WETTING DYNAMICS AND THE LEIDENFROST TRANSITION

OF LIQUID DROPS IMPACTING ON A HOT PLATE

K. Harth[1], M. Rump[1], S.-H. Lee[2], K. Fezzaa[3], J. H. Je[2] and D. Lohse[2]

[1]Physics of Fluids/University and Max Planck Center Twente, Enschede, The Netherlands;

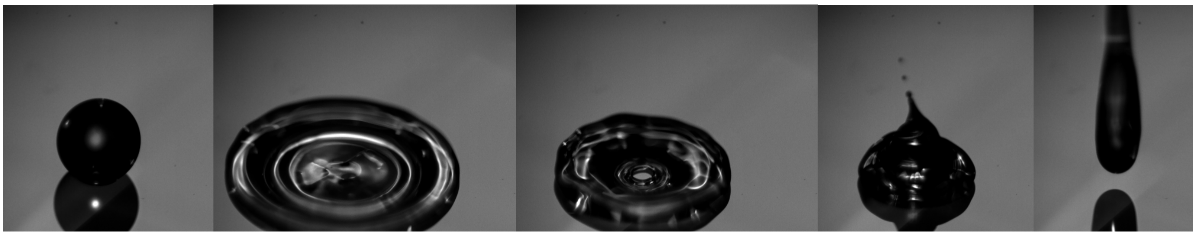
[2]X-Ray imaging Center, Pohang University of Science and Technology, Pohang, Korea;

[3]X-Ray Science Division, Advanced Photon Source, Argonne National Laboratory, Argonne, USA

kirsten.harth@ovgu.de

Most of us are acquainted with the Leidenfrost effect from dancing water drops in a sufficiently hot pan: such drops levitate on a stable layer of their own vapour, thereby evaporating much slower than any contacting drop. Similar effects are highly relevant for, e.g., cooling of hot metals or, conversely, efficient drop removal for corrosion avoidance in industrial processes. In those cases, the drops will impact onto the surfaces at considerable velocities. Due to the short time scale of drop impact, the vapour layers get much thinner, leading to touchdown at increased temperatures compared to the case of gentle deposition. The determination of the *dynamic* Leidenfrost point via the final impact outcome or side view imaging becomes impossible.

We combine high-speed Total Internal Reflection (TIR) measurements with high-speed phase contrast X-ray data obtained at the Advanced Photon Source at Argonne National Laboratory to determine the dynamic Leidenfrost point for a number of liquids, which appears to be at much higher temperatures than previously anticipated. For a range of Weber number, we derive that statistically, lamella rupture is a clear signature of and initial, short-lived contact of the drop with the hot substrate. Here, hole formation is absent for all Leidenfrost drops. This finally allows us to determine the dynamic Leidenfrost point with simple shadowgraphy imaging.



Ethanol drop (2mm diam.) impacting at v=0.89 m/s on a hot sapphire plate (250°C). After brief contact, a central hole forms during drop retraction. Times: 0 ms, max. spreading 4 ms, visible hole at 7 ms, jet from collapse at 9 ms, rebound at 19 ms after impact.

ACKNOWLEDGEMENTS: This work was funded by the Mac Planck Center Twente (K. H. and M. R.), German Science Foundation (DFG) Grant HA8467-1/1 (K. H.). S.-H. Lee and J. H. Je thank The Ministry of Trade, Industry and Energy (MOTIE) and the Korean Institute for Advancement of Technology (KIAT) for funding in project Brain Korea 21 Plus and the National Research Foundation of Korea (NRF) for funding in grant 2017R1E1A1A01075274. The use of the Advanced Photon Source, an Office of Science User Facility operated for the US Department of Energy (DOE) Office of Science by the Argonne National Laboratory, was supported by the US DOE under contract no. DE-AC02-06CH11357.