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How does an air film evolve into a bubble during drop impact? JI SAN LEE, BYUNG MOOK WEON, JUNG HO JE, Pohang University of Science and Technology, KAMEL FEZZAA, Argonne National Laboratory — When a liquid drop impacts on a solid substrate, a tiny air film is generally entrapped between the drop and the substrate and eventually evolves into a bubble by surface energy minimization. We investigated how air evolves into a bubble during drop impact using ultrafast x-ray phase-contrast imaging that enables us to track the detailed morphological changes of air with high temporal and spatial resolutions. We found that the evolution takes place through complicated three stages: inertial retraction of the air film, contraction of the top air surface into a toroidal bubble, and pinch-off of a daughter droplet inside the bubble. The collapse and the pinch-off can be explained by energy convergence that is associated with Ohnesorge number (Oh) regarding capillary waves and viscous damping. We measured a critical Oh number, Oh* $\sim 0.026 \pm 0.003$, above which the generation of the daughter droplet is suppressed. Interestingly we found that the bubble is detached favorably from wettable surfaces, which suggests a feasible way to eliminate bubbles for many applications by controlling surface wettability. The threshold angle for bubble detachment was measured as $\sim 40 \pm 5^\circ$ for water, which agrees with a geometrical estimation.

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