Nanowire position and orientation precisely controlled using fluid flow

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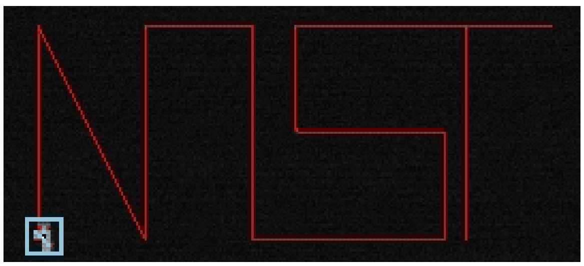

Video showing a 10 µm × 1 µm fluorescently labeled rod being controlled using a combination of electric fields and fluid flow to travel along the “NIST” path, graphically underlaid in red. The rod is made to simultaneously rotate and align itself tangential to each of the 12 line segments by the time its center of mass reaches the end of a segment. The imaged area is 160 µm × 70 µm.

(Phys.org) —Scientists from the the NIST Center for Nanoscale Science and Technology and the University of Maryland have used a combination of electric fields and fluid flow to precisely move and rotate nanowires, and have demonstrated that this method can be used to manipulate nanowires regardless of whether they are made from dielectric, semiconducting, or metallic materials. Since electro-osmosis, which uses an applied electrostatic potential to move liquid across a fluid channel, is equally effective at moving nanowires regardless of what they are made from, the technique has potential use in a wide variety of applications, including building structures to sense and guide electromagnetic waves, steering nanowire light sources, and guiding nanowires to precisely deliver chemicals to cells.

The researchers fabricated a 170 µm × 170 µm central control region at the intersection of four microchannels. A feedback-control system was used to generate the fluid flows needed to translate and rotate the nanowire. Based on a nanowire's position and orientation, which are observed through a microscope objective, a computer algorithm determines the quartet of voltages needed on the peripheral electrodes to create a fluid flow that will precisely move the nanowire to another specific location and orientation. The device is capable of moving nanowires with an average trapping precision of 600 nm in position and 5.4° in orientation.

Because the technique is material-independent, it can be used to manipulate any type of nanowire or other, more complex rod-shaped structures, leading the researchers to envision a variety of new measurement methods. For example, nanowires can be engineered to respond to their environment by emitting fluorescent light with an intensity related to the local optical field. Using this new method, one could steer such nanowires in liquids around an object of interest, with the fluorescence intensity serving as a reporter of the local field, and thereby map those fields remotely on the nanometer scale.

More information: Mathai, P. et al. Simultaneous positioning and orientation of single nano-wires using flow control, *RSC Advances* 3, 2677–2682 (2013). pubs.rsc.org/en/content/articl … g/2013/ra/c2ra23190e

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