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Enhancement of flagellated bacterial motility in polymer solutions[1] WENYU ZHANG, SHA SHA, ROBERT PELCOVITS, JAY TANG, Brown University — Measurements of the swimming speed of many species of flagellated bacteria in polymer solutions have shown that with the addition of high molecular weight polymers, the speed initially increases as a function of the kinematic viscosity. It peaks at around 1.5-2 cP with typically 10-30% higher values than in cell media without added polymers ($\sim$ 1 cP). Past the peak, the average speed gradually decreases as the solution becomes more viscous. Swimming motility persists until solution viscosity reaches 5-10 cP. Models have been proposed to account for this behavior, and the magnitude of the peak becomes a crucial test of theoretical predictions. The status of the field is complicated in light of a recent report (Martinez et al.,PNAS, 2014), stressing that low-molecular weight impurities account for the peaked speed-viscosity curves in some cases. We measured the swimming speed of a uni-flagellated bacterium, caulobacter crescentus, in solutions of a number of polymers of several different sizes. Our findings confirm the peaked speed-viscosity curve, only as the molecular weight of the flexible polymers used surpassed $\sim$ 50,000 da. The threshold molecular weight required to augment swimming speed varies somewhat with the polymer species, but it generally corresponds to radius of gyration over tens of nanometers. This general feature is consistent with the model of Powers et al. (Physics of Fluid, 2009), predicting that nonlinear viscoelasticity of the fluid enhances swimming motility.

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Jay Tang
Brown University

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