The formation principle of micro-droplets induced by optical tweezers

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Supplementary Material

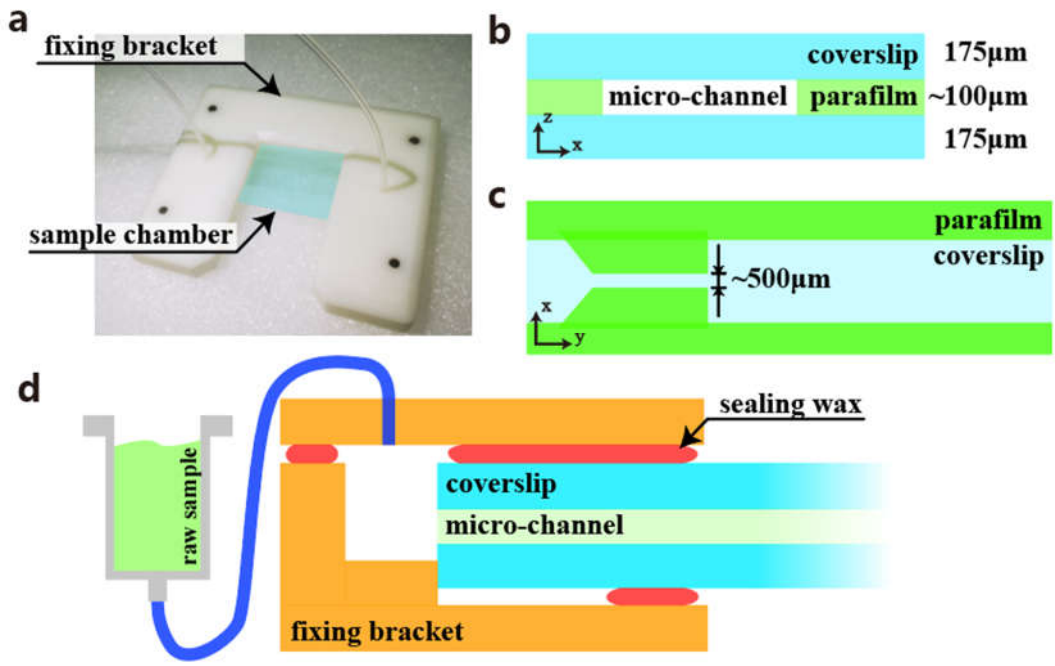


Figure S1. Structure diagram of the sample chamber. a) is the glass-based chamber, it actually is composed of two coverslips and a supporting structure made of parafilm. b) is the longitudinal section of the sample chamber. Both optical trap and Raman laser can be easily focused in the micro-channel because the overall thickness is less than 500 μm. During the drying of the droplets, the top coverslip can be removed to dry the droplets as soon as possible. c) is the top view structure diagram, and d) is the schematic diagram of the connection between the sample chamber, the fixing bracket and the raw sample injector.

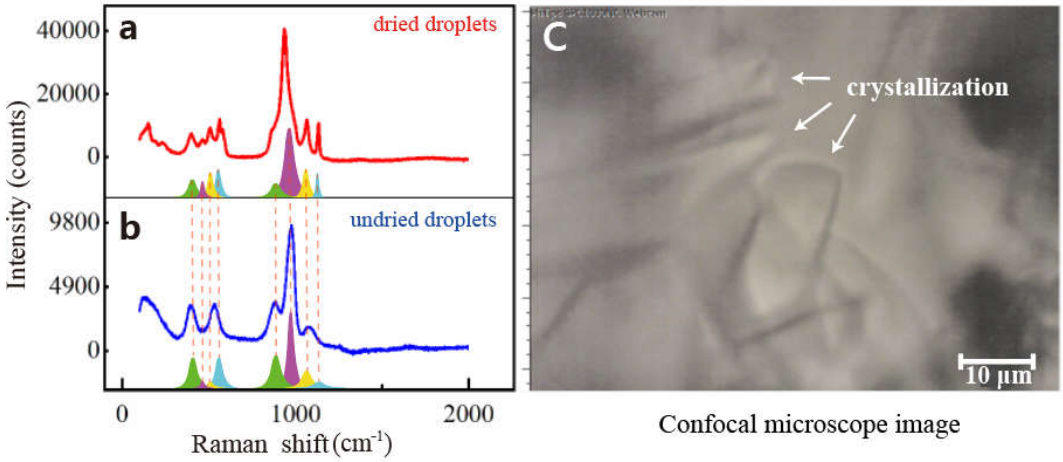


Figure S2. Comparison of Raman spectra before and after droplets drying and the crystallization of droplets. a-b) are the analysis results of the peak curve superposition of the Raman spectra. By analyzing the peak value of the waveform it can be noted that the horizontal shift of the peak has not changed. Only the amplitude has a significant increase after the droplets are dried. c) is the crystallization of droplets under the confocal microscope in the Raman spectrometer. It proves that the Raman scattering is sensitive to the crystal form and crystallinity of the material, while the droplets will crystallize during the drying process.

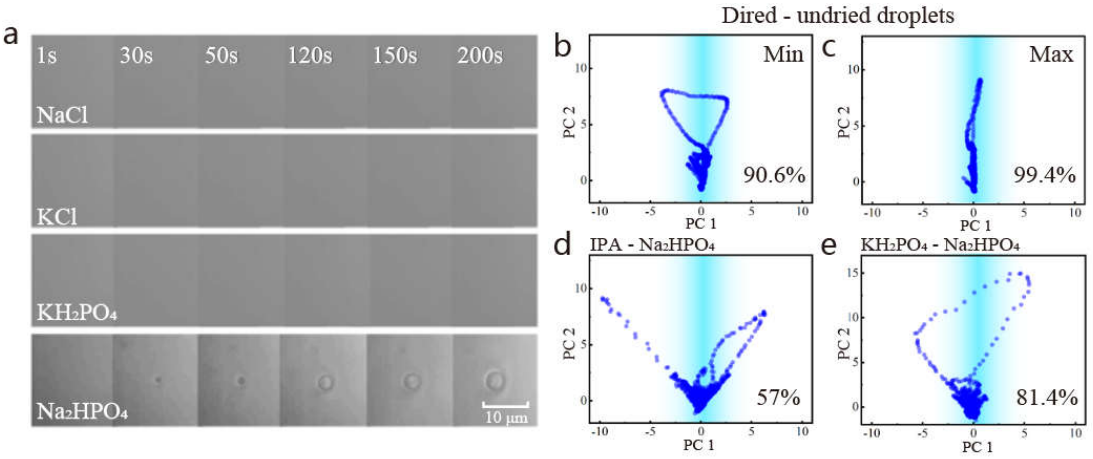


Figure S3. Phenomena of the single salt solution under the optical trap and the additional PCA results. a) shows the situation of a single salt solution under the light trap. These four salt solutions are the main components of PBS. It can be seen that only Na_2HPO_4 can generate droplets. This is because the refractive index of Na_2HPO_4 solution is significantly higher than the medium, which is one of the essential conditions of the optical trapping force. We also conduct several PCA comparisons for the composition of droplets and PBS. b-c) respectively represent the minimum and maximum similarity of the droplets spectra before and after drying; d-e) compare Na_2HPO_4 with IPA and KH_2PO_4, and these similarities are completely consistent with the comparison results of droplets. It also proves that the main component of the droplet is Na_2HPO_4

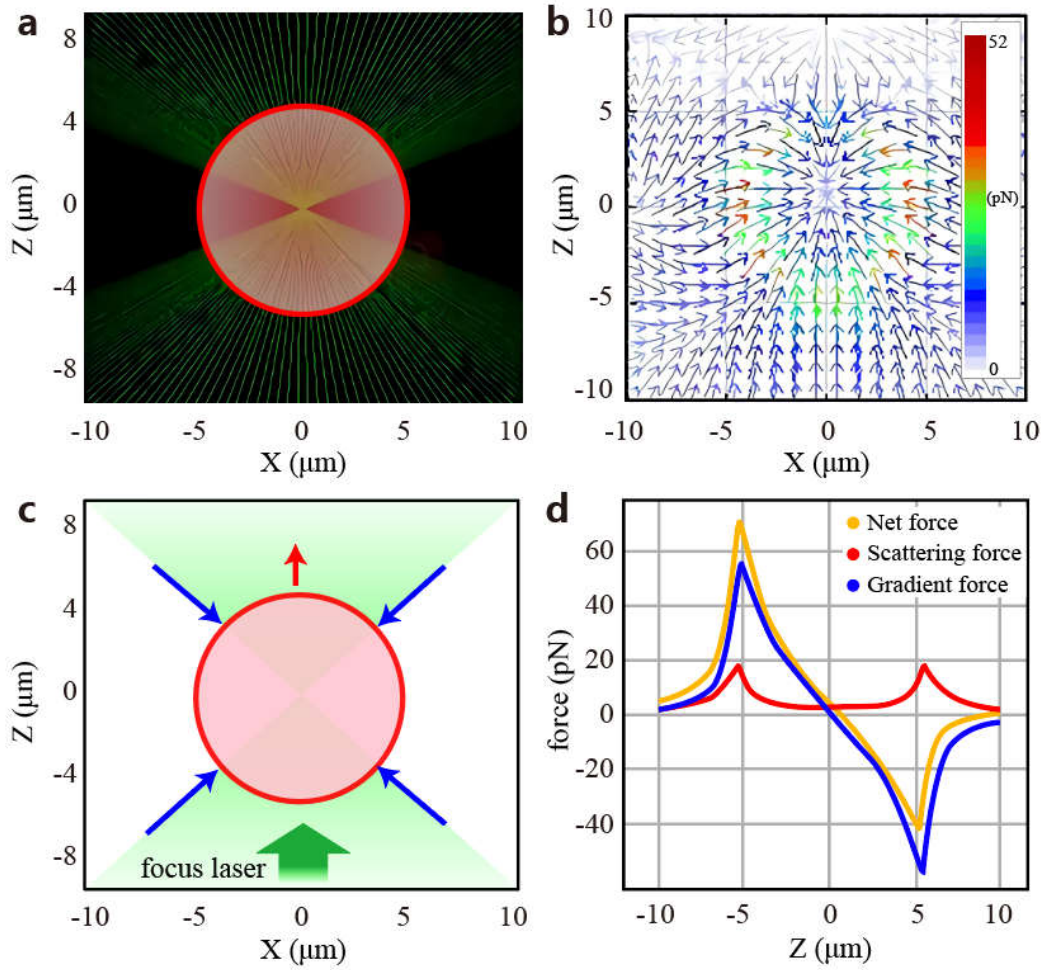


Figure S4. Trapping force analysis of droplets by ray optics. a) sets a 10 μm droplet to be placed in the center of the optical trap; b) is the longitudinal force of this droplet at this time; c) is the force diagram of the droplet; d) is the force curve of the droplet on the z-axis. Obviously, the optical trap has a strong capture for the generated droplets.

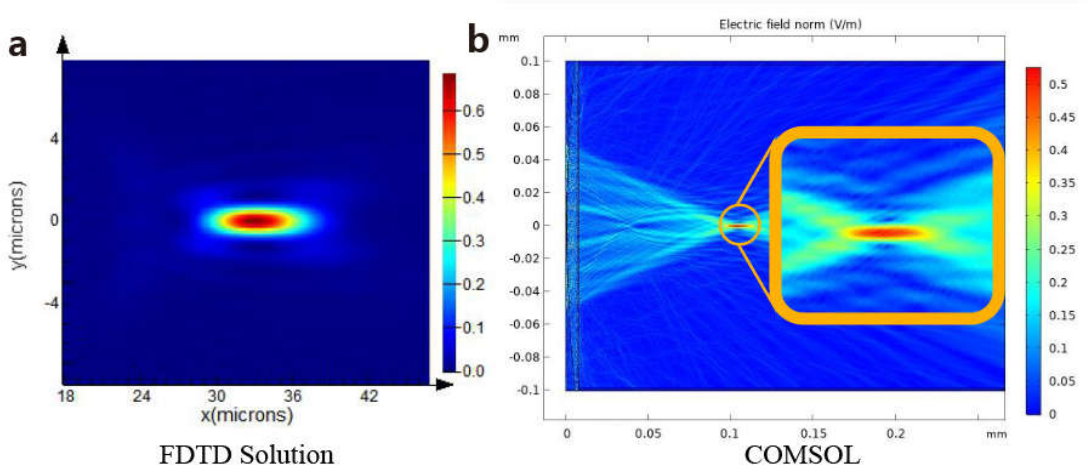


Figure S5. Save optics simulation comparison of "FDTD Solution" and "COMSOL". It is obvious that these two simulation results are highly consistent. Considering multiple verifications is a benefit for reliability, we finally chose the finite difference analysis software "FDTD Solution" to simulate the energy transmission of light waves.

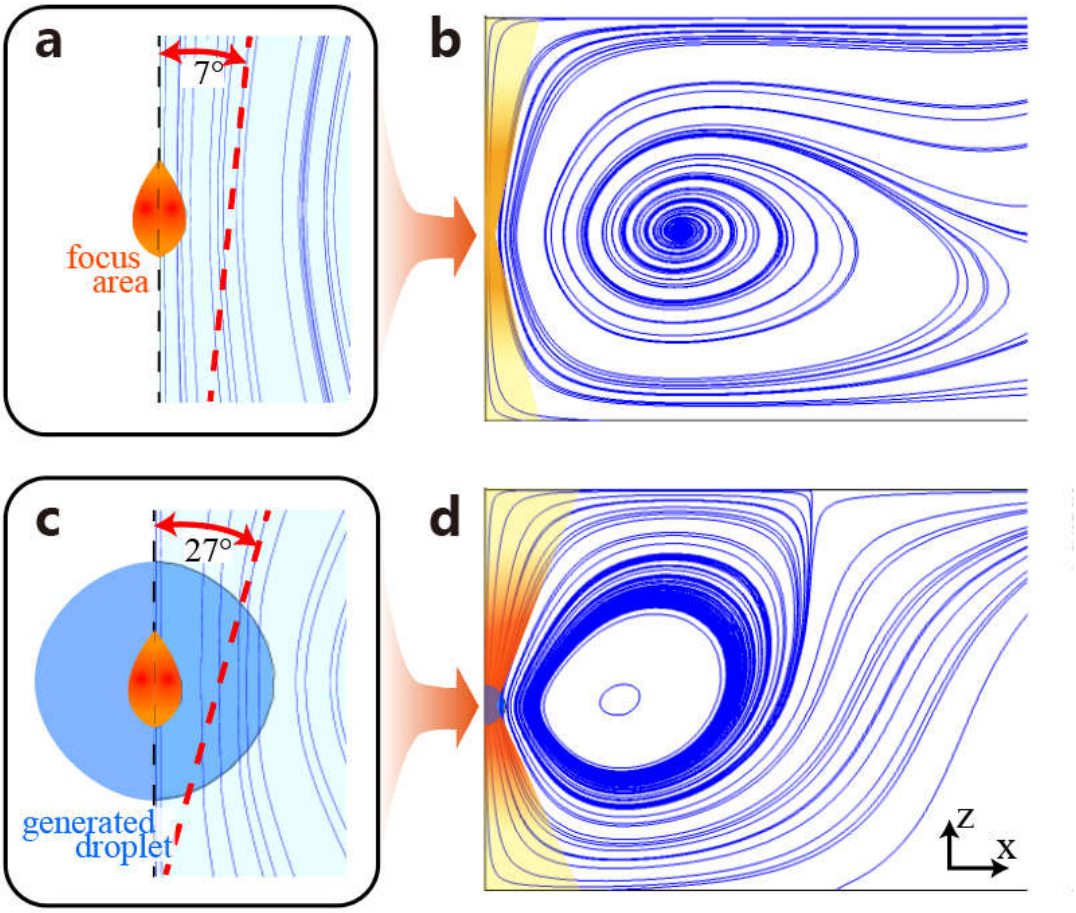
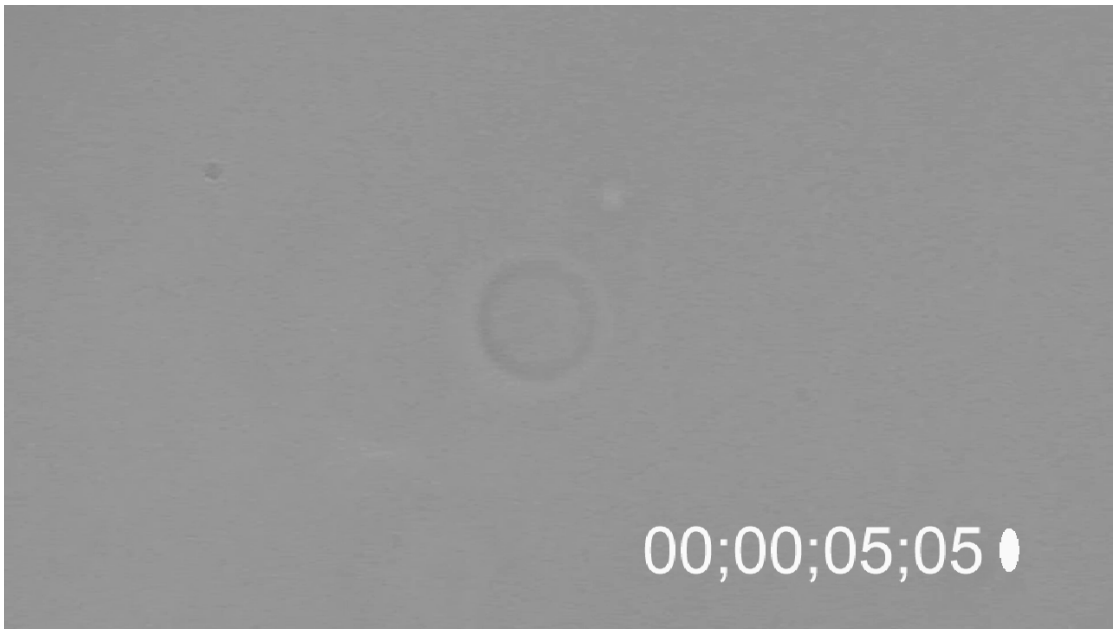


Figure S6. Effect of the generated droplets on the circulation. b-d) are the streamline simulations before and after the larger droplet generation, a-c) are the corresponding enlarged views of the optical trap center. Obviously, the generated large droplet significantly changes the direction of thermal diffusion in the solution. This significantly improves the circulation of the solution in the sample chamber.

Other Supplementary Files



Video 1: Generation process of a single droplet. In this video, it is clear to see that the surrounding tiny droplets are converging toward the formed droplets under the action of the light trap. Within a minute, the droplet size grew to more than 10 μm.