majority of the kinetic energy is oscillatory and eventually dissipated.

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