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Fluid pumping using magnetic cilia[1] SRINIVAS HANASOGE, MATT BALLARD, ALEXANDER ALEXEEV, PETER HESKETH, Georgia Tech, WOODRUFF SCHOOL OF MECHANICAL ENGINEERING TEAM — Using experiments and computer simulations, we examine fluid pumping by artificial magnetic cilia fabricated using surface micromachining techniques. An asymmetry in forward and recovery strokes of the elastic cilia causes the net pumping in a creeping flow regime. We show this asymmetry in the ciliary strokes is due to the change in magnetization of the elastic cilia combined with viscous force due to the fluid. Specifically, the time scale for forward stroke is mostly governed by the magnetic forces, whereas the time scale for the recovery stroke is determined by the elastic and viscous forces. These different time scales result in different cilia deformation during forward and backward strokes which in turn lead to the asymmetry in the ciliary motion. To disclose the physics of magnetic cilia pumping we use a hybrid lattice Boltzmann and lattice spring method. We validate our model by comparing the simulation results with the experimental data. The results of our study will be useful to design microfluidic systems for fluid mixing and particle manipulation including different biological particles.

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