Strain and spin may enable ultra-low-energy computing

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By combining two frontier technologies, spintronics and straintronics, a team of researchers from Virginia Commonwealth University has devised perhaps the world's most miserly integrated circuit.

Their proposed design runs on so little energy that batteries are not even necessary; it could run merely by tapping the ambient energy from the environment. Rather than the traditional charge-based electronic switches that encode the basic 0s and 1s of computer lingo, spintronics harnesses the natural spin – either up or down – of electrons to store bits of data.

Spin one way and you get a 0; switch the spin the other way – typically by applying a magnetic field or by a spin-polarized current pulse – and you get a 1. During switching, spintronics uses considerably less energy than charge-based electronics. However, when ramped up to usable processing speeds, much of that energy savings is lost in the mechanism through which the energy from the outside world is transferred to the magnet.

The solution, as proposed in the AIP's journal *Applied Physics Letters*, is to use a special class of composite structure called multiferroics. These composite structures consist of a layer of piezoelectric material with intimate contact to a magnetostrictive nanomagnet (one that changes shape in response to strain). When a tiny voltage is applied across the structure, it generates strain in the piezoelectric layer, which is then transferred to the magnetostrictive layer.

This strain rotates the direction of magnetism, achieving the flip. With the proper choice of materials, the energy dissipated can be as low as 0.4 attojoules, or about a billionth of a billionth of a joule. This proposed design would create an extremely low-power, yet high-density, non-volatile magnetic logic and memory system.

The processors would be well suited for implantable medical devices and could run on energy harvested from the patient's body motion. They also could be incorporated into buoy-mounted computers that would harvest energy from sea waves, among other intriguing possibilities.

More information: "Hybrid spintronics and straintronics: A magnetic technology for ultra-low-energy computing signal processing" is published in *Applied Physics Letters.*

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