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Joule heating-enabled nanoparticle enrichment in insulator-based dielectrophoretic microdevices.[1] AMIRREZA MALEKANFARD, ZHIJIAN LIU, XIANGCHUN XUAN, Clemson University — Dielectrophoresis has become a popular method for particle manipulation in microfluidic devices. It requires electric field gradients that can be created using in-channel hurdles and posts etc. However, these insulating structures amplify the Joule heating effect, leading to a non-uniform fluid temperature and in turn gradients in fluid conductivity and permittivity (as well as viscosity). The action of electric field on the Joule heating-induced fluid property gradients causes a regional fluid flow in the form of vortices. This so-called electrothermal flow has been previously found to reduce the particle focusing and trapping performance in insulator-based dielectrophoretic microdevices. We demonstrate in this work that the electrothermal flow vortices can be utilized to entrain nanoparticles for a localized enrichment near the insulating tips of a ratchet microchannel. We also develop a depth-averaged numerical model to simulate the fluid, heat, charge and mass transport involved in the process. A good agreement is obtained for each of the various parametric studies.

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