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Use of Buckling Instabilities in Micro Pumps, Valves, and Mixers

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— We use the buckling of thin, flexible plates for pumping fluids, controlling the flow rate, and mixing different media within a microfluidic channel. A dielectric elastomeric film with a confined geometry buckles out of the plane when exposed to an electric field. Solid or grease electrodes have traditionally been used as conductive materials to aid in voltage application to both sides of the film. In this work, we use an electrolytic fluid solution as the electrode to enable buckling at relatively low voltages, and to enhance the rate of deformation. We show that this mechanism can be implemented as a microvalve that controls flow rate, or as a micropump that operates over a range of frequencies. A similar mechanism can be used to aid diffusion between two adjacent laminar streams and improve mixing. These low-cost micropumps, microvalves, and micromixers rely on the reversible buckling of thin plates, are easily embeddable in a microfluidic chip, and can potentially be used in variety of applications to accurately control and manipulate fluid flow in a microchannel.

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