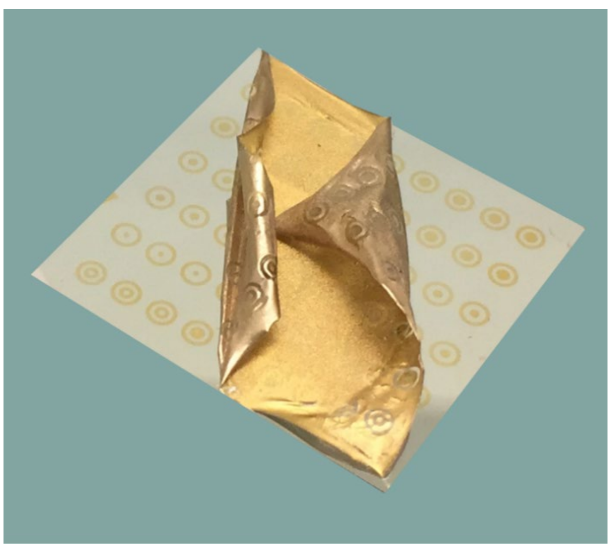
“Appealing” nanogap devices

As demand for faster and more powerful electronics grows, the size of individual components must shrink. Making these tiny components usually requires complicated techniques carried out in clean rooms with expensive equipment – but John de Mello, Bård Hoff and Sihai Luo from the Department of Chemistry at NTNU are working on a decidedly lower tech approach to making what will hopefully become high performance devices.

Sihai Lou, Photo: Per Henning/NTNU

The technique, known as adhesion lithography, involves layering two different metals onto glass, with a material to stop them sticking together sandwiched in between. Until now, finishing the process involved using adhesive tape to peel off all the extraneous materials, leaving two metals side by side separated by spaces called “nanogaps”. “A bit like pulling a plaster from your skin, it's not the most controlled process,” says de Mello.

But in a paper published in the journal *Advanced Material Interfaces*, the team have come up with a more controlled way to carry out this final step. Instead of peeling off the excess manually, they use a “self-peeling” layer that is applied at a high temperature – and removes itself spontaneously as it cools down.



Formation of gold/aluminium nanogap array by self-peeling adhesion lithography.

This self-peeling layer removes some of the unreliability from the previous technique. “What we're actually doing is reducing the externally applied forces to zero,” says de Mello. “We're basically ending up in a situation where we're not disturbing the material underneath.”

The method produces components with a gap of around 10 nanometres (nm). “Below 10 nm is a target for nanogap devices,” he says, but there isn’t currently a scalable technique for reliably producing gaps this small. A smaller gap means faster electronic devices, as electrons have a shorter distance to traverse. Similarly, biosensors that detect biological molecules – for example, to diagnose disease or detect allergens in food – need gaps as small as the molecules they are designed to detect, so smaller gaps mean they can be sensitive to smaller molecules.

Being able to control the size of the gap is also key. The next step is to fine-tune the process to make devices with a range of gap widths that would be suitable for different applications. “At the moment we’re a bit like Ford – we can give you one colour, or rather we can give you one gap width, which is around this 10 nm level," says de Mello. "What we'd like to be able to do is tailor that from gaps of two nanometres to gaps of 100 nm."

Kelly Oakes, September 2019

https://onlinelibrary.wiley.com/doi/abs/10.1002/admi.201900243