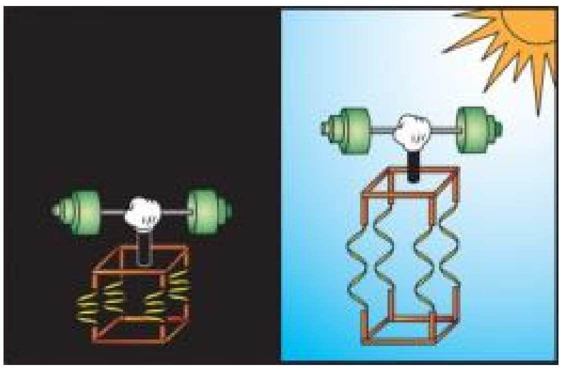
New, light-driven nanomotor is simpler, more promising, scientists say

June 4 2009



Sunlight prompts a newly developed molecular nanomotor to unclasp in this artist's illustration. In a paper expected to appear soon in the online edition of the journal Nano Letters, a team of researchers from the University of Florida reports building a new type of "molecular nanomotor" driven only by photons, or particles of light. While it is not the first photon-driven nanomotor, the almost infinitesimal device is the first built entirely with a single molecule of DNA - giving it a simplicity that increases its potential for development, manufacture and real-world applications in areas ranging from medicine to manufacturing, the scientists say. (Yan Chen/University of Florida)

(PhysOrg.com) -- Sunflowers track the sun as it moves from east to west. But people usually have to convert sunlight into electricity or heat to put its power to use.

Now, a team of University of Florida chemists is the latest to report a new mechanism to transform light straight into motion - albeit at a very,

very, very tiny scale.

In a paper expected to appear soon in the online edition of the journal Nano Letters, the UF team reports building a new type of "molecular nanomotor" driven only by photons, or particles of light. While it is not the first photon-driven nanomotor, the almost infinitesimal device is the first built entirely with a single molecule of DNA — giving it a simplicity that increases its potential for development, manufacture and real-world applications in areas ranging from medicine to manufacturing, the scientists say.

"It is easy to assemble, has fewer parts and theoretically should be more efficient," said Huaizhi Kang, a doctoral student in chemistry at UF and the first author of the paper.

The scale of the nanomotor is almost vanishingly small.

In its clasped, or closed, form, the nanomotor measures 2 to 5 nanometers — 2 to 5 billionths of a meter. In its unclasped form, it extends as long as 10 to 12 nanometers. Although the scientists say their calculations show it uses considerably more of the energy in light than traditional solar cells, the amount of force it exerts is proportional to its small size.

But that won't necessarily limit its potential.

In coming years, the nanomotor could become a component of microscopic devices that repair individual cells or fight viruses or bacteria. Although in the conceptual stage, those devices, like much larger ones, will require a power source to function. Because it is made of DNA, the nanomotor is biocompatible. Unlike traditional energy systems, the nanomotor also produces no waste when it converts light energy into motion.

"Preparation of DNA molecules is relatively easy and reproducible, and the material is very safe," said Yan Chen, a UF chemistry doctoral student and one of the authors of the paper.

Applications in the larger world are more distant. Powering a vehicle, running an assembly line or otherwise replacing traditional electricity or fossil fuels would require untold trillions of nanomotors, all working together in tandem — a difficult challenge by any measure.

"The major difficulty lies ahead," said Weihong Tan, a UF professor of chemistry and physiology, author of the paper and the leader of the research group reporting the findings. "That is how to collect the molecular level force into a coherent accumulated force that can do real work when the motor absorbs sunlight."

Tan added that the group has already begun working on the problem.

"Some prototype DNA nanostructures incorporating single photo-switchable motors are in the making which will synchronize molecular motions to accumulate forces," he said.

To make the nanomotor, the researchers combined a DNA molecule they created in the lab with azobenzene, a chemical compound that responds to light. A high-energy photon prompts one response; lower energy another.

To demonstrate the movement, the researchers attached a fluorophore, or light-emitter, to one end of the nanomotor and a quencher, which can quench the emitting light, to the other end. Their instruments recorded emitted light intensity that corresponded to the motor movement.

"Radiation does cause things to move from the spinning of radiometer wheels to the turning of sunflowers and other plants toward the sun," said Richard Zare, distinguished professor and chairman of chemistry at Stanford University. "What Professor Tan and co-workers have done is to create a clever light-actuated nanomotor involving a single DNA molecule. I believe it is the first of its type."

Source: University of Florida (news : web)