Researchers create new nanotechnology field

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A University of Alberta research team has combined two fields of study in nanotechnology to create a third field that the researchers believe will lead to revolutionary advances in computer electronics, among many other areas.

Dr. Abdulhakem Elezzabi and his colleagues have applied plasmonics principles to spintronics technology and created a novel way to control the quantum state of an electron's spin.

The new technology, which the researchers call spinplasmonics, may be used to create incredibly efficient electron spin-based photonic devices, which in turn may be used to build, for example, computers with extraordinary capacities.

"We've only just begun to scratch the surface of this field, but we believe we have the physics sorted out and one day this technology will be used to develop very fast, very small electronics that have a very low power consumption," said Elezzabi, the Canada Research Chair in Ultrafast Photonics and Nano-Optics and an electrical and computer engineering professor at the U of A.

Elezzabi's work addresses a number of challenges that, to this point, have hindered further advancement in computer electronics, such as in the creation of smaller devices. One such challenge is that as traditional, silicon-based semiconductor devices approach the nanoscale, the laws of quantum physics take control over their performance (specifically the flow of charges—i.e. electrons) and render them inoperable.

Researchers in the field of spintronics have tried to address this problem by building metal-based devices that harness the magnetic quantum properties of the spin of electrons. Although the spintronics field is barely a dozen years-old, some devices that incorporate spintronics technology are already on the market.

The field of plasmonics, which is even younger than spintronics, involves the transfer of light electromagnetic energy into a tiny volume, thus creating intense electric fields—a phenomenon that has many scientists rethinking the laws of electromagnetics on a nanoscale. The plasmonics field has many wide-ranging applications, from guiding light through metal wires, to bio-sensing, to making objects invisible to the eye.

One of the main challenges for plasmonics researchers is finding a way to propagate light over a long distance through solid materials. However, Elezzabi and his colleagues, U of A graduate student Kenneth Chau and Dr. Mark Johnson of the U. S. Naval Research Laboratory, have successfully combined plasmonics and spintronics in a way that puts plasmonics in a new light, and puts a new spin on spintronics.

Working with gold and cobalt samples, Elezzabi and his team were able to demonstrate a plasmonically-activated spintronic device that switches light on and off by controlling electron spins. Also, they believe that with a slight alteration of the sample structure the effect is non-volatile, meaning that any given result can be maintained indefinitely without the necessity of a power source.

"With the development of this technology I envision a move from semiconductors [silicon chips] to metal based electronics with light-driven circuits," Elezzabi said.

The research was published recently in the academic journal Physical

Review Letters, and the researchers have filed for a patent for the applications they have developed.

"To me this is almost a natural evolution of the two fields. I'm actually surprised that no one else looked around and saw what others were doing and combined the two before we did," Elezzabi added. "This opens up a lot of possibilities; this is just the beginning."

Source: University of Alberta

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