Passive and electrically active coalescence and mixing of pairs of trapped squeezed nanodroplets were studied in this work. PDMS–glass microfluidic devices were designed and fabricated using multilevel photolithography technique. Flow–focusing method was used to generate nanoliter droplets of died glycerol inside oleic acid. The effect of factors such as flow rates and their ratio, interfacial tension, and viscosities on the size and frequency of droplet generation was studied and concluded by demonstrating the capillary number effect. A passive droplet trapping technique based on minimizing the surface energy of the droplets was employed to minimize the shear flow effects and increase the accuracy of passive coalescence and mixing experiments. The theoretical platform was presented for the analysis of this multiphase problem and a numerical solver was developed based on the lattice Boltzmann method to simulate the passive and electric coalescence of the droplet pairs. Mixing of nanodroplets was studied by discussing the contributing mixing time scales and passive mixing of glycerol nanodroplets was experimentally realized. The rate of passive mixing percentage was derived by performing image processing and its exponential asymptotical behavior was presented. This study provided physical perspectives for droplet coalescence and mixing and can be extended in several numerical and experimental aspects.

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The public is welcome to attend.