**Formation of surface nanodroplets under controlled flow conditions**

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Nanodroplets on a solid surface (i.e., surface nanodroplets) have practical implications for high-throughput chemical and biological analysis, lubrications, laboratory-on-chip devices, and near-field imaging techniques. Oil nanodroplets can be produced on a solid–liquid interface in a simple step of solvent exchange in which a good solvent of oil is displaced by a poor solvent. In this work, we experimentally and theoretically investigate the formation of nanodroplets by the solvent exchange process under well-controlled flow conditions. We find significant effects from the flow rate and the flow geometry on the droplet size. We develop a theoretical framework to account for these effects. The main idea is that the droplet nuclei are exposed to an oil oversaturation pulse during the exchange process. The analysis shows that the volume of the nanodroplets increases with the Peclet number Pe of the flow as $Pe^{3/4}$, which is in good agreement with our experimental results. In addition, at fixed flow rate and thus fixed Peclet number, larger and less homogeneously distributed droplets formed at less-narrow channels, due to convection effects originating from the density difference between the two solutions of the solvent exchange. The understanding from this work provides valuable guidelines for producing surface nanodroplets with desired sizes by controlling the flow conditions.

References

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