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Bubble length affects bubble speed in a rough microfluidic channel QUAN ZHANG, University of Chicago, KONSTANTIN TURITSYN, Los Alamos National Laboratory, TOM WITTEN, University of Chicago — We discuss the creeping motion of bubbles of different length in rough capillary tubes filled with carrier fluids. This extends the results of Bretherton[1] for an infinite-length bubble at small capillary number Ca in a circular tube. We first derive the asymptotic corrections to the speed owing to finite length. This dependence on length is exponentially small, with a decay length much shorter than the tube radius R. Then we discuss the effect of azimuthal roughness of the tube on the bubble speed. Tube roughness leads to a carrier fluid flow in the azimuthal plane; this flow controls the relaxation of the bubble shape to its infinite length limit. For long-wavelength roughness, we find that the above decay length becomes much longer and even comparable to R. This implies a much-enhanced dependence of the bubble velocity on length. A shorter bubble should then catch up with a longer bubble ahead of it in the same channel. This mechanism may explain catch-up effects seen experimentally.[2]

[1]F.P.Bretherton, 1961, J. Fluid Mech., 10, 166.
[2]R.Ismagilov, private communication.

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