Creating a new kind of electronics

At the border between physics and material science, Dennis Meier and his colleagues are searching for a new kind of electronics.

They hope to make circuits that are smaller, faster, and better for the environment than today's electronics, by taking advantage of defects that already exist within materials.

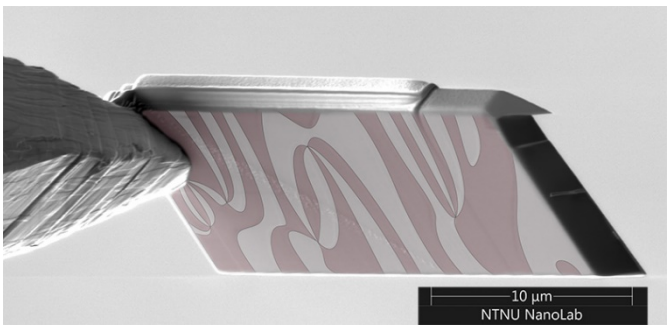
The electronic components the team have made so far are just a few atoms long, and could eventually be connected together to form circuits that measure mere nanometres across – far smaller than those we use today.

"We're working at the limit of what is doable in a solid-state system when you want to construct electronic components," says Meier, a professor in the Department of Materials Science and Engineering at NTNU.

The defects used to create these components are made when two parts of the same material have different properties. For example, their electric dipole moments – a measure of the distribution of charge in a material – might point in different directions.

When these contrasting sections meet at an interface, they create what is known as a domain wall. The domain wall doesn't behave like the rest of the material – for instance, it might be electrically conducting, even though the rest is an insulator.

So far Meier's team have created two electrical components using domain walls: a digital switch and a half-wave rectifier. A rectifier turns alternating current that reverses direction regularly to direct current that just flows one way.



First steps in the preparation of a domain wall device. Photo Erik Roede/NTNU NanoLab

The next step in his research is to connect components together.
Once that's possible, the team can start thinking about creating logic gates and doing some basic computing with the circuits.

Theoretically, circuits made with these materials could be tweaked when new technology demands it. “Once you have made your nanoscale circuit you can update it, you can upgrade it if needed, or even erase it and rewrite it – all within the same material,” says Meier.

Because domain walls occur naturally in materials, the production process should – in theory – be simple. “The interfaces are always there and they are perfect, no additional work is needed,” says Meier.

These two features would mean that less material is needed to manufacture electronics, and we wouldn’t need to throw things away as often.

But making everyday electronics from these materials is not the end goal for Meier. “It's not necessarily about building a computer,” he says. “It's more about opening up prospects and showing what we could do.”