Electronic Supplementary Material (ESI) for Soft Matter.

SPI Supplementary Figures: S1, S2, and Table S1, S2

Stable-streamlined cavities following the impact of non-superhydrophobic spheres on water

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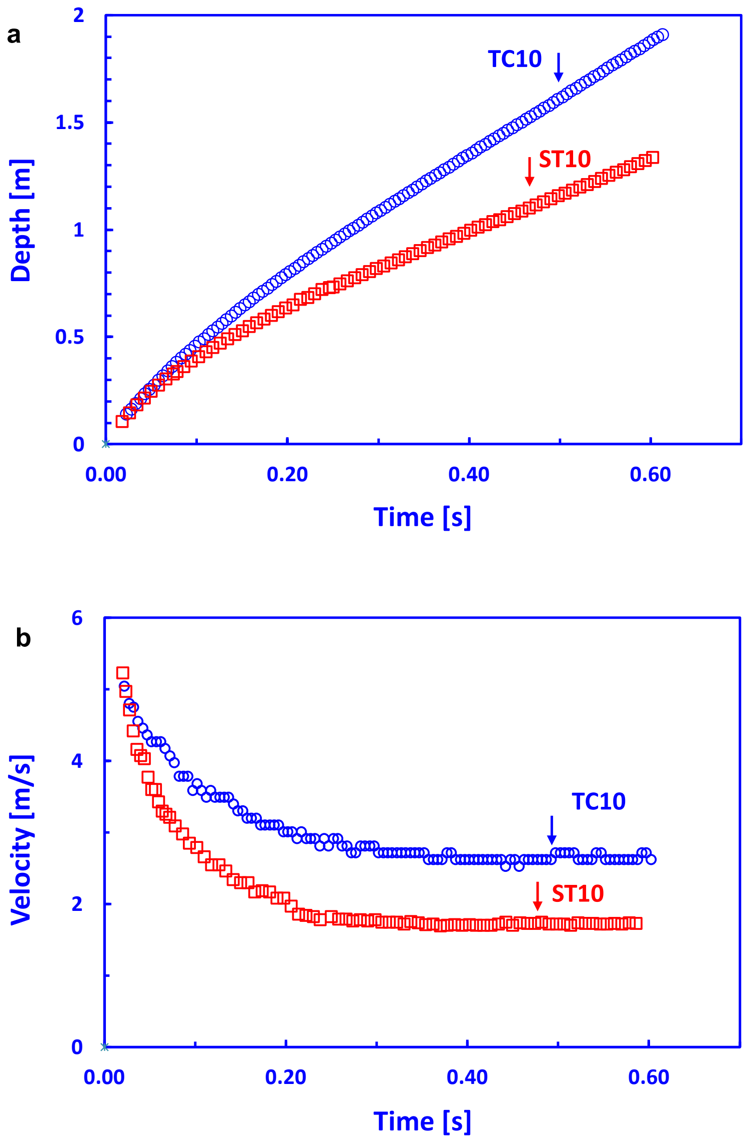

Fig. S1. Examples of the depth trajectory vs time (a) and decent velocity vs time (b) for the case of a 10 mm unmodified steel sphere with attached cavity impacting from about 2 m height above the water surface (red squares, shown in Video 2 and manuscript Fig. 2) and 10 mm unmodified tungsten carbide sphere impacting from about the same height of about 2 meter above the water surface (blue circles). Arrows mark the establishment of the steady streamlined cavity regime, with no more bubble shedding.

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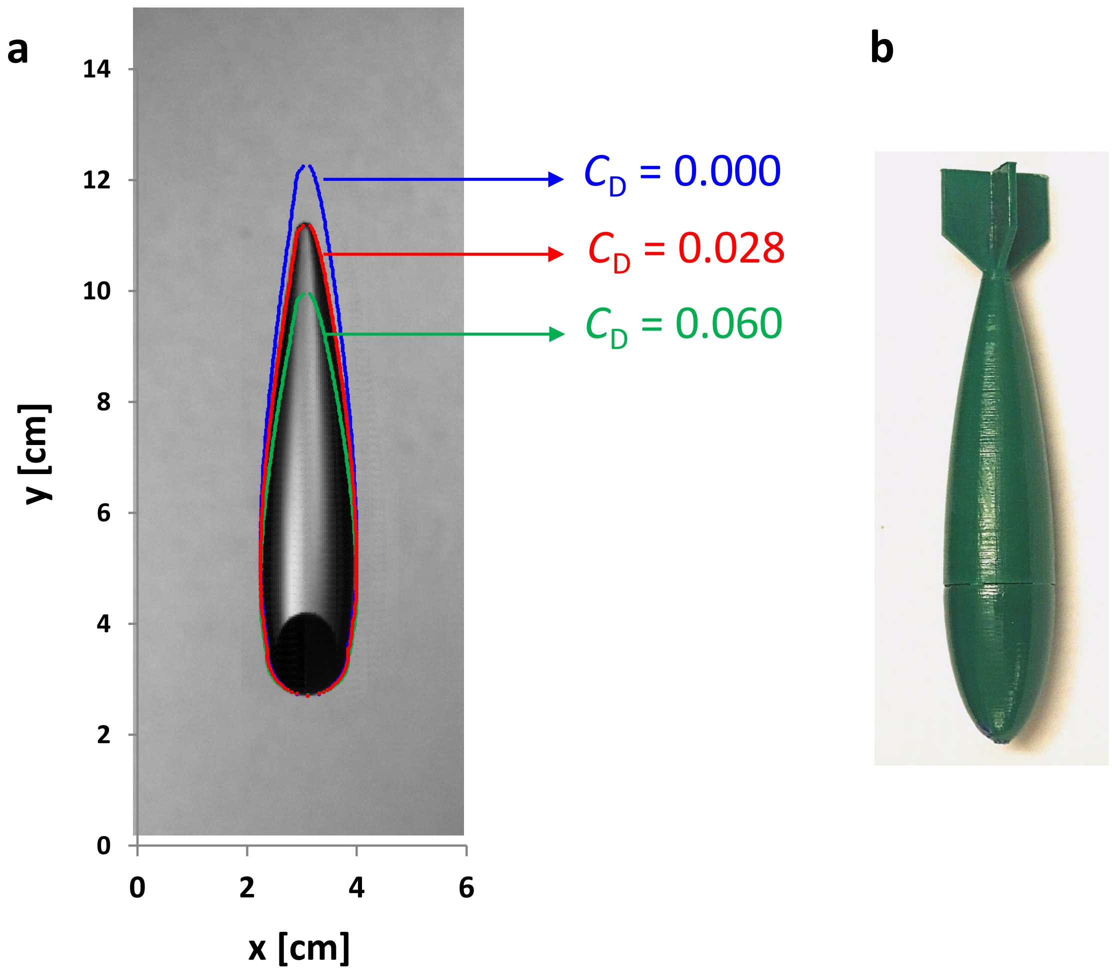

Fig. S2. (a) An example of a high-speed video-camera snapshot used to determine the volume of the sphere-with-cavity formation, V_{SC}. Shown is the case of a 15 mm unmodified steel sphere that is free-falling in pure water. The red line is the profile extracted by the in-house MATLAB image processing code and used to calculate the volume that corresponds to C_D = 0.028. For comparison we also show the profiles that correspond to neutral buoyancy or C_D = 0.000 (blue line) and to C_D = 0.060 (green line). (b) Photograph of a 3D-printed solid projectile used to estimate the drag on a similar streamlined-shape solid body, as the air-cavity shown in Figure 4 of the main manuscript. The buoyancy of the two-part projectile can be adjusted by inserting metallic spheres inside the main body. Full details on the projectile drag-coefficient measurements can be found in Vakarelski *et al.* 2017 (reference 14 in the main manuscript).

Supplementary Table S1

Material	Sphere diameter	Sphere density	Formation diameter/length		Reynolds number	Formation velocity	Drag coefficient
	D_S (mm)	ρ (g/cm^3)	D (mm)/L (mm)	L/D	Re	U (m/s)	C_D (± 0.01)
ZO	10	5.73	11.1/41.5	3.71	1.6×10^4	1.44	0.030
ZO	15	5.77	16.7/68.2	4.06	3.0×10^4	1.78	0.019
ZO	20	4.94	21.0/87.4	4.16	4.3×10^4	1.90	0.027
ST	10	7.73	11.5/53.8	4.66	2.0×10^4	1.74	0.024
ST	15	7.72	17.5/84.7	4.84	3.7×10^4	2.13	0.028
ST	20	7.71	23.7/11.3	4.74	5.4×10^4	2.42	0.020
TC	10	14.89	13.1/87.1	6.6	3.4×10^4	2.48	0.027
TC	15	14.88	20.1/125.1	6.2	6.7×10^4	3.03	0.017

Table S1. Physical parameters for zirconium oxide (ZO), steel (ST) or tungsten carbide (TC) spheres with attached cavity formation falling at constant velocity in room temperature water, $T_W = 21$ °C. All data are collected using unmodified spheres of $\Theta \approx 90°$ which were released from about 2.0 meter height above the water level in the tank for a tank filled with pure water.

Supplementary Table S2

Water solution short name used in the text	Composition	Surface tension (mN/m)	Surface modus E_S (mN/m) [(a)]
Water	21 °C DI water	72.4	N/A
SDS	8 mM sodium dodecylsulfate (SDS)	38.5	4
SLES + CAPB + MAc	2.6 wt % sodium lauryl-dioxyethylene sulfate (SLES) + 1.4 wt % cocoamidopropyl betaine (CAPB) + 0.16 wt % myristic acid (MAc)	26.9	305
Shampoo	1 wt % of Johnson's® Baby Shampoo	25.8	< 8
Soap	0.04 wt % of Coast® soap	27.1	410

Table S2. Short names, composition, surface tension and surface-dilation modulus of the surfactant solutions used. The surface tensions were measure with a Kruss tensiometer. Data for the surface dilation modulus E_S are taken from Denkov *et al.* 2005 (reference 34 in the main manuscript).