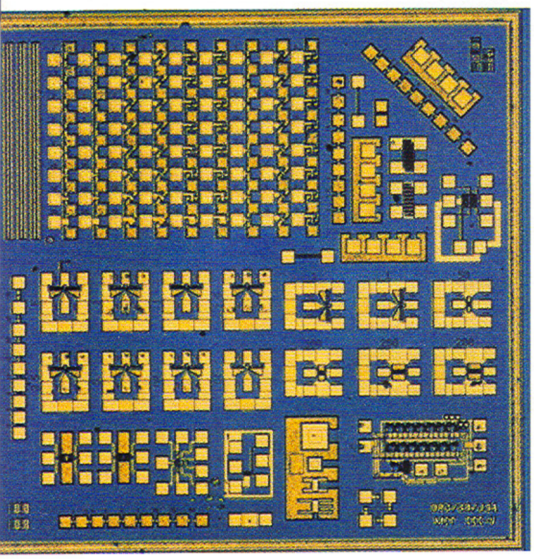
INFORMATION TECHNOLOGY

After Silicon

Microprocessors made of a different semiconductor

SOURCE: "Beyond CMOS: Logic Suitability of $In_{0.7}Ga_{0.3}As$ HEMT"
D. H. Kim and J. A. del Alamo
Paper presented at the International Conference on Compound Semiconductor Manufacturing Technology, April 24–27, 2006, Vancouver, British Columbia

RESULTS: MIT researchers have made a transistor out of a nonsilicon semiconductor that, in early stages of development, provides speed and performance similar to those of state-of-the-art silicon transistors while consuming less power.



A new chip uses indium gallium arsenide.

COURTESY OF JESUS DE ALAMO/MIT

WHY IT MATTERS: The properties of compound semiconductors such as indium gallium arsenide or indium antimonide make them attractive alternatives to silicon. Electrons move through compound semiconductors as much as 50 times faster than they do through silicon; compound-semiconductor transistors thus operate at a lower voltage, consume less power, and produce less heat that can damage a chip.

The excellent optical properties of compound semiconductors could offer another advantage. Since compound semiconductors easily produce light, photons could potentially zip data between transistors without copper wires.

METHODS: The researchers used a common deposition process to build up layers of indium gallium arsenide and of the insulating material indium aluminum arsenide—the "gate dielectric" that prevents electron leakage between the transistor and its "gate," which turns it on and off. They then used an electron beam to carve out the gate. Finally, the researchers added the metal contacts—made of nickel, germanium, and gold—that are used to put electrons in and take them out of the transistor.

NEXT STEPS: With silicon transistors, the gate dielectric, which is made of an insulator called silicon dioxide, grows on top of the silicon when it is exposed to oxygen. Compound semiconductors, however, have poor interfaces with their oxides. The researchers are conducting tests to determine which gate dielectric material will optimize the performance of their transistors.

Quantum Key Extended

Technique keeps information private over greater distances

SOURCE: "Experimental Quantum Key Distribution with Decoy States"
Yi Zhao et al.
Physical Review Letters 96: 070502

RESULTS: Researchers at the University of Toronto have dramatically increased the distance that a quantum key—photons that represent bits of data for encoding and decoding secret communications—can travel by modifying a commercial quantum encryption system.

WHY IT MATTERS: Quantum encryption is, in theory, a perfectly secure method for communications. Perfect security would require sending an encryption key on the backs of polarized photons, which would be transmitted—either via fiber optics or through the air—one at a time. The peculiar laws of quantum mechanics dictate that, if an eavesdropper picked off just one of these photons, the entire transmission would be altered, prompting the sender to transmit another key along a more secure path.

Unfortunately, no single-photon emitter actually exists. So scientists use the next best thing: strong filters that can winnow a laser pulse down to approximately one photon. Long-distance transmissions, however, require laser pulses of particularly high intensity, which increases the probability that two photons per pulse will slip past the filter. If two identically polarized photons are sent at once, an eavesdropper can pick off one of them without disturbing the other.

Hoi-Kwong Lo and his group used the duplicate photons to their advantage. They purposely generated extra photons that contained no information about the key by passing a laser beam through a *weak* filter instead of a strong one. An eavesdropper wouldn't know which photons held the key and which were decoys.

METHODS: The researchers modified a commercial quantum encryption system by adding a modulator that adjusts the intensity of both decoy and key-carrying laser pulses. The filter allows the person who sends the key to randomly blend both types of pulses into the transmission.

NEXT STEPS: On their first pass, the researchers were able to transmit a blended light signal over 60 kilometers of telecommunication fibers. With some slight modifications, the scientists say, their quantum decoy system will be