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Viscous droplet in a nonthermal plasma: microflow at plasma-liquid interface

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Abstract content

We study the interactions of microplasma with a viscous liquid droplet in a narrow gap [1]. We show that local change of properties at their interface caused by actions of plasma can induce radial viscous fingering. The system is investigated experimentally employing synchronized optical and electrical time-resolved measurements. Temporal development of the destabilization, stretching, and fragmentation of the plasma-liquid interface is studied for the whole event lifespan. The perturbation wavelength and temporal development of fingering speed, plasma-liquid interface length, dissipated power, and fractal dimension of the pattern are determined. Recorded changes in the dissipated mean power show a strong correlation to subsequent stretching of the interface. Our extensive parametric study shows that oil viscosity and applied voltage amplitude both have a significant impact on the interface evolution. Notably, at relatively high voltages the destabilized interface featured properties noticeably diverging from the theoretical prediction of a known model. We propose an explanation based on the change of the liquid viscosity with increased heating at high applied voltage amplitudes. Furthermore, the introduced methodology enables spatially resolved quantification of the dissipated power density, i.e. the main cause of the process, and of the unstable plasma-liquid interface velocity, i.e. the main result of the process. We demonstrate how the irregular distribution of these parameters leads to the observed microflow. The viscous fingering process and the secondary droplets pinch-off are investigated for two power scenarios.

Thanks/Acknowledgement

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References

[1] Lucia Potocnakova, Petr Synek, and Tomas Hoder 2020 Viscous droplet in nonthermal plasma: Instability, fingering process, and droplet fragmentation PHYSICAL REVIEW E 101, 063201