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Particle separation in microchannel at vicinity of gas-liquid interface using modified Taylor's flow

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ABSTRACT

In this study, the separation of micron-size particles from a liquid slug is achieved by using a novel passive mechanism called modified Taylor's flow. We have exploited the recirculation across the air- liquid interfaces to align particles in a streamline. The interfacial recirculation of concentrates particles is achieved along the center of the microchannel and this microchannel is fabricated through a three- step manufacturing process. When the flow regime is fully developed, particles far from the interface can be observed to follow the parabolic velocity profile that supports the no-slip boundary condition. A liquid-repellent solid wall, or a super hydrophobic solid wall, such as the one we fabricated in this case, shifts the parabolic profile, affecting the location of the maximum velocity along the channel. Similarly, along the channel with one wall of superhydrophobic coating, the interface also experiences an asymmetric drag resulting in a shift of particles away from the center line regime. This shift guides particles to one arm of the Y section of the channel, located downstream of the flow. To demonstrate this shift in particle stream, we conducted experiments along two different channels - one with a perfectly smooth surface and no superhydrophobic coating, and the second with a coating exhibiting a contact angle of 153◦. Moreover, we studied particle separation at different flow rates in order to understand the role of hydrodynamic operating parameters and determine the optimal flow rate. Higher separation efficiency can be achieved by adjusting the Capillary number and Reynolds number.

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