東京大学
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# *New strategies for antifogging and antifrosting surfaces*

M1/M2 Internship


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The recent progress of micro/nanoscale surface modification for wetting control allowed to obtain efficient antirain [1] and anticondensation surfaces [2-5]: condensation droplets merging on hydrophobic nanocones are almost always jumping from the surface. However, obtaining passive antifrosting surfaces remains a challenge. Most of the time, frosting begins with a condensation step before the propagation of a freezing front which dynamics is highly dependent on both the drops sizes and spatial distribution. One promising strategy to prevent frosting consists in controlling the condensation.

The objective of this internship is to explore experimentally how spatial control of nucleation combined with the exceptional jumping droplet abilities of nanocones allows to limit condensation and to prevent frosting. Using environmental scanning electron microscopy (ESEM), we will explore how condensation nucleation can be controlled at the nanoscale by chemical patterning. At the micrometric scale, we will study with high-speed camera, how the jumping dynamics of the condensation droplets is affected by the chemical patterning. Depending on the intern's preference, another research axis is to use statistical analysis of condensation movies to unveil the key parameters of condensation distribution leading to frost.

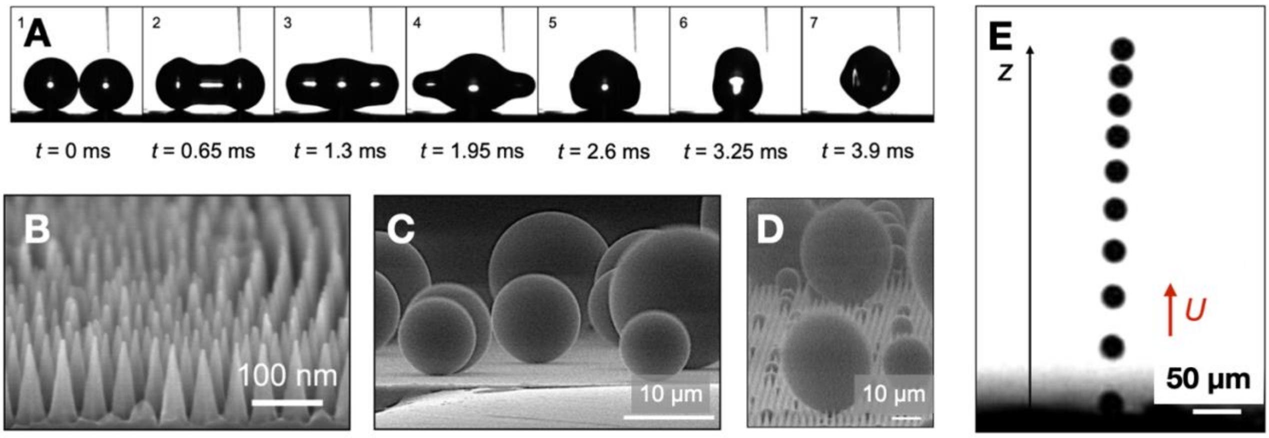


**Figure. A.** High-speed imaging of the jumping droplets mechanism. **B.** Surface covered with nanocones allowing near 100% jumping probability. **C.** ESEM images of drops condensing on nanocones and **D.** microcones. (Images C and D are adapted from the PhD thesis of Pierre Lecointre). **E.** Side-view chronophotography of a jumping drop with radius $R$ = 11.3 ± 0.1 μm resulting from the coalescence of a pair of droplets with $r$ = 8.9 ± 0.1 μm. Images are separated by 0.125 ms. The drop takes off with a vertical jumping velocity $U$ = 55 ± 5 cm/s.


**[1]** T. Mouterde, P. Lecointre, G. Lehoucq, A. Checco, C. Clanet & D. Quéré. Two recipes for repelling hot water. ***Nature Communications***, ***10***, 1410, 2019.

**[2]** T. Mouterde, G. Lehoucq, S. Xavier, A. Checco, C. T. Black, A. Rahman, C. Clanet & D. Quéré. Antifogging abilities of model nanotextures. ***Nature Materials***, ***16***, 658–663, 2017.

**[3]** P. Lecointre, S. Laney, M. Michalska, T. Li, A. Tanguy, I. Papakonstantinou & D. Quéré. Unique and universal dew-repellency of nanocones. ***Nature Communications, 12***, 3458, 2021.

**[4]** T. Mouterde, T-V. Nguyen, H. Takahashi, C. Clanet, I. Shimoyama & D. Quéré. How merging droplets jump off a superhydrophobic surface: Measurements and model. ***Physical Review Fluids***, ***2***, 112001, 2017.

**[5]** P. Lecointre, T. Mouterde, A. Checco, C. T. Black, A. Rahman, C. Clanet & D. Quéré. Ballistics of self-jumping microdroplets, ***Physical Review Fluids***, 4, 013601, 2018.