Electronics advance moves closer to a world beyond silicon

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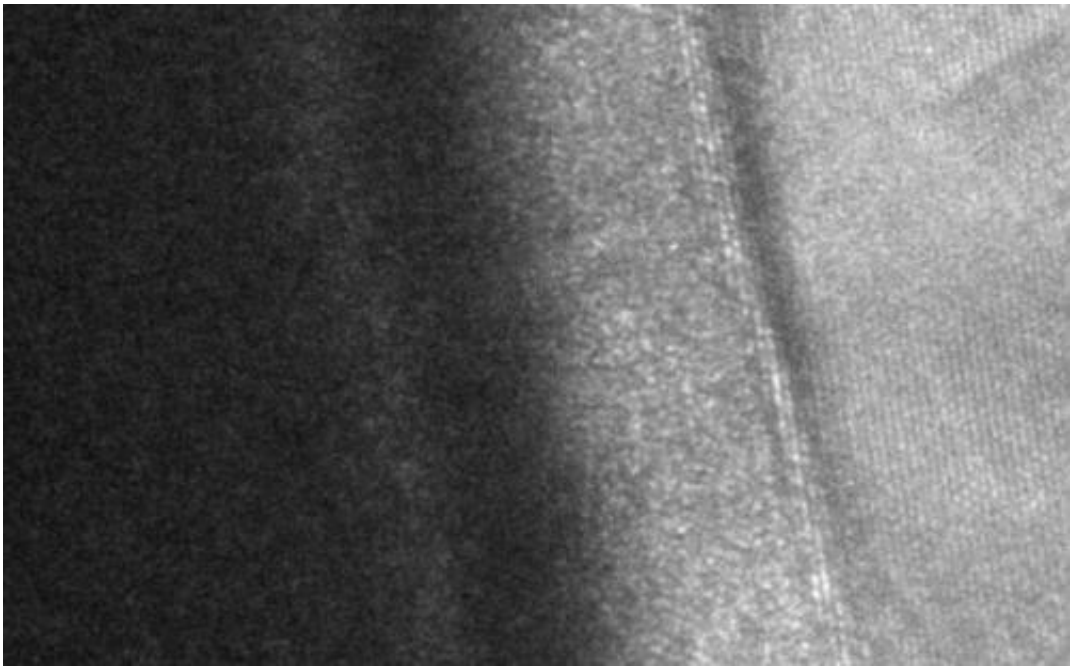

This MIIM diode has a layer of metals at each side and two insulators in between, an important step toward a future of high speed electronics not limited by the use of silicon. Credit: Oregon State University

(Phys.org) —Researchers in the College of Engineering at Oregon State University have made a significant advance in the function of metal-insulator-metal, or MIM diodes, a technology premised on the assumption that the speed of electrons moving through silicon is simply too slow.

For the extraordinary speed envisioned in some future electronics applications, these innovative diodes solve problems that would not be possible with silicon-based materials as a limiting factor.

The new diodes consist of a "sandwich" of two metals, with two insulators in between, to form "MIIM" devices. This allows an electron not so much to move through materials as to tunnel through insulators and appear almost instantaneously on the other side. It's a fundamentally different approach to electronics.

The newest findings, published in *Applied Physics Letters*, have shown that the addition of a second insulator can enable "step tunneling," a situation in which an electron may tunnel through only one of the insulators instead of both. This in turn allows precise control of diode asymmetry, non-linearity, and rectification at lower voltages.

"This approach enables us to enhance device operation by creating an additional asymmetry in the tunnel barrier," said John F. Conley, Jr., a professor in the OSU School of Electrical Engineering and Computer Science. "It gives us another way to engineer quantum mechanical tunneling and moves us closer to the real applications that should be possible with this technology."

OSU scientists and engineers, who only three years ago announced the creation of the first successful, high-performance MIM diode, are international leaders in this developing field. Conventional electronics based on silicon materials are fast and inexpensive, but are reaching the top speeds possible using those materials. Alternatives are being sought.

More sophisticated microelectronic products could be possible with the MIIM diodes – not only improved liquid crystal displays, cell phones and TVs, but such things as extremely high-speed computers that don't depend on transistors, or "energy harvesting" of infrared solar energy, a

way to produce energy from the Earth as it cools during the night.

MIIM diodes could be produced on a huge scale at low cost, from inexpensive and environmentally benign materials. New companies, industries and high-tech jobs may ultimately emerge from advances in this field, OSU researchers say.

Provided by Oregon State University