A clear way forward

Nowadays, we tap and swipe the touchscreens of our phones and tablets so routinely that we rarely stop to marvel at the amazing material technology that we're relying on. MacDiarmid Institute scientists, however, are thinking about it a great deal.

Natalie Plank, Alison Downard, Roger Reeves, Martin Allen and Uli Zülicke

The substances that coat our touchscreens and make them work need two key qualities: conductivity, so that they're sensitive to the position of our fingers; and transparency, so that we can see what's on the screen. They also need to be able to be mass produced economically and robust enough to facilitate long-term everyday use.

Race for replacement

Currently, most touchscreens in the world owe their functionality to a very thin layer of indium tin oxide. But there is global worry about the continued supply of this transparent conductive oxide. Supply of the mined ingredient that it's based on, indium, is finite, and prices for it are going up. The search is on to develop other transparent conductors that can be used in its place. This is where the MacDiarmid Institute scientists come in.

Something old, something new

Principal Investigators Associate Professor Martin Allen, Professor Alison Downard, and Professor Roger Reeves at the University of Canterbury, along with Principal Investigator Dr Natalie Plank, from Victoria University of Wellington's School of Chemical and Physical Sciences, are working with a tried and true material – zinc oxide. This is similar to indium tin oxide, but it's cheaper, and the ingredients needed to make it are much more readily available.

Meanwhile, Principal Investigator Professor Uli Züelicke, also at the Victoria University of Wellington School of Chemical and Physical Sciences, is working on understanding the new and exciting properties of graphene, a material made up of a microscopically thin sheet of carbon atoms arranged in a honeycomb lattice. Touchscreen manufacturers have already begun to use zinc oxide-based materials, but the field is wide open for further development. And the possibilities for zinc oxide – and other transparent conductors like graphene – don't stop there.

Wonder material

Graphene was isolated and studied electronically in 2004, and a Nobel Prize was awarded in 2010 in relation to its potential use in electronic devices. Scientists around the world have found increasingly effective ways to produce it, and have been experimenting with its exciting and unusual physical properties. Graphene is mechanically strong, and conducts electric current and heat better than almost anything else. This makes it an almost ideal candidate for use as a durable touchscreen material. Professor Züelicke is researching new ways to manipulate graphene's properties using mathematical models and simulations. In particular, he is investigating how graphene reacts to electric and magnetic fields as well as mechanical stress, which are crucial features for touchscreen development.

Safe, but not boring

While graphene is a young, unconventional material, zinc oxide has been used for years in sunscreens and other skin products, and as a nutritional food additive. It's inexpensive to produce, recyclable, and is known to be non-toxic and biocompatible. Plank, Allen, Downard and Reeves are excited by the numerous possibilities that such a safe and abundant substance offers. To make the best use of zinc oxide, and produce stable, viable devices, they and their teams are working on understanding and controlling its very unusual surface properties in detail. Other oxides are on their radar too: tin oxide, gallium oxide, and combinations of these.

A window to the future

Graphene, oxides, and other transparent conductors could form the basis for a new range of transparent devices for smart windows. Think invisible solar panels. Or thin-film transistors – where the finest of transparent coatings can be activated to become a video screen.

There are various ways of coating screens with transparent conductors, but nano-technology offers particularly exciting possibilities. Nanowires, so fine they can't be seen by the naked eye, can be made from an oxide, or a conductive metal, and placed across screens as a mesh.

Increasing flexibility

Dr Plank has developed a method to cheaply 'grow' nanowires. She says that while zinc oxide nanowires are usually around 150nm wide, she can now make wires that are only 10 to 20nm. "This gives them a vastly improved electronic response." Dr Plank says nanowires have the advantage of flexibility. "If you pull, press or bend them, they won't break. They can be used on flexible substrates like plastic, and could have all sorts of exciting and innovative uses on clothing and in medical diagnostic tools."