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Micropillar sequence design for inertial fluid flow sculpting[1]
DANIEL STOECKLEIN, BASKAR GANAPATHYSUBRAMANIAN, Iowa State University, CHUEH-YU WU, DINO DI CARLO, University of California at Los Angeles — New methods for controlling fluid flow in microchannels make use of inertial fluid flow deformation around pillar structures spanning the height of the channel. A small set of micropillar sizes and locations has been shown to produce a rich phase space with a wide variety of flow transformations, demonstrating the untapped wealth of possibilities in this fluid flow manipulation scheme. Previous work has successfully demonstrated the potential, with experimental validation, for manual hierarchical design where sequences of pillars are stacked to create flow sculpting. But such a method is not ideal for seeking out complex sculpted flows where the search space quickly becomes too large for efficient manual discovery. This is further complicated by the non-uniqueness of pathways to a desired fluid transformation, and the effect of diffusion as the number of micropillars increases. We formulate the inertial flow transformation as a set of state transition matrix operations. This allows rapid simulation of different design configurations, enabling efficient optimization over a large search space. We show how this framework can be used for novel fluid sculpting targets with application in microelectronics and medical diagnostics, and also show validation via confocal imaging.

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Daniel Stoecklein
Iowa State Univ

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