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Kimberly Branshaw
Illinois Wesleyan University

Yiping Zhu
Illinois Wesleyan University

Narendra Jaggi, Faculty Advisor
Illinois Wesleyan University

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Kimberly Branshaw, Yiping Zhu
and Narendra K. Jaggi*
Physics Department, Illinois Wesleyan University

Giant electromotility of a class of polyelectrolyte gels in ionic solutions has recently attracted much attention as a possible route to chemomechanical engines. Studies[1] conducted in the Laboratory for Materials Physics at IWU have demonstrated that electric field induced asymmetry in the diffusion coefficient is the fundamental mechanism responsible for electromotility in these materials. This led to experiments designed to characterize the zero field diffusion in complete detail.

These materials can absorb a large amount of water. They swell to a volume that can be up to 60 times their initial volume. During our experiments, we discovered what at first seemed to be a nonintuitive diffusion behavior. For the most weakly crosslinked material, the mass uptake was discovered to be non-monotonic in time! Initially, the amount of absorbed water increases with time, as expected. At long times however, the material starts shrinking by expelling water from within. This would be akin to a sponge squeezing itself!

A number of hypotheses, ranging from the cute to the bizarre (bugs feeding on these polymers) were experimentally tested. Our tentative explanation of this apparently nonintuitive behavior consists of a competition between an inward traditional diffusion of water and an outward diffusion of linearly polymerized but **uncrosslinked** material. The underlying diffusion coefficients are very strong functions of the concentration of water. This makes the solution of coupled diffusion equations nontrivial. We are trying to numerically solve a simplified version of this model. We hope to retain the essence of the problem and find non-monotonic solutions in qualitative agreement with our experiments.

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