Scientists seek silicon's successor

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In the hunt for a sequel to silicon, scientists at the SLAC National Accelerator Lab have flipped an "on-off" switch in the mineral magnetite that is far faster than today's transistors.

Computer circuits can't be made ever-smaller and faster with existing materials. So researchers at the Stanford-operated lab are preparing for the day when the famed Moore's Law hits the speed limit - that is, the number of transistors on a circuit no longer double every 1.5 years, as forecast by Intel co-founder Gordon Moore.

Magnetite, a naturally occurring mineral, isn't the answer, but it puts science one step closer.

"Miniaturization requires new materials," said Hermann Durr, the lead investigator of the SLAC team. "For me, this class of material is fascinating."

Using the lab's high-powered Linac Coherent Light Source X-ray laser, the scientists found that it takes just one-trillionth of a second to switch magnetite's electrical conductivity from "on" to "off."

That's thousands of times faster than silicon chip transistors.

Magnetite is what gives magnets their pull. It is a common mineral - a type of iron oxide - found in the black sands of beaches and elsewhere.

In the experiment, the laser struck the mineral - and in a tiny split of a

second, the magnetite's electronic structure rearranged into "islands" of electrical nonconductivity surrounded by conductive regions. The findings are reported in the latest issue of the journal *Nature Materials*.

But the mineral has too many practical limitations for use in computers.

For instance, the success of the experiment depended on an extremely frigid state: minus 310 degrees Fahrenheit.

"For this to be practical, we need to explore other materials and other methods," said Durr, also a staff scientist at the Stanford Institute for Materials and Energy Science. "We are just at the beginning."

The team is already testing another oxide compound, vanadium dioxide, which could have speedy switch speeds at room temperature - making it a more promising candidate for commercial use than magnetite.

Elsewhere, researchers are developing alternative materials such as gallium arsenide, graphene and carbon nanotubes.

They envision a day when transistors are so fast, small and energy-efficient that smartphones have the power of supercomputers.

"This is the dream," Durr said, "and to realize a little bit of it is terrific.

"Transistors took 50 years from demonstration to dominance," he said. "It's very hard to imagine what we'll have 50 years from today."