Supplementary Information

Self-propelling motion of the swimmer

The animation demonstrates self-propelling motion of the gel micro-swimmer in a highly-viscous low-Reynolds-number fluid. The swimmer motion is due to non-reciprocal beating of rigid propulsive flaps driven by oscillating swimmer body that periodically expands and contracts. The swimmer first moves along a straight line during ten oscillation periods. After that the steering flap, attached to the swimmer front end, bends due to an external stimulus (indicated by a light bulb) and causes swimmer turning. The swimmer turns due to the asymmetry of the curved steering flap and its periodical beating. The swimmer parameters are $\mathscr{E} = 3$, $AR_p = 2$, $AR_s = 0.5$, $\Lambda = 2.12$, and $\kappa = 1$.

Fluid flow induced by the swimmer motion

The figure shows fluid velocities in the $x-y$ and $x-z$ planes through the middle of the swimmer body during one period of the gel body oscillations. Blue arrows represent velocity vectors and black contours represent swimmer body and flaps. The size of the reference arrow in the figure top corresponds to the magnitude of the characteristic velocity V_c. The swimmer parameters are $AR_p = 2$, $AR_s = 1$, and $\mathscr{E} = 3$.