Supporting Information

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SI Text

Materials and Methods

We use multiple low-surface-tension and low-viscosity liquids to perform our experiments, as listed in Table S1. The low surface tension makes splashing occur easily and reproducibly, and the low viscosity guarantees that we are not in the high-viscosity regime where a different type of splash occurs (1). The experimental results from different liquids are all consistent with each other, indicating the robustness of our findings.

We make the substrates with the optical lithography technique. First, we spin coat a thin layer of UV-epoxy (SU8-2025; MicroChem) onto a clean silicon wafer and then cover the wafer with a mask of predesigned pattern and expose it under UV light. After development, arrays of holes are made on the epoxy layer. Then we fill liquid polydimethylsiloxane (PDMS) into this structure and solidify it, achieving a PDMS layer with circular pillars. At the end we fill optical adhesive (NOA81; Norland Products) into this PDMS structure and solidify it, obtaining transparent substrates of NOA81 with arrays of holes. The thicknesses of the substrates are typically 50 μm and the diameters of holes are 75 ± 5 μm. Typical examples are shown in Figs. 1–3 in the main text.

The Match Between k_m^{-1} and d for Various Situations

As demonstrated in Fig. 3*C* in the main text, we have experimentally verified that the critical region for splashing initiation is indeed at the location where the instability size, k_m^{-1}, matches the liquid tip thickness, d. To confirm its general robustness, here we show more experiments with different liquids and velocities. In Fig. S1*A* we show the results of an ethanol drop impacting on the optical adhesive NOA81 substrates with $V_0 = 2.16$ m/s. The data for two substrates are shown: One has pores around the critical radius and the other is completely smooth without pores. We note that for the critical substrate, splashing is significantly eliminated (around 80%) but not completely eliminated; whereas for pores made at other locations the splashing reduction is far less significant. In Fig. S1*B* we use a different liquid, oil-1.04, and eliminate splashing completely by making pores around the critical radius. All data demonstrate that the critical region for splashing overlaps with the region around r_0, where k_m^{-1} matches d. Moreover, we also illustrate the exact approach of how to find r_0 values on a smooth substrate. With our model, we can predict the splash onset location, r_0, by intersecting k_m^{-1} and d curves, as shown in Fig. S1 *C* and *D*: Each panel determines one particular r_0 value used in Fig. 3*D* in the main text.

1. Xu L (2010) Instability development of a viscous liquid drop impacting a smooth substrate. *Phys Rev E Stat Nonlin Soft Matter Phys* 82(2 Pt 2):025303.

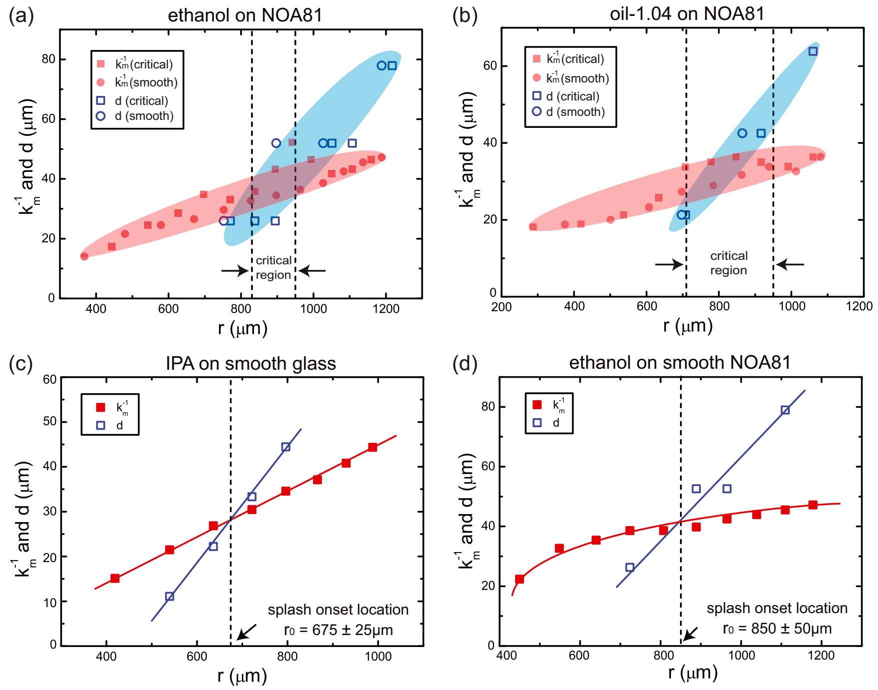
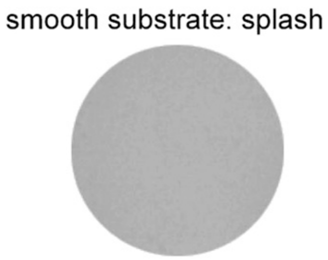


Fig. S1. The match between k_m^{-1} and d for various liquids, substrates, and impact velocities. (*A*) An ethanol drop impacting on NOA81 substrates with $V_0 = 2.16$ m/s. The data for two substrates are shown: One has pores around the critical radius and the other is completely smooth without pores. (*B*) An oil-1.04 drop impacting on NOA81 substrates with $V_0 = 1.92$ m/s. Again the data for two similar substrates as in *A* are shown. (*C*) An isopropyl alcohol (IPA) drop impacting on a smooth glass substrate with $V_0 = 2.04$ m/s. From the cross of the two curves, we can determine the splash onset location with our model, which gives one value of r_0 for Fig. 3*D* in the main text. (*D*) An ethanol drop impacting on a smooth NOA81 substrate with $V_0 = 1.92$ m/s. Again we can determine one value of r_0 for this impact condition.

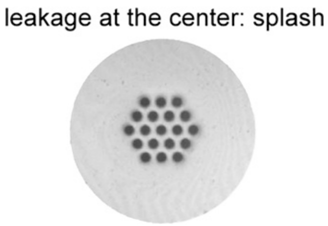
Table S1. Material properties of different liquids

Liquid	ρ, kg/m^3	σ, mN/m	μ, mPa·s	Drop diameter, mm
Methanol	791	22.1	0.61 ± 0.02	3.5 ± 0.1
Ethanol	789	22.6	1.15 ± 0.02	3.5 ± 0.1
IPA	786	21.7	2.07 ± 0.02	3.5 ± 0.1
Oil-0.65	760	15.9	0.65 ± 0.02	3.0 ± 0.1
Oil-1.04	816	17.4	1.04 ± 0.02	3.0 ± 0.1
Oil-1.95	873	18.7	1.95 ± 0.02	3.0 ± 0.1



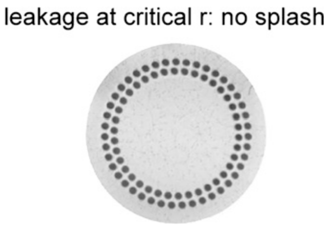
Movie S1. Significant splash occurs on the smooth substrate, no splash appears on the leaking substrate, and splash reappears on patterned but nonleaking substrate. $V_0 = 1.92$ m/s.

Movie S1



Movie S2. Air leakage at the center still leads to splash, whereas air leakage at the edge eliminates splash. $V_0 = 1.92$ m/s.

Movie S2



Movie S3. Air leakage at the critical radius r_0 eliminates splash completely, but air leakage at a smaller or a larger radius still leads to splash. $V_0 = 1.92$ m/s.

Movie S3