Researchers use light beams to grab molecules

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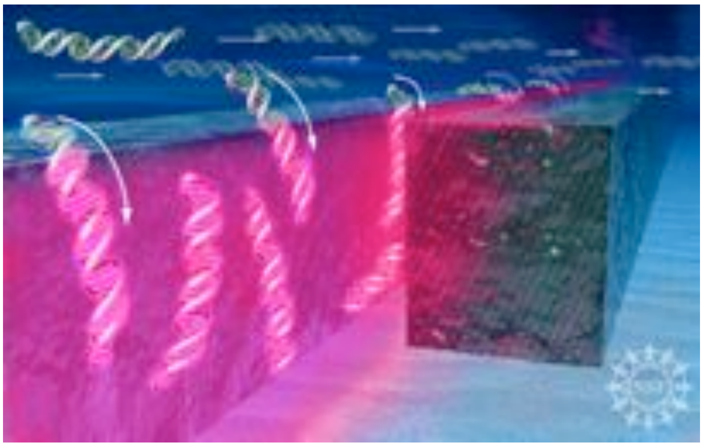
Courtesy National Science Foundation and World Science staff



Using a beam of light shunted through a tiny silicon channel, researchers say they've created a nanoscale, or molecular-scale, trap that can capture individual DNA molecules.

The work is part of research into systems designed to manipulate nanoscale objects so that they can be moved to desired places for analysis or for building tiny structures, such as machines.

Researchers from Cornell University in New York reported the findings in the Jan. 1 issue of the research journal Nature. Engineers need to "manipulate matter at the scale of molecules and atoms," said William Schultz, a program officer at the U.S. National Science Foundation who oversaw the funding for the research. "The Cornell researchers have made an important step in realizing the full potential of these devices."

Light had been used to manipulate cells and even nanoscale objects before, but the new technique allows researchers to manipulate the particles more precisely and over longer distances, developers said.

Physicists found decades ago that light can be thought of either as a form of waves, or as streams of weightless particles. Although the two pictures are hard to reconcile, researchers often find they must use both descriptions of light interchangeably as they describe phenomena related to light.

With this in mind, one way to think about the new research is that it provides a way to condense streams of light particles "to a very small area," said Cornell engineer David Erickson, one of the co-authors of the study. This is done by streaming the particles, called photons, "along a special type of waveguide," a device that constrains their path.

When molecular-sized bits of matter such as DNA float near these photons, they're "sucked in and pushed along with the flow," he added. "The effect is sort of like moving a truck by throwing baseballs at it. The trick is that we found a way to have a large number of highly efficient 'collisions' between the photons" and target objects, "getting them to stay in our device and keep them moving along it."

Erickson and colleagues crafted a waveguide that would shunt light into a narrow beam containing tiny channels 60 to 120 billionths of a meter wide, designed to keep light waves focused. These condense a wave's energy to scales as small as the target molecules, overcoming prior limitations caused by light diffraction, or spreading out of the waves.

The researchers used water solutions containing either DNA or tiny nanoparticles, or nano-scale objects, washing the fluids over the “microchannels.”

“What we’re hoping to do now is better understand some of the underlying physics to see what else might be possible with this approach,” said Erickson. “Hopefully in the future we can shuttle around individual strands of DNA the same way we now shuttle around light,” as is done with optical fibers.

In future versions of the system, he added, the light will both capture the particles and transport them. The DNA would arrive at the trap and then be directed to another location, such as a sensor or a staging ground for the assembly of a structure.

Image; When DNA molecules suspended in a tiny stream of water flow through a nano scale channel, they can be captured by a field of light if that light is confined in a device called a slot wave guide. The pressure from the light can then propel the DNA along the wave guide channel to bring the molecules to new locations. Such manipulation could prove valuable for assembling nano scale structures, driving powerful sensors and developing a range of other technologies. (Credit: Nicolle Rager Fuller, National Science Foundation)