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How the natural structure of cuttlebone facilitates efficient microfluidic transport KARL FROHLICH, EHSAN ESMAILI, Cornell University, TING YANG, LING LI, Virginia Tech, SUNGHWAN JUNG, Cornell University —
When a viscous fluid is displaced by a less viscous fluid in a thin channel, the interface moves unevenly due to the SaffmanTaylor instability. Suppressing such instability plays a key role in many petroleum industries and biological systems. One natural example of this phenomenon is in the bones of cuttlefish. These cuttlebones contain multiple parallel microscopic chambers which are reinforced by winding vertical wall-like structures. It has been studied that the cuttlefish regulates its buoyancy by pumping water in and out of this structure. In this study, we investigate the cuttlebone structure for its unique ability to suppress the instability of a moving liquid-gas interface. Cuttlebone samples were studied in vitro to understand how fluid moves through the structure at different pressures and flow rates. Additionally by using cuttlebone structure as biological inspiration, we fabricated simplified channels using 3D resin printing in order to more rigorously test the impact of the liquid-gas meniscus at varying channel curvatures, pressures and other arrangements. Results show that a presence in channel curvature and positioning, like that seen in cuttlebone, can prevent the uneven growth of menisci, helping to transport a liquid-gas interface more uniformly.

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