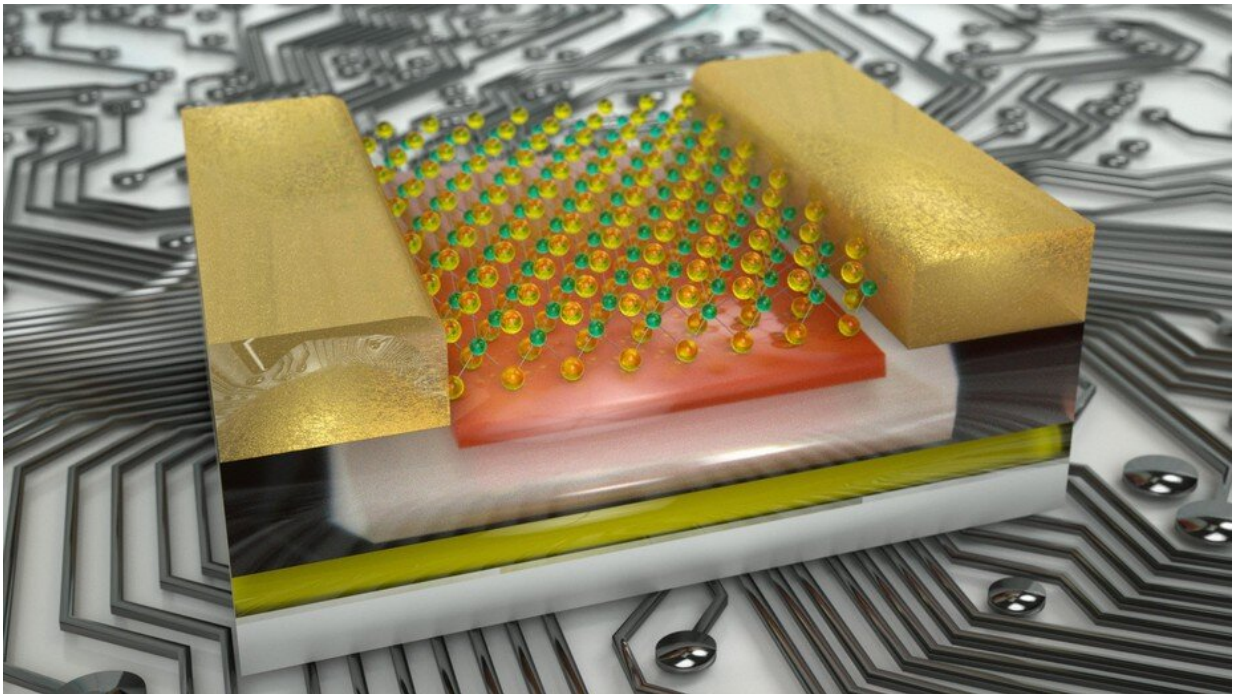


# Next-generation computer chip with two heads

November 5 2020, by Sarah Perrin

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Credit: Ecole Polytechnique Federale de Lausanne

EPFL engineers have developed a computer chip that combines two functions—logic operations and data storage—into a single architecture, paving the way to more efficient devices. Their technology is particularly promising for applications relying on artificial intelligence.

It's a major breakthrough in the field of electronics. Engineers at EPFL's

Laboratory of Nanoscale Electronics and Structures (LANES) have developed a next-generation circuit that allows for smaller, faster and more energy-efficient devices—which would have major benefits for artificial-intelligence systems. Their revolutionary technology is the first to use a 2-D material for what's called a logic-in-[memory architecture](#), or a single architecture that combines logic operations with a memory function. The research team's findings appear today in *Nature*.

Until now, the energy efficiency of [computer chips](#) has been limited by the von Neumann architecture they currently use, where [data processing](#) and [data storage](#) take place in two separate units. That means data must constantly be transferred between the two units, using up a considerable amount of time and energy.

By combining the two units into a single structure, engineers can reduce these losses. That's the idea behind the new [chip](#) developed at EPFL, although it goes one step beyond existing logic-in-memory devices. The EPFL chip is made from MoS<sub>2</sub>, which is a 2-D material consisting of a single layer that's only three atoms thick. It's also an excellent semiconductor. LANES engineers had already studied the specific properties of MoS<sub>2</sub> a few years ago, finding that it is particularly well-suited to electronics applications. Now the team has taken that initial research further to create their next-generation technology.

The EPFL chip is based on floating-gate field-effect transistors (FGFETs). The advantage of these transistors is that they can hold [electric charges](#) for long periods; they are typically used in flash memory systems for cameras, smartphones and computers. The unique electrical properties of MoS<sub>2</sub> make it particularly sensitive to charges stored in FGFETs, which is what enabled the LANES engineers to develop [circuits](#) that work as both memory storage units and programmable transistors. By using MoS<sub>2</sub>, they were able to incorporate numerous processing functions into a single circuit and then change them as

desired.

## **In-depth expertise**

"This ability for circuits to perform two functions is similar to how the human brain works, where neurons are involved in both storing memories and conducting mental calculations," says Andras Kis, the head of LANES. "Our circuit design has several advantages. It can reduce the energy loss associated with transferring data between memory units and processors, cut the amount of time needed for computing operations and shrink the amount of space required. That opens the door to devices that are smaller, more powerful and more energy efficient."

The LANES research team has also acquired in-depth expertise in fabricating circuits out of 2-D materials. "We made our first chip ten years ago by hand," says Kis. "But we have since developed an advanced fabrication process that lets us make 80 or more chips in a single run, with well-controlled properties."

**More information:** Guilherme Migliato Marega et al. Logic-in-memory based on an atomically thin semiconductor, *Nature* (2020).  
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