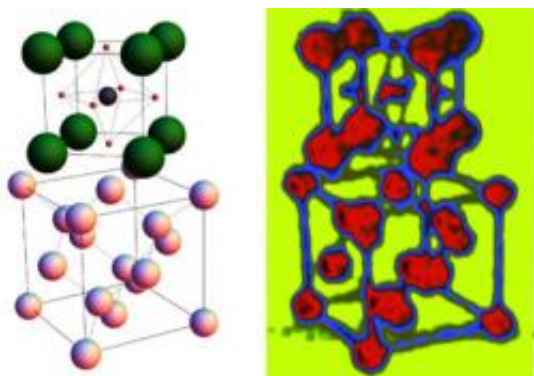


# Putting the squeeze on an old material could lead to 'instant on' electronic memory

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The arrangement between atoms of a film of strontium titanate and the single crystal of silicon on which it was made is shown on the left. When sufficiently thin, the strontium titanate can be strained to match the atom spacing of the underlying silicon, and it becomes ferroelectric. On the right this schematic has been written into such a film, utilizing the ability of a ferroelectric to store data in the form of a re-orientable electric polarization.

(PhysOrg.com) -- The technology of storing electronic information - from old cassette tapes to shiny laptop computers - has been a major force in the electronics industry for decades.

Low-power, high-efficiency electronic memory could be the long-term result of collaborative research led by Cornell materials scientist Darrell Schlom. The research, to be published April 17 in the journal *Science* (Vol. 324 No. 5925), involves taking a well-known oxide, strontium

titanate, and depositing it on silicon in such a way that the silicon squeezes it into a special state called ferroelectric - a result that could prove key to next-generation memory devices.

[Ferroelectric materials](#) are found today in "smart cards" used in many subways and ski resorts. The credit card-sized devices are made with such materials as lead zirconium titanate or strontium bismuth tantalate, which can instantly switch between different memory states using very little electric power. A tiny microwave antenna inside the card, when waved before a reader, reveals and updates stored information.

For more than half a century, scientists have wanted to use ferroelectric materials in transistors, which could lead to "instant-on" computing - no more rebooting the operating system or accessing memory slowly from the hard drive. No one has yet achieved a ferroelectric transistor that works.

"Adding new functionality to transistors can lead to improved computing and devices that are lower power, higher speed and more convenient to use," said Schlom, professor of materials science and engineering.

"Several hybrid transistors have been proposed specifically with ferroelectrics in mind. By creating a ferroelectric directly on silicon, we are bringing this possibility closer to realization."

Ordinarily, strontium titanate in its relaxed state is not ferroelectric at any temperature. The researchers have demonstrated, however, that extremely thin films of the oxide - just a few atoms thick - become ferroelectric when squeezed atom by atom to match the spacing between the atoms of underlying silicon.

"Changing the spacing between atoms by about 1.7 percent drastically alters the properties of strontium titanate and turns it into a material with useful memory properties," said Long-Qing Chen, professor of [materials](#)

science and engineering at Pennsylvania State University, a member of the research team whose calculations predicted the observed behavior five years ago.

Schlom called the work a good example of "theory-driven research."

"From various predictions, some dating back nearly a decade, we knew exactly what we were after, but it took our team years to achieve and demonstrate the predicted effect," he said.

The researchers described successfully growing the strontium titanate on top of silicon - the semiconductor found in virtually all electronic devices - using molecular-beam epitaxy, a technique akin to atomic spray painting.

"The technological implications are staggering," said Jeremy Levy, professor of physics and astronomy at the University of Pittsburgh, the research team member whose measurements showed the thin strontium titanate layers on [silicon](#) to be ferroelectric.

Source: Cornell University ([news](#) : [web](#))

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