Electronic circuits with reconfigurable pathways closer to reality

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Multitasking circuits capable of reconfiguring themselves in real time and switching functions as the need arises—this is the promising application stemming from a discovery made at EPFL and published in *Nature Nanotechnology*. Other potential uses: miniaturizing our electronic devices and developing resilient circuits.

Will it be possible one day to reconfigure electronic microchips however we want, even when they are in use? A recent discovery by a team at EPFL suggests as much. The researchers have demonstrated that it is possible to create conductive pathways several atoms wide in a material, to move them around at will and even to make them disappear.

Adaptable electronics is generating significant interest in the scientific community because of the many applications. Imagine for a moment that one single microchip was capable of accomplishing the tasks of several different circuits. For example, a circuit assigned to process sound information could, when not being used for this purpose, be reassigned to process images. This would allow us to miniaturise our [electronic devices](#).

At the same time, it would become possible to develop resilient circuits. Whenever a microchip is damaged, it could theoretically reconfigure itself so that it could still function using the components that remain intact. "An effective way to keep faulty devices working when they are in hard-to-reach places, like space," says Leo McGilly, the article's lead author.

Underlying this promising technology are so-called 'ferroelectric' materials in which it is possible to create flexible conductive pathways. These pathways are generated by applying an [electric field](#) to the material. More specifically, when the electric current is applied, certain atoms moves either "up" or "down," which is known as polarisation. In recent years, the academic world has observed that conductive pathways several atoms wide - called 'walls' - form between these polarized zones. The only problem is that, until now, it was impossible to control how these pathways form.

At EPFL, the researchers demonstrated that it was possible to control the formation of walls on a film of ferroelectric material, and thus to create pathways where they wanted at given sites. The trick lies in producing a sandwich-like structure with platinum components on the outside and a ferroelectric material on the inside. "By applying electric fields locally on the metal part, we were able to create pathways at different sites and move them, and also to destroy them with a reverse electric field," says Mc Gilly. Low conductive electrodes were used to surround the ferroelectric material. This means that the charge spreads very slowly in the structure, making it possible to control exactly where it is applied. "When we use highly conductive materials, the charge spreads rapidly and walls form randomly in the material."

At this point, the researchers have tested their research on isolated materials. The next step consists in developing a prototype of a reconfigurable circuit. Leo McGilly would go even further. "The fact that we can generate pathways wherever we want could allow us to imitate in the future phenomena that take place inside the brain, with the regular creation of new synapses. This could prove useful in reproducing the phenomenon of learning in an artificial brain."

  More information: Controlling domain wall motion in ferroelectric thin films, *Nature Nanotechnology*, [DOI: 10.1038/nnano.2014.320](#)