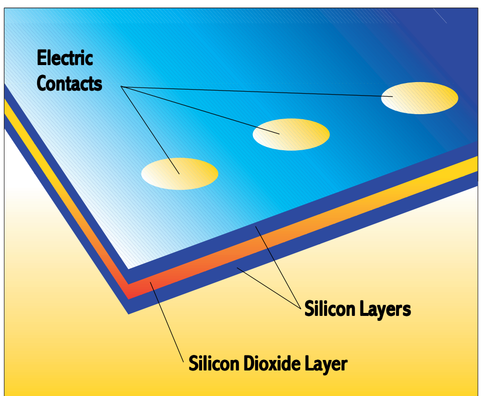
c Circuits that Use Less Power

- More effective radar receivers and missile seekers by adding greater computational capabilities and reducing power consumption and system weight. For missile seekers, more complex target recognition algorithms can be employed. The lighter weight will increase the range, allowing for greater stand-off distances.
- Reduced logistical support or "logistical tail" needed to conduct operations since products incorporating the technology will offer high-data transfer rates at double the current rates, while reducing the number of components ten-fold. Additionally, power consumption could drop anywhere from 10-2,000 times.

HOW THEY WORK:

In today's logic circuits, the smallest features of the transistors and wires which connect them are about 50 times narrower than a human hair, or about 0.35 microns (a micron is a millionth of a meter). A state-of-the-art logic chip contains about 4 million transistors per square centimeter, an area about the size of a small fingernail. The semiconductor industry plans to continue doubling the number of transistors on a chip every three years. According to that plan, state-of the-art transistors will be almost 10 times smaller in 15 years.

Transistors work much like a light switch in that they can be turned on and off. When they are turned on, electrons flow to other parts of the circuit. Likewise, when they are turned off, it blocks those electrons from flowing; resulting in a barrier.



The RTD consists of three ultra-thin layers. A layer of silicon is sandwiched between two layers of silicon dioxide with electric contacts on top and bottom to provide a variety of "on" and "off" states.

Problems in turning the transistor on and off arise when the barrier is as small as the wavelength of an electron. Even when the switch is turned off, some electrons can actually disappear on one side of the barrier and reappear on the other side. The phenomenon, known as "tunneling," makes the transistor act like a leaky faucet because it can no longer positively control the passage of electrons.

The RTD, developed by researchers, consists of a set of three ultra-thin layers. Those layers— a layer of silicon sandwiched between two layers of silicon dioxide with electrical contacts on the top and bottom— can be on and off in several distinct ways — some with as many as 19 different "on" and "off" states. These varying on and off states correspond to different levels of applied voltage. Since a normal transistor has only an on/off state, the RTD can often do the work of several conventional traditional transistors.

Instead of functioning as a simple switch, a tunnel diode controls the flow of electrical current in an unusual way that causes an up-and-down pattern of current flow in response to an applied voltage. This allows for more complex logic with fewer electronic parts. Thus, systems are smaller, need less power, and are easier to harden to the harsh environments of space and modern warfare.

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AFOSR Support Helps Aid Nobel Prize Winner's Work

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His insights have helped scientists understand how certain molecules are synthesized, how energy is released in reactions and how the outcome of chemical reactions might be controlled. Dr. Zewail's research will have far-reaching applications. Scientists throughout the world are using his research to probe nature at a fundamental level. Among the applications are determining how molecular electronic components must be designed, understanding the most delicate mechanisms in life processes and guiding how the medicines of the future should be produced.

"We will also be able to understand and control signatures from aircraft and rockets, processes that affect chemical erosion in space, and the drag on satellites from their environments," said Dr. Michael Berman, AFOSR program manager.