Ion Exchange Micropumps

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The development of micro/nanomachines which can move in a controlled way and perform useful tasks in a fluid environment is one of the most interesting challenges confronting nanoscience and nanotechnology today. Besides the difficulties of nanofabrication, fighting against the dominance of viscous forces and Brownian motion makes necessary the development of efficient strategies to convert chemical energy into directed motion. In this context, different methods of self-propulsion have been investigated, such as catalytic reactions or bubble propulsion.

Ion exchange polymers, such as Nafion, constitute an interesting alternative mechanism to achieve self-propulsion. The exchange of ions with different mobilities generates the interesting formation of solute exclusion zones that could be tailored to generate directed motion.

In this contribution, we will discuss the interesting non-equilibrium thermodynamics mechanism driving the formation of exclusion zones and the operation of ion-exchange micropumps. Experiments, simulations, and theory will be combined to provide a better understanding of this process and important clues on how to design efficient autonomous micropumping of fluids for different applications.