

Major advance made in transparent electronics

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Researchers at Oregon State University and Hewlett Packard have reported their first example of an entirely new class of materials which could be used **to make transparent transistors** that are inexpensive, stable, and environmentally benign. This could lead to new industries and a broad range of new consumer products, scientists say.

The possibilities include [electronic devices](#) produced so cheaply they could almost be one-time "throw away" products, better large-area electronics such as flat panel screens, or flexible electronics that could be folded up for ease of transport.

Findings about this new class of "thin-film" materials, which are called amorphous heavy-metal cation multicomponent oxides, were just published in a professional journal, Applied Physics Letters. The research was funded by the National Science Foundation and Army Research Office.

This is a significant breakthrough in the emerging field of transparent electronics, experts say. The new transistors are not only transparent, but they work extremely well and could have other advantages that will help them transcend carbon-based transistor materials, such as organics and polymers, that have been the focus of hundreds of millions of dollars of research around the world.

"Compared to organic or polymer transistor materials, these new inorganic oxides have higher mobility, better chemical stability, ease of manufacture, and are physically more robust," said John Wager, a

professor of electrical and computer engineering at OSU. "Oxide-based transistors in many respects are already further along than organics or polymers are after many years of research, and this may blow some of them right out of the water."

"Frankly, until now no one ever believed we could get this type of electronic performance out of transparent oxide transistors processed at low temperatures," Wager said. "They may be so effective that there will be many uses which don't even require transparency, they are just a better type of transistor, cheap and easy to produce."

The newest devices are zinc-tin-oxide thin film transistors, according to collaborating researchers in the OSU College of Engineering, OSU College of Science and at Hewlett Packard. They are an evolution of zinc oxide transistors, which gained attention as the world's first see-through transistor when OSU scientists announced their discovery last year. But this new material combines the characteristics of different elements to give levels of electronic performance and "mobility" – in electronics, an observation about how fast electrons can move within a material – that are an order of magnitude faster than the earlier transparent transistors, Wager said.

They are amorphous, meaning they have no long range crystalline order, which helps to keep processing costs a great deal lower. They are also physically robust – hard to scratch, chemically stable, resist etching, and have a very smooth surface. They are made from low cost, readily-available elements such as zinc and tin, which raise no environmental concerns.

"What has been most surprising, however, is that we can make high quality oxide transistors with these new materials at just above room temperature," Wager said. "Simply put, that's shocking. Most integrated circuits made today, by comparison, are produced at temperatures

between 700-1,100 degrees centigrade."

According to the OSU and HP researchers, this group of transistor materials will not challenge the silicon-based products that form the basis for most of the computer industry. But they may find their way into specialty electronic products – many of which do not yet exist – that will probably lead to billion-dollar industries of the future.

"HP is excited about the possibilities that this development may enable, especially for our customers in imaging and printing," said Tim Weber, the director of the Advanced Materials and Processes Laboratory located in Corvallis, Ore. "We are pleased with the rapid progress the OSU and HP team has made in this area."

OSU has used a multidisciplinary research approach to the creation of these new transparent transistors, purposefully focusing on materials that have desirable physical properties, and could be cheaply and realistically produced for the consumer marketplace. The group of "heavy metals" that could potentially yield new advances also includes such elements as gold, silver, mercury, arsenic or lead, but these elements have been intentionally avoided because of their real-world cost or toxic environmental concerns.

Further fundamental research will continue on such topics as device physics and modeling, transparent circuits, new materials and other areas.

Private industry is already beginning to identify new applications for these materials, Wager said.

One possibility is with gas sensor systems. These sensors are used extensively in automotive and other mechanical applications, and the new zinc-tin oxide transistors might allow the creation of a new type of

gas sensor whose sensitivity is electronically controlled over a wide dynamic range.

In the field of transparent applications, there should be uses in consumer electronics, transportation, business and the military. Automobile windshields could transmit visual information. Glass in almost any setting could also double as an electronic device, possibly improving security systems or transparent displays. The military is extremely interested in research of this type because of possible uses in sophisticated technology or fighting equipment. Liquid crystal displays could be improved. New types of copy machines may be created. Better solar cells are possible.

"One other thing that comes to mind is games and toys," Wager said. "It's not unusual for the creators of innovative game products to be the first people to implement a new technology. Some of the first illustrations we've seen of the things you could do with transparent electronics have been in science fiction movies that show futuristic types of computer equipment.

"Some of those things, which were basically special effects produced by Hollywood, may soon become a reality," he said.

Source: Oregon State University

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