Vanadium oxide bronze: A replacement for silicon in microchips?

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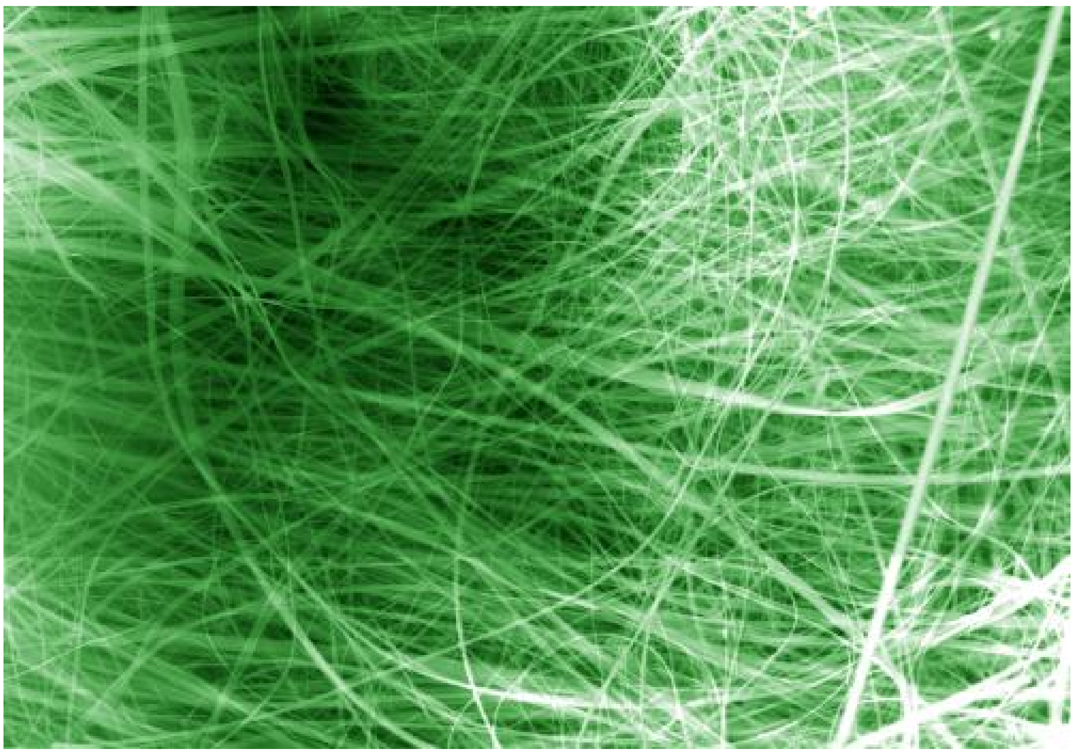


Nanowires crafted from vanadium oxide and lead. These wires' unique electrical properties could make them ideal for use in switching components of computers. Image by Peter Marley, with colored added.

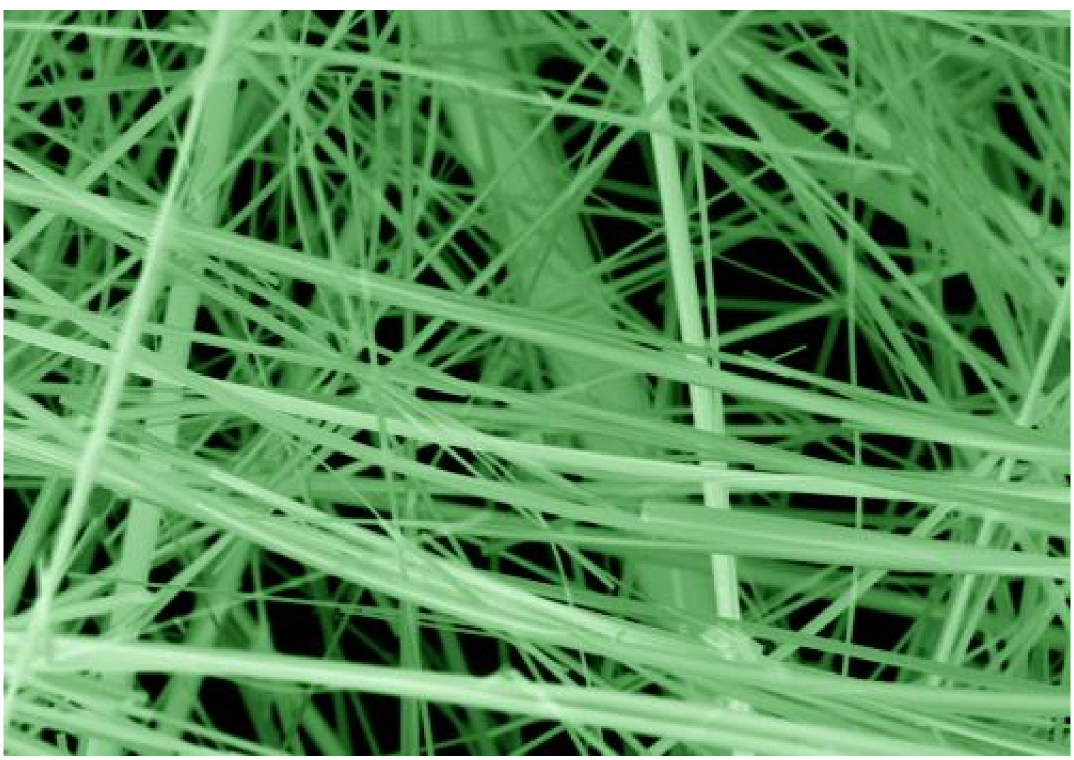
(Phys.org)—Few modern materials have achieved the fame of silicon, a key element of computer chips and the namesake for Silicon Valley, home to some of the world's most prominent technology firms.

The next generation of computers, however, may not rely so much on silicon.

University at Buffalo researchers are among scientists working to identify materials that could one day replace silicon to make computing faster. Their latest find: A vanadium oxide bronze whose unusual electrical properties could increase the speed at which information is transferred and stored.

In Advanced Functional Materials, the research team reports that they have synthesized nanowires made from vanadium oxide and lead.

The reason that these nanowires are so special is that they perform a rare trick: When exposed to an applied voltage near room temperature, the wires transform from insulators that are resistant to carrying electricity to metals that more readily conduct electricity.



When exposed to an applied voltage near room temperature, these nanowires transform from electrical insulators to electrical conductors. Each wire is about 180 nanometers wide. Image by Peter Marley, with color added.

Each of these two states—insulator and metal—could stand for a 0 or 1 in the binary code that computers use to encode information, or for the "on" and "off" states that the machines use to make calculations.

"The ability to electrically switch these nanomaterials between the on and off state repeatedly and at faster speeds makes them useful for computing," said study co-author Sambandamurthy Ganapathy, a UB associate professors of physics.

"Silicon computing technology is running up against some fundamental road blocks, including switching speeds," added Sarbajit Banerjee, another co-author and a UB associate professor of chemistry. "The voltage-induced phase transition in the material we created provides a way to make that switch at a higher speed."

As with other nanomaterials, the health and environmental impacts of the nanowires would have to be investigated before their widespread use, especially since they contain lead, Banerjee cautioned.

Banerjee and Ganapathy oversaw the study, which appeared online Aug. 17 in the journal Advanced Functional Materials. UB chemistry PhD student Peter Marley was lead author. Other contributors include Peihong Zhang, a UB associate professor of physics, and students from Ganapathy's research group.

One intriguing characteristic of the material they synthesized is that it only exhibits valuable electrical properties in nano-form. That's because nanomaterials often have fewer defects than their bulkier counterparts, Banerjee and Marley explained.

In the case of the lead vanadium oxide nanowires, the wires' distinctive structure is crucial to their ability to switch from an insulator to a metal.

Specifically, in the insulator phase, the position of the lead in the nanowires' crystalline structure induces pools of electrons to gather at designated locations. Upon applying a voltage, these pools join together, allowing electricity to flow freely through them all and transforming the material into a metal.

"When materials are grown in bulk, there's a lot of defects in the crystals, and you don't see these interesting properties," Marley said. "But when you grow them on a nanoscale, you're left with a more pristine material."

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