Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Dynamics of self-oscillating cilia designed from active polymer gels PRATYUSH DAYAL, AMITABH BHATTACHARYA, OLGA KUKSENOK, ANNA C. BALAZS, University of Pittsburgh — Using theory and simulations, we design active synthetic surfaces which are capable of replicating functionalities of biological cilia. In order to design such exquisite biomimetic systems we harness unique properties of polymer gels that undergo photosensitive Belousov-Zhabotinsky (BZ) reaction. Powered by internalized BZ reaction these polymer gels swell and de-swell autonomously by chemo-mechanical transduction and therefore are ideal materials for designing our system. In order to simulate the dynamics of the BZ cilia in surrounding fluid we have developed a nonlinear hybrid 3D model which captures elasto-dynamics of polymer gel and diffusive exchange of BZ reagents between the gel and the fluid. Here we show that the geometrical arrangement of cilia and the distribution of BZ activator in the fluid determine the dynamic response of the cilia. We further show that using light as an external stimulus we can sequentially modulate height of individual cilium and thereby create the "piano effect". Finally, we demonstrate that synchronized oscillations in the cilia result from the distribution of BZ-activator in the surrounding fluid. Our findings can be used to design active surfaces which can be remotely tuned depending upon the magnitude of external stimuli.

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Date submitted: 11 Nov 2011 Electronic form version 1.4