Light-driven plasmonic nanoswitch may pave way for new computers, tech

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(PhysOrg.com) -- The ability to stream videos online with the quality of high-end home theater systems, and to run computer programs a thousand times faster, are some of the future advances being made possible by a Penn State research team led by Tony Jun Huang, the James Henderson assistant professor of engineering science and mechanics.

Huang's Biofunctionalized NanoElectroMechanicalSystems (BioNEMS) group has developed a working plasmonic switch, the first step in building optical computers with frequencies 100,000 times greater than the ones of current microprocessors.

Huang explained, "Computer chips have circuits. Today's electronic circuits are good and small, but they're slow and have low capacity, relatively speaking. To make the big jump, we need to develop photonic circuits. Photonic circuits use light to carry information, similar to the technology behind fiber optic cables, and have higher speeds and higher capacities. But the problem with photonic circuits is that they're too big."

The answer, Huang said, is to create something that combines the speed and capacity of photonic circuits with the small size of electronic circuits — a plasmonic circuit.

"Plasmonic circuits are a hybrid of electronics and photonics," he stated. "They can transmit electrons and light at the same time."

Huang's BioNEMS group has been focusing on the first step towards a plasmonic circuit puzzle: the plasmonic switch.

"In electronic circuits, transistors amplify and switch electric current to realize two different states: ones and zeros," he said. "It's the same for plasmonic circuits where plasmonic transistors and switches are required."

The plasmonic switches designed so far haven't been very efficient, the engineer stated. "Few people have made plasmonic switches. They have used chemicals or electricity to do the switching. Using chemicals is very slow and would produce waste because you have two chemicals that have to react. It's just not practical.

"Using electricity is better, but we want to make our whole system modulated by light. So using electricity to drive it is not as compatible as a light-driven device as we're proposing."

Huang's team, which includes postdoctoral researcher Vincent Hsiao and graduate students Yuebing Zheng and Bala Krishna Juluri, has done just that, creating a light-driven plasmonic switch. Molecules in the group's plasmonic switch change shape, causing the device's liquid crystals to align or de-align, in essence changing from a one to a zero.

The work has already caused a stir in the scientific community. It has been featured as the cover image of the Sep. 17, 2008, issue of the journal Advanced Materials. It also was recently highlighted in the journal Nature Photonics.

"There's still a long way to go," cautioned Huang. He characterizes the team's work as more fundamental research instead of applied work. "There are a lot of questions we have not been able to answer at this moment."

The BioNEMS team will continue its work in plasmonic switches, including investigating different nanomaterials that might work better.

Huang thinks that it may be at least five years before a true working plasmonic circuit might be created.

"Practically, we have to be able to integrate these plasmonic switches with other components, such as plasmonic waveguides, before we can demonstrate a plansmonic circuit."

Provided by Penn State

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