

Supporting information

Biofouling-resistant tubular fluidic device with magneto-responsive dynamic walls

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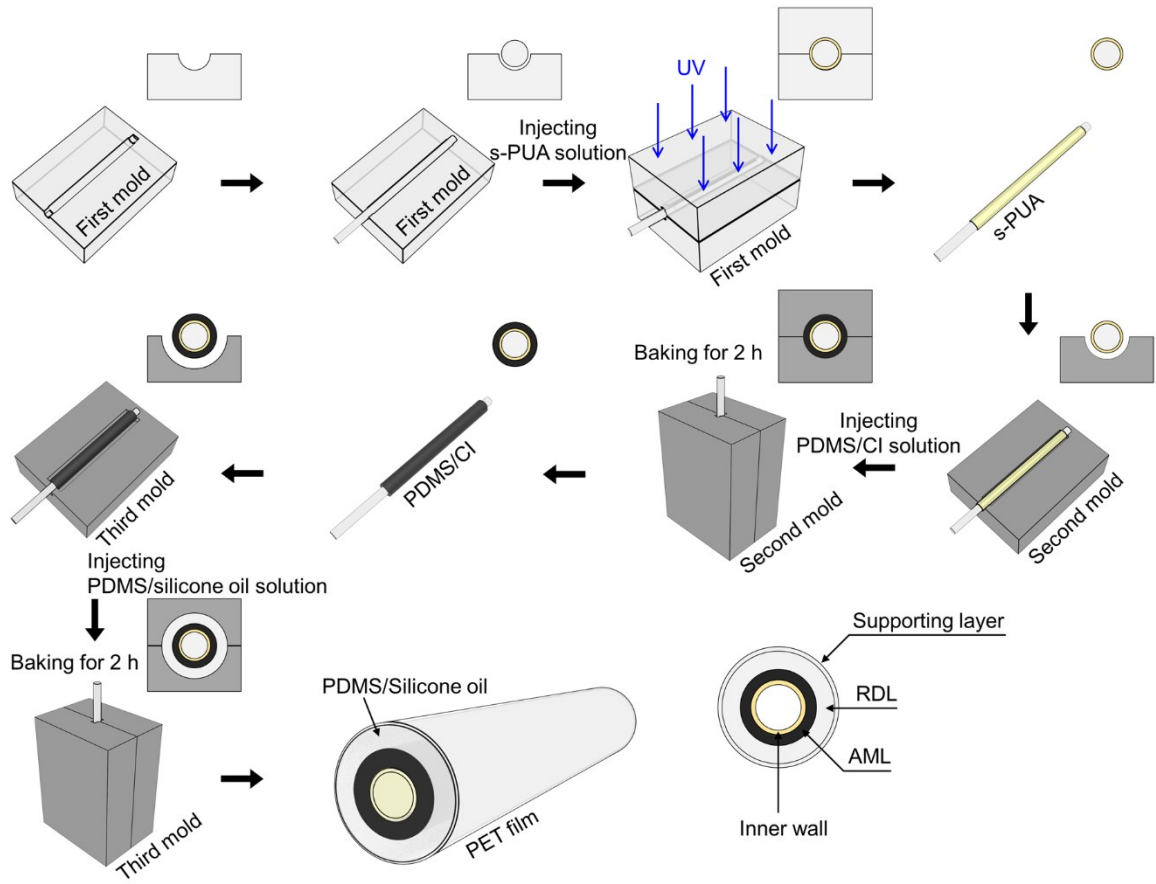


Fig. S1. Schematic of fabrication process of the composite tubular device with dynamic undulatory inner walls.

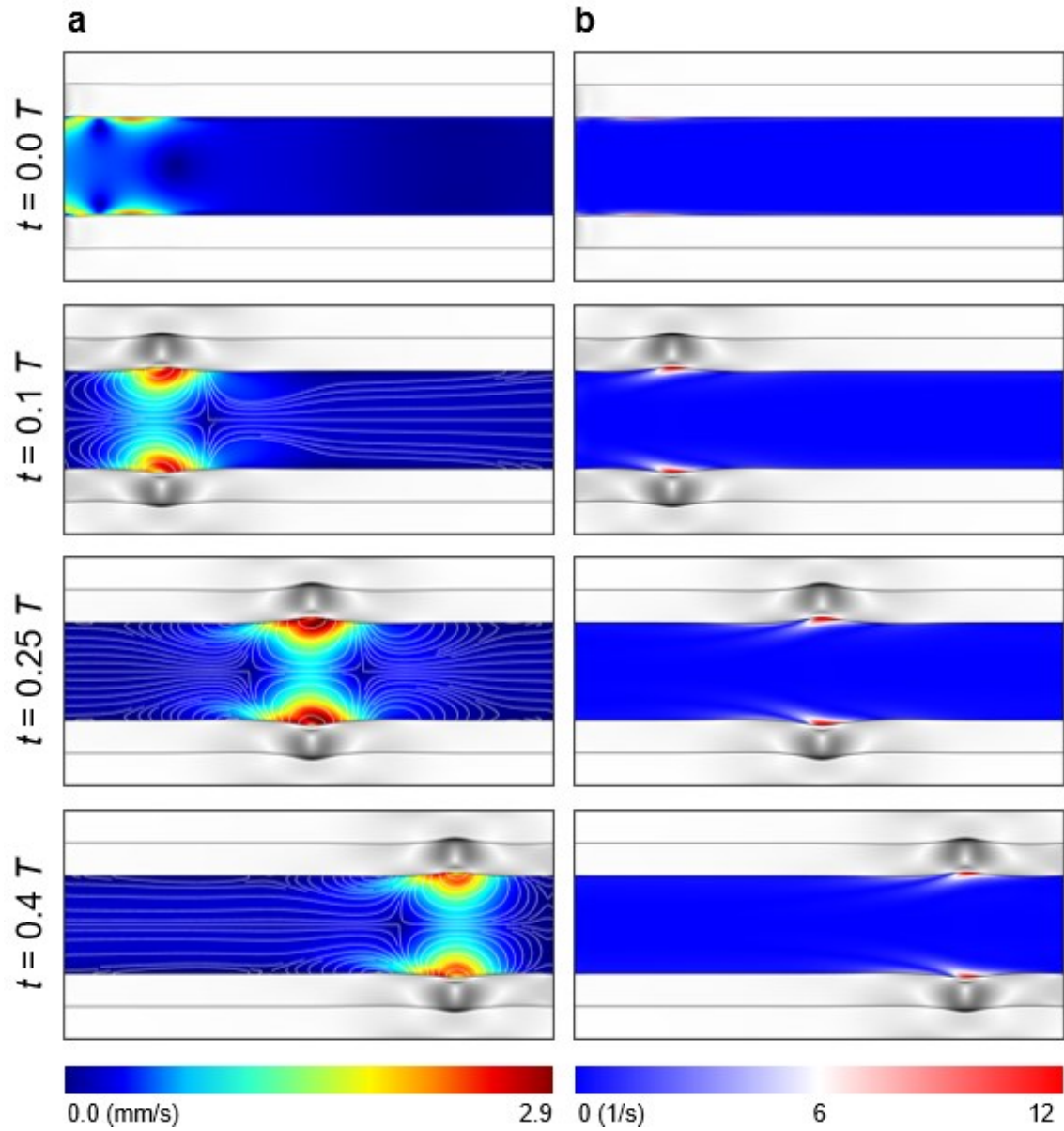


Fig. S2. FEA of the fluid velocity field and magnitude of vorticity in the composite tube with dynamic undulatory inner walls. a) Simulation results of the velocity field of the flow in the dynamic tube for $T = 3$ s and $H = 0.63$ mm. b) Simulation results of magnitude of vorticity in the dynamic tube for $T = 3$ s and $H = 0.63$ mm.

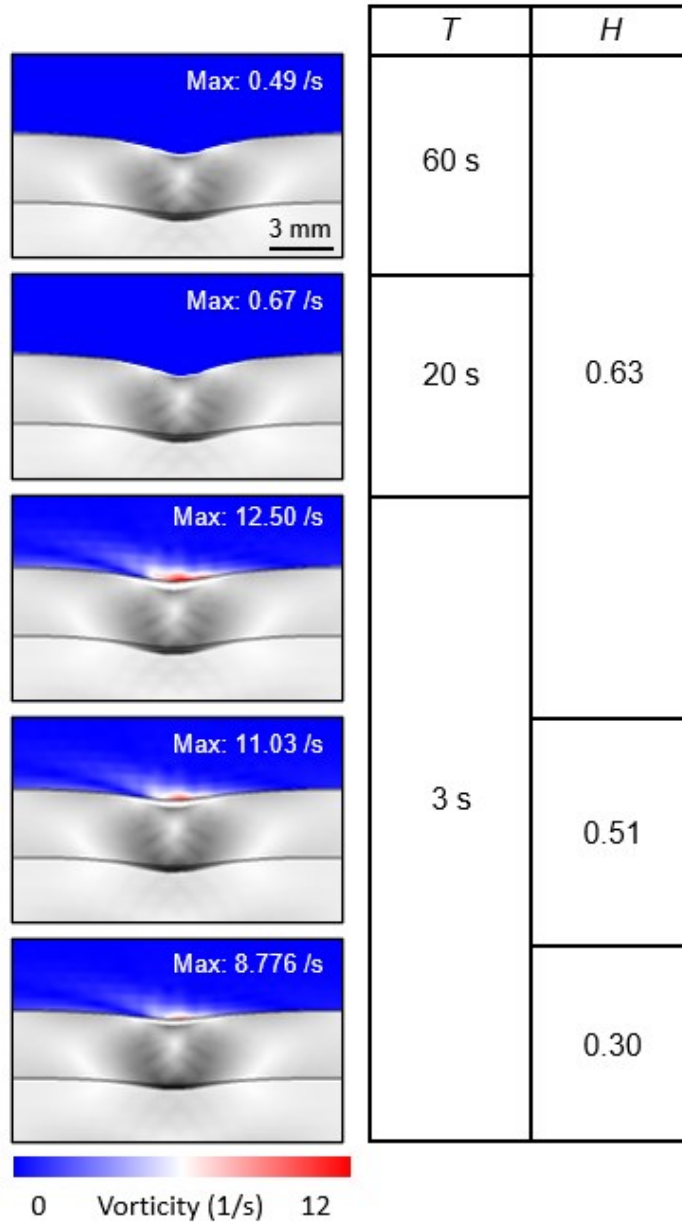


Fig. S3. FEA of the magnitude of vorticity in the dynamic tubes with undulatory waves of different periodic times ($T = 3, 20, 60$ s) and amplitudes ($H = 0.30, 0.51, \text{ and } 0.63$ mm).

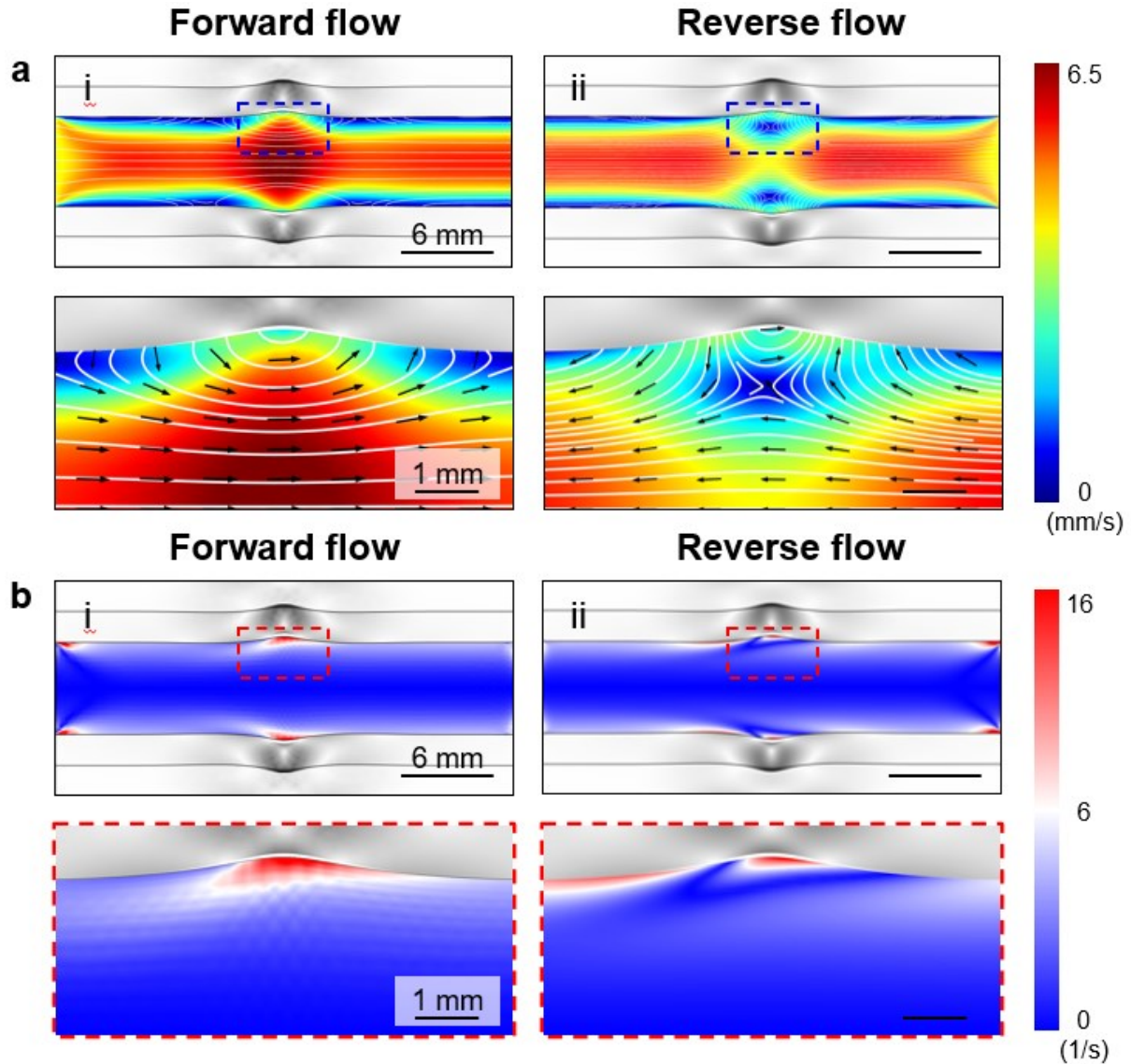


Fig. S4. a) FEA of the fluid velocity field inside the dynamic tube ($T = 3$ s and $H = 0.63$ mm) through which a fluid flows in the (i) forward or (ii) reverse directions. b) FEA of the vorticity inside the dynamic tube ($T = 3$ s and $H = 0.63$ mm) through which a fluid flows in the (i) forward or (ii) reverse directions. This FEA was performed to investigate if the vortex generated by the surface waves disturb the fluid flow through the tube. By considering the minimum fluid velocity in the central venous catheter or urethral catheter, we set the fluid velocity of the forward or reverse flow as 4.0 mm s^{-1} . [1-3] FEA results show that the vortex generated by the surface waves did not disturb the overall fluid flow through the catheter.

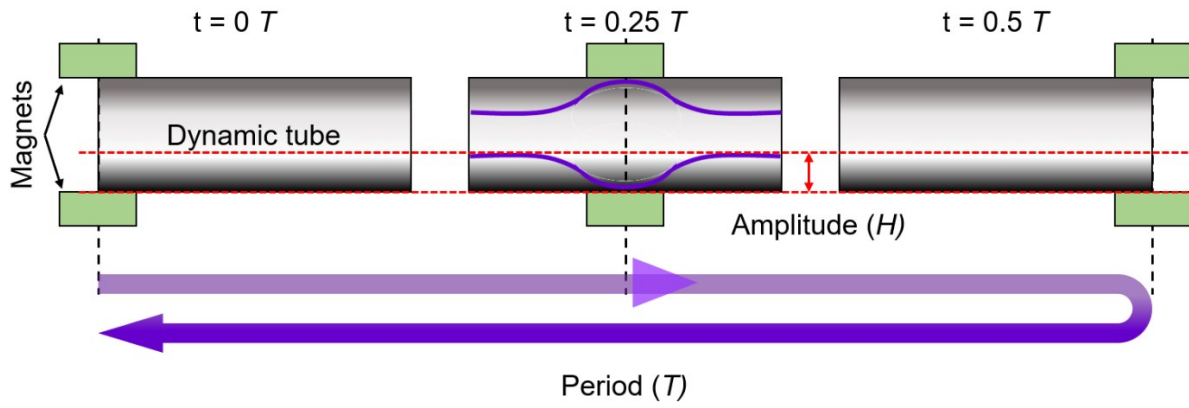
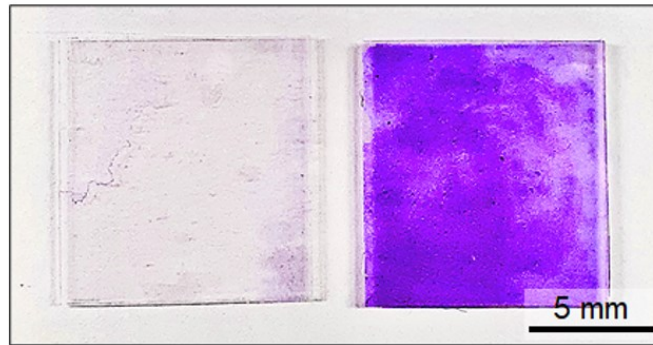


Fig. S5. A schematic illustration describing the terms of amplitude (H) and periodic time (T) of the surface wave.

Crystal violet-stained biofilm



Dynamic
 $T = 3, H = 0.63$

Static
 $T = \infty, H = 0$

Fig. S6. A photograph of the unfolded tube's innermost walls stained with crystal violet after the 14d-exposure to *B. subtilis* culture with- (left) and without- (right) topographical wave generation ($T = 3$ s, $H = 0.63$ mm).

Movie S1. Real-time fluorescence video recording of undulatory inner walls of the composite tube generated by the translation of a permanent magnet.

Movie S2. Real-time monochromic video recording of undulatory inner walls of the composite tube generated by the translation of a permanent magnet.

Movie S3. Real-time fluorescence video recording of tracer particles inside the dynamically undulating composite tube in response to a translating magnetic field.

References

- [1] A.G. Baseman, J.G. Baseman, P.E. Zimmern, G.E. Lemack, Effect of 6F urethral catheterization on urinary flow rates during repeated pressure-flow studies in healthy female volunteers. *Urology* 59 (6) (2002) 843-846.
- [2] B.R. Herts, C.M. O'Malley, S.L. Wirth, M.L. Lieber, B. Pohlman, Power injection of contrast media using central venous catheters: feasibility, safety, and efficacy. *AJR Am. J. Roentgenol.* 176 (2) (2001) 447-453.
- [3] L.M. Moist, B.R. Hemmelgarn, C.E. Lok, Relationship between blood flow in central venous catheters and hemodialysis adequacy. *Clin. J. Am. Soc. Nephrol.* 1 (5) (2006) 965-971.