360i Self-Propelling Semiconductor Devices Demonstrate New Electroosmotic Motility Principles

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A range of "smart" particles that respond to external stimuli are presently developed by many groups, however, no particles that are able to self-propel in pure water or arbitrary liquids have been demonstrated. The major obstacles to making artificially moving microdevices include finding a source of power for motility, developing propellency principles and methods to control the direction and speed of motion. We demonstrate that various types of miniature semiconductor diodes floating in water can act as self-propelling particles when an alternating electric field is applied across the container with the liquid. The millimeter-sized diodes generate electroosmotic force, which propels them in the direction of either the cathode or the anode depending on the surface charge of the particles. The velocity depends on the electrolyte concentration and pH of the solutions. The electroosmotic fluxes and the equivalent electric circuits can the modeled and interpreted with a satisfactory precision by using commercial computational packages. The voltage generated across the electrodes could be used to power additional functions and potentially turn these particles into functional microdevices. The diode motility can, for example, be used to power rotating "gears" and can be controlled by light. Thus, we have demonstrated rudimentary solutions to problems facing autonomous self-propelling micromachines, including providing power by external fields, controlled directional movement, and potential for a range of additional functions.