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**Flow reversal in enzymatic microfluidic pumps** HENRY SHUM, University of Pittsburgh, ISAMAR ORTIZ-RIVERA, ARJUN AGRAWAL, AYUSMAN SEN, Pennsylvania State University, ANNA BALAZS, University of Pittsburgh —
A chemical reaction occurring at an enzyme-covered patch in a closed fluid chamber generates local solute concentration gradients and, hence, fluid density gradients. This has recently been shown to drive fluid flows with speeds of the order of microns per second. We develop and analyze a model that accounts for fluid density changes due to consumption of the reaction substrate and accumulation of products for such a fluid pump based on the enzyme urease. Hydrolysis of urea by urease produces ammonium bicarbonate, which leads to a net increase in solution density. Higher density fluid is expected to sink and spread horizontally away from the pump. Modeling reveals, however, that the local fluid density is not necessarily greatest near the pump and fluid flow can even reverse in direction after some time. The qualitative behavior depends on two dimensionless parameters, the ratio of solutal expansion coefficients and the ratio of diffusion coefficients for the reaction substrate and product. The predicted reversal of pumping direction is experimentally verified and we show that the direction of pumping also depends on the amount of enzyme present on the patch. A better understanding of these pumps will aid in the design of responsive, chemically powered microfluidic flow control.

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