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Simulations of Micropumps Based on Tilted Flexible Fibers MATTHEW HANCOCK, NAGI ELABBASI, Veryst Engineering, LLC, MELIK DEMIREL, The Pennsylvania State University — Pumping liquids at low Reynolds numbers is challenging because of the principle of reversibility. We report here a class of microfluidic pump designs based on tilted flexible structures that combines the concepts of cilia (flexible elastic elements) and rectifiers (e.g., Tesla valves, check valves). We demonstrate proof-of-concept with 2D and 3D fluid-structure interaction (FSI) simulations in COMSOL Multiphysics®of micropumps consisting of a source for oscillatory fluidic motion, e.g. a piston, and a channel lined with tilted flexible rods or sheets to provide rectification. When flow is against the rod tilt direction, the rods bend backward, narrowing the channel and increasing flow resistance; when flow is in the direction of rod tilt, the rods bend forward, widening the channel and decreasing flow resistance. The 2D and 3D simulations involve moving meshes whose quality is maintained by prescribing the mesh displacement on guide surfaces positioned on either side of each flexible structure. The prescribed displacement depends on structure bending and maintains mesh quality even for large deformations. Simulations demonstrate effective pumping even at Reynolds numbers as low as 0.001. Because rod rigidity may be specified independently of Reynolds number, in principle, rod rigidity may be reduced to enable pumping at arbitrarily low Reynolds numbers.

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