Drop impact-based energy harvesting using charged hydrophobic polymer surfaces

H. Wu[1, 2] , A. Banpurkar[1,3], I. Siretanu[1], D. van den Ende[1], G. Zhou[2] and F. Mugele [1]

[1] Physics of Complex Fluids, MESA+ Institute, University of Twente, 7500 AE Enschede, The Netherlands

[2] South China Academy of Advanced Optoelectronics, South China Normal University, 510006, Guangzhou, China

[3] Center for Advanced Studies in Materials Science and Condensed Matter Physics, Department of Physics, University of Pune, Pune-411 007, India

f.mugele@utwente.nl

Hydrophobic polymer surfaces spontaneously accumulate negative charge upon contact with water. Likewise, rolling drops on hydrophobic surfaces tend to leave traces of negative charge due to a poorly understood triboelectric change transfer process, which has recently been used to harvest energy from rolling drops. Here, we present an alternative droplet-based energy harvesting process, which relies on drop impact onto polymer surfaces treated by a dedicated charging process [1,2] that deposits substantially higher amounts of stable, permanently trapped charge than previously reported. We quantify the trapped charge density and its life time using electrowetting and measure the resulting electrical current signal upon drop impact. A kinetic model is proposed to describe the charging mechanism. The enhanced charge density enables more efficient conversion of droplet kinetic energy into electric energy. The underlying mechanism is based on transient variations of electrical capacitances due to drop spreading, retraction, and rebound upon impact on the surface. Synchronized high speed video imaging of impacting drops [3] and electrical current measurements confirm the proposed energy conversion mechanism.

ACKNOWLEDGEMENTS: H.W. thanks the National Key R&D Program of China and Guangdong Province Key Laboratory of Optical Information Materials and Technology for supporting this work.

REFERENCES:

[1] A.G. Banpurkar, Y. Sawane, S.M. Wadhai, C. U. Murade, I. Siretanu, D. van den Ende, F. Mugele, 'Spontaneous electrification of fluoropolymer–water interfaces probed by electrowetting', *Faraday Discussions* **2017**, *199*, 29.

[2] H. Wu, R. Dey, I. Siretanu, D. van den Ende, L.L. Shui, G. Zhao, F. Mugele, 'Electrowetting-induced localized trapping of high charge densities on fluoropolymer surfaces' (in preparation)

[3] J. de Ruiter, R. Lagraauw, D. van den Ende, F. Mugele, 'Wettability-independent bouncing on flat surfaces mediated by thin air films', *Nature Physics* **2015**, *11*, 48.