BLACK, BENDABLE, LIGHTWEIGHT AND CHEAP – THE SOLAR PANEL REVOLUTION

When we imagine solar panels, we think of hard rectangular frames sitting on roofs, or spread out across expanses of deserts.

But imagine flexible, bendy solar panels, supple enough to skim a curved roof, pliable enough to be rolled up and transported easily, lightweight enough to be a thin film for the roof of a tent, and portable enough to be rolled out to generate power for emergency relief operations or taken into remote areas.

Printable solar materials that will allow all of this are closer than we think. Lead researcher in this MacDiarmid project, Associate Professor Justin Hodgkiss, says new printable photovoltaics will be low cost and able to replace silicon as the next generation of photovoltaic materials.

"Silicon cells are getting cheaper but still require a high-temperature, high-vacuum manufacturing process. For solar energy to be really accessible it needs to be much cheaper and faster to manufacture," says Hodgkiss.

He says these printable semiconductors, including polymers and nanoparticles, can potentially be manufactured on a roll, cutting production costs.

"Their ease of transport and light weight also mean it is feasible for these to be manufactured in New Zealand and shipped anywhere in the world."

Shiny is the enemy of good

When we see photos of those bright, shiny swathes of solar farms, we don't automatically think of their shininess as a problem. But Hodgkiss says an ideal solar panel would look black. "Every bit of light that reflects off a solar panel is light not transformed into electricity. When no light bounces off, it means all visible light is getting in."

This is where nanotechnology comes in. Hodgkiss compares the idea to radio antennae on the roof of a building. "When you see large antennae on the top of buildings, their size is related to the radio frequencies they're tracking. Radio waves are of the order of metres, so the antenna discs are this size. But optical wavelengths are in the order of hundreds of nanometres."

Imagine flexible, bendy solar panels

He says the MacDiarmid team working on this (which includes University of Canterbury Professor Maan Alkaisi and Victoria University of Wellington Professor Eric Le Ru) is effectively creating tiny antennae that capture light and can direct it inside the solar panels.

"We're making nanopatterns that make sure that light gets in and is not bounced away, and that capture and focus the light waves directly where they are needed in the solar panels."

Blitzing with lasers

Figuring out which new materials are going to work best as solar panels involves a bit of trial and error, and a lot of very precise laser measurement. This has shaped the career of Hodgkiss, who switched from straight chemistry to using physics techniques to trial new solar contenders.

"When I started out as a chemist I was looking at molecular models for solar power conversion and trying to devise the best 'recipe'. But I soon realised that real devices were already way more effective at solar-energy conversion than our models were ever likely to be. So we changed our approach; instead, we tried to understand how real solar photovoltaic devices work, and when comparing lots of them, to find the perfect recipe. We study the cells by blitzing them with very short pulses of lasers – essentially doing strobe photography – and taking snapshots of the electricity being produced.

"The MacDiarmid team is using lasers to understand where the energy losses are happening, where, for example, heat is being generated instead of electricity," Hodgkiss explains.

The team also includes Professor Keith Gordon from Otago University, who is using lasers to help see the structure of materials inside a solar cell.

Hodgkiss emphasises the New Zealand-wide nature of these projects. "Each of these solar projects involves researchers from universities up and down New Zealand who wouldn't be working together if it wasn't for the MacDiarmid funding the research and collaboration, which enables them to connect."