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Contact lines are unstable even under non-splashing droplets MIN PACK, PAUL KANEELIL, YING SUN, Drexel University — Drop impact is fundamental to natural and industrial processes such as rain-induced soil erosion and spray coating technologies. In this study, we elucidate the interfacial instabilities formed by air entrainment at the wetting front of impacting droplets on atomically smooth, viscous silicone oil films of constant thickness with varying droplet velocity, viscosity, surface tension, and ambient pressures. A high-speed total internal reflection microscopy technique accounting for the Fresnel relations at the droplet interface allowed for in-situ measurements of an entrained air rim at the wetting front. The growth of the air rim is a prerequisite to the instability which is formed when the gas pressure balances the capillary pressure near the wetting front. A critical capillary number, which inversely scales as the ambient pressure, is predicted and the result agrees well with the experiments. The wavenumber in the instability is shown to increase with viscosity and velocity but decrease with surface tension of the impacting drop. We thus conclude that the instability mechanism is in qualitative agreement with the Saffman-Taylor instability – where the low viscosity air is displacing the higher viscosity droplet. The low We contact line instabilities observed in this study provide a paradigm shift in the conventional understanding of hydrodynamic instabilities under drop impact which usually require We >>10.

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