Nanomotors controlled with laser light

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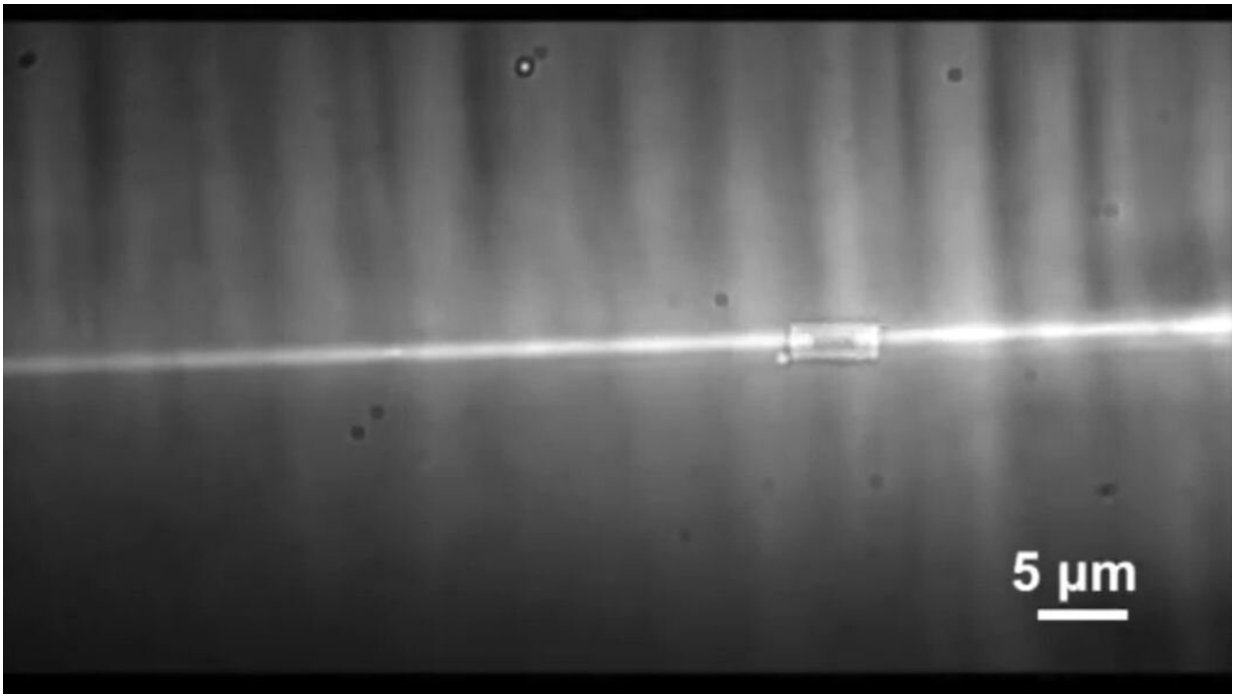

Credit: University of Tokyo

Researchers from the Institute of Industrial Science, the University of Tokyo (UTokyo-IIS) have designed novel linear nanomotors that can be moved in controlled directions using light. This work opens the way for new microfluidics, including lab-on-a-chip systems with optically actuated pumps and valves.

The world of nanoscale machines looks very different to the one

containing the contraptions to which we have become accustomed. For example, powering and precisely controlling a motor smaller than a single bacterium can be much more difficult than, say, driving a car.

Now, a team of scientists led by UTokyo-IIS have introduced a system of linear motors made from gold nanorods that can move in a controlled direction when exposed to laser light. Like a sailboat that can move in any desired direction by adjusting the rigging, these nanomotors are not constrained to follow the direction of the light. Rather, they move based on their orientation even when exposed to a laser beam traveling from another angle.

The motion is powered by the lateral optical force created from the sideways scattering of light from the particles. As a result, the need to focus or shape the laser beam with lenses, which was once a difficult task, is eliminated. In addition, motor sizes are not constrained by the wavelength of light, unlike with previous devices.

"Instead of being limited to moving in the direction of laser light or the field gradient, the direction is determined by the orientation of the nanoparticles themselves," first author Yoshito Tanaka says. The key to this technology is the localized surface plasmon resonance—collective oscillations of free electrons—within periodic arrays of nanorods. These can produce scattered light in a particular direction. "Careful design of the separation between nanorods leads to constructive interference in one direction and destructive interference in the other. This allows us to produce directional scattering to propel the nanomotor," senior author Tsutomu Shimura says.

The researchers envision using this technology to create a new platform for nano-sized machinery with moving parts that follow predetermined paths while being nudged along by unfocused light. This will greatly reduce the cost and complexity of these devices while also improving

precision and reliability.

The work is published in *Science Advances* as "Plasmonic linear nanomotor employing lateral optical forces."

More information: "Plasmonic linear nanomotor using lateral optical forces" *Science Advances* (2020). advances.sciencemag.org/lookup … .1126/sciadv.abc3726

Provided by University of Tokyo