

[News](#) - February 5, 2008

New Electronics Promise Wireless at Warp Speed

Company uses nanoscale metals to build faster radios to wirelessly process video and other massive data files

By Larry Greenemeier

[Wireless](#) networking technology will one day deliver high-definition video content and other large data files via the airwaves far faster than that information can be now be delivered over wired systems. But it will take major advances in the electronics that drive computer and radio-frequency systems to create such a high-powered wireless highway.

One of the most basic examples of such a system is a laptop computer equipped with a radio for wireless connectivity. The computer's performance has generally been improved through upgrades in [digital semiconductor](#) performance: shrinking the size of the semiconductor's [transistors](#) to ramp up transaction speed, [packing more of them onto the chip](#) to increase processing power, and even substituting silicon with compounds such as gallium arsenide or indium phosphide, which allow electrons to move at a higher velocity.

The key to squeezing higher performance out of the radio side of the equation, according to one company, is using metal-insulator components. "We are potentially at another stepping point, where instead of solid-state semiconductor electronics, we will have metal-insulator electronics," says Garret Model, chief technology officer and chairman of Phiar Corporation in Boulder, Colo.

Model has good reason to believe this, given that his company builds diodes, radio-frequency (RF) detectors and RF receivers using metal-insulator technology.

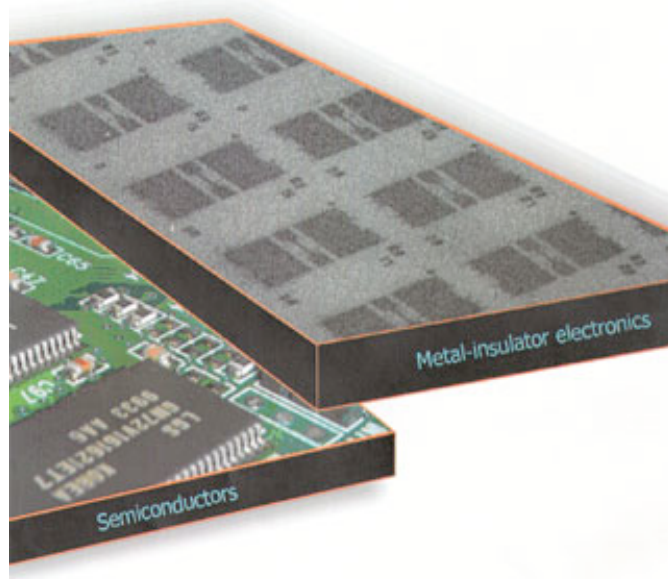
Although Phiar's technology will not be commercially available until next year, the company's approach is expected to enhance the performance and cut the costs of wireless networks by introducing a simpler, less expensive manufacturing process. The company does this by using stacks of metals and insulators at nanoscale thicknesses—tens of angstroms, a unit of length equal to one ten-billionth of a meter; the space between atoms is generally two or three angstroms—to create high-frequency, up to three terahertz. (A terahertz is a trillion hertz, a thousand times speedier than a gigahertz-level processor, but slower than an optical network.)

"We're bridging the performance between photonics and electronics," says Adam Rentschler, Phiar's director of business development.

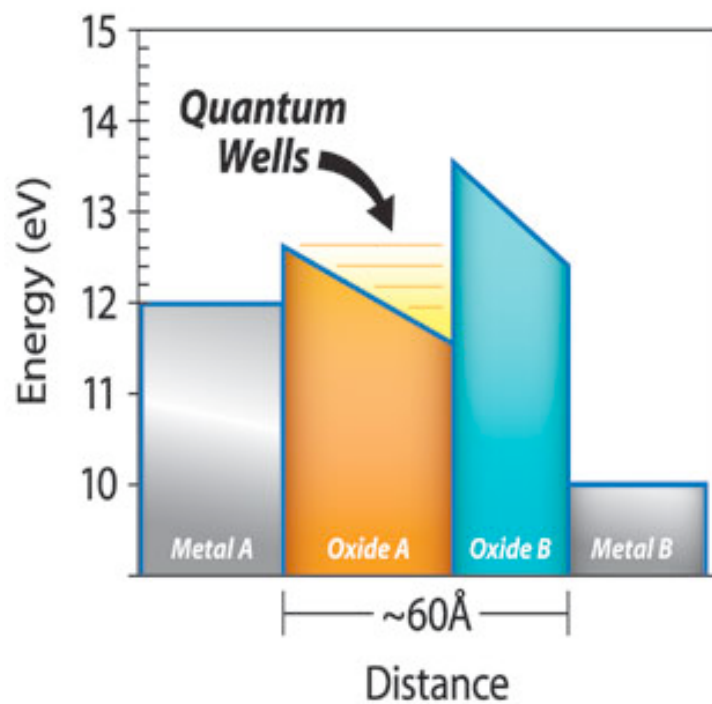
Conventional semiconductors are built using [silicon-based](#) substrates (the material upon which semiconductor devices are fabricated), but metal-insulator electronics can be made atop less pricey glass, metal or plastic substrates. Phiar's approach is to place two metal layers on either side of a double layer of insulation. When voltage is applied, electrons tunnel through the insulator layers with the help of a "quantum well" that forms between the two insulators.

Phiar will not specify which metals it uses, it is a trade secret, but says they are amorphous rather than crystalline, like [silicon](#). This means these metals can be layered on top of a variety of other substances, including standard complementary metal-oxide semiconductor (CMOS) circuitry. As such, Phiar's metal-insulator diodes or other electrical components could be combined with semiconductors on the same microchip. Among other potential options: using metal-insulator radios to replace the copper chip-to-chip interconnect wires on today's printer circuit boards, eliminating one of computing's worst performance bottlenecks. In the more distant future, metal-insulator devices could even replace the digital transistors within a semiconductor.





PHIAR'D UP: Phiar's metal-insulator technology stacks metals and insulators at nanoscale thicknesses to enhance the performance and cut the costs of wireless networks, introducing a simpler, less expensive manufacturing process compared to silicon-based semiconductors.



METAL SANDWICH: Phiar's basic metal-double-insulator-metal (MIIM) diode includes sputter-deposited thin films of metals and their oxides that create quantum wells at the insulators' interface.

Phiar's technology is expected to hit the market through a series of partnerships. Phiar and Motorola, Inc., last year signed a joint development agreement that could make Phiar's metal-insulator electronics an integral part of the 60-gigahertz mobile wireless high-definition multimedia interfaces and imaging technologies that Motorola is developing. Motorola has successfully incorporated Phiar's metal-insulator diodes into a 60-gigahertz prototype system and demonstrated multigigabit-per-second data rates.

The ability to operate at 60 gigahertz—where wavelengths are only a few millimeters—is crucial to the wireless personal area networks (PANs) that Motorola and other tech vendors are looking to offer. Whereas Wi-Fi signals—which operate at frequencies no greater than 5.8 gigahertz—can penetrate walls, glass and other barriers, enabling one wireless access point to serve an entire household, 60-gigahertz signals are more easily contained. This means a household could have one 60-gigahertz network in one room and an entirely different 60-gigahertz setup in the next room (hence the name "personal area" network). Operating in the wider bandwidth 60-gigahertz range also increases the speed of Wi-Fi data transfers.

"The seminal point about moving to higher frequencies is that there is more bandwidth available, which means it's faster," Modelle says. This translates into content that is delivered faster over wireless networks, which is important because the demand for large data files and video content is on the rise.

Phiar's technology is optimal for building radios because metal-insulator electronics can detect higher frequency signals than silicon-based semiconductors can. "Phiar's technology vastly bumps up the speed at which you can detect an incoming signal," Ian Lao, a senior analyst with In-Stat, a technology research firm based in Scottsdale, Ariz., and a division of tech publisher Reed Elsevier, Inc. This has many implications in the development of new sensors and telecommunications equipment that will be able to quickly detect and accurately read wireless signals.

This could be a useful component in a high-speed communications network, "the kind of thing that a wireless company would want for their base stations," says Michael Kozicki, an Arizona State University professor of electrical engineering and director of the school's [Center for Applied Nanoionics](#). Phiar technology could become a central part of imaging systems such as airport security devices that rely on radiation moving at terahertz speeds to scan passengers for contraband, penetrating materials otherwise opaque to visible or infrared radiation.

Motorola and Phiar's approach is expected to face competition from a number of companies eager to take wireless communications beyond Wi-Fi speeds. IBM and Taiwanese semiconductor maker Mediatek, Inc., are developing their own very fast chip sets that can wirelessly transmit a full-length, high-definition movie to and from a home PC, handheld device, retail kiosk or television set. IBM and Mediatek plan to ultimately develop ways to wirelessly connect high-definition TVs to set-top boxes using millimeter-wave radio technology, which takes advantage of the highest frequency portion of the radio spectrum where massive amounts of information can be sent quickly.

The companies will integrate IBM's millimeter-wavelength radio chips, antenna and package technology with Mediatek's digital base band and video processing chips. IBM demonstrated a prototype packaged chip set as small as a dime to wirelessly transmit uncompressed HD video two years ago.

"Don't sell your stock in all of those silicon companies because this is not a replacement for silicon in any way, shape or form," Kozicki says. Although Phiar's metal-insulator technology could become a crucial component of future high-frequency imaging systems or communications networking equipment, it is not meant to perform the kind of processing that silicon does so well.