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Transport of Micro-particles by Active Cilia Arrays AMITABH BHATTACHARYA, Department of Chemical Engineering, University of Pittsburgh, GAVIN BUXTON, Department of Science, Robert Morris University, O. BERK USTA, Center for Engineering in Medicine, Massachusetts General Hospital, ANNA. C. BALAZS, Department of Chemical Engineering, University of Pittsburgh — Biological organisms are known to use hair-like filaments called cilia to manipulate and transport particles. The coordinated motion of cilia is known to be effective at propelling surrounding fluid. In this work, we show that adhesive interaction between the actuated cilia and particulates can be crucial towards controlling particle transport. We model transport of a microscopic particle via a regular array of beating elastic cilium, whose tips experience an adhesive interaction with the particle's surface. At optimal adhesion strength, the average particle velocity is maximized. Using simulations spanning a range of cilia stiffness, particle radius, and cilia-particle adhesion strength, we explore the parameter space over which the particle can be "released," "propelled" or "trapped" by the cilia. We use a low-order model to predict parameters for which the cilia are able to attach themselves to the particle. We also study the effect of varying the particle size and stiffness on its transport properties. This is the first study that shows how both stiffness and adhesion strength are crucial for manipulation of particles by active cilia arrays.

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