

## Frog venom to solar panels

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### A molecule maker comes home

Solar panels you can paint on the wall – that's one of the dreams of one of Victoria's star science recruits, organic chemist Professor Andrew Holmes.

Professor Holmes and his team have already invented and commercialised a new kind of low cost computer display while in Cambridge. Now they plan to apply the same ideas to create low cost plastic solar panels, and to make molecules to meet the needs of Victoria's biotechnology researchers.

He returned to Melbourne from the UK in October 2004, attracted by a package of federal and state funding including a Federation Fellowship, a VESKI Fellowship, and a custom-designed laboratory at the University of Melbourne's new Bio21 Institute.

He said, "What attracted me most was the opportunity to combine my chemistry knowledge and skills to biological issues, and work on new technology for solar cells – desperately needed if Australia is going to meet its long term needs for sustainable power generation."

In the early 1980s Andrew's team at Cambridge University was working on ways to make the active molecule of the venom of the South American poison arrow frog. Serendipitously they made a strange new plastic which glowed green if an electrical current passed through it. The end result was a new kind of computer screen and a company – the NASDAQ-listed Cambridge Display Technology.

Now in Melbourne, Professor Holmes is taking the next step – turning light emitting plastics into light absorbing plastics. "I believe these plastics could be used to create low cost solar panels. They won't be as efficient as silicon-based panels, - an area where Australia also leads. But their low cost will allow them to be used where silicon panels are too expensive," he said.

Professor Holmes is working with a coalition of organisations including CSIRO Molecular Science and the CRC for Polymers.

Professor Holmes said he came to the Bio21 Institute with an open mind to potential projects. "There are world class researchers in the biosciences in this area. I want to see what they think."

He has already spoken with Bio21 colleagues such as Associate Professor Philip Batterham, who is investigating the genetic basis of resistance and behaviour in insects, and Associate Professor Malcolm McConville, who is studying the molecular activation of diseases such as Leishmania and tuberculosis.

Not that he is devoid of ideas of his own. All his projects, however, have to pass one acid test—they need to produce a useful product. Holmes said he would only make molecules if he could do something with them, like probe a biological system or develop a smart material with industrial applications.

Professor Holmes was VESKI's first catch as part of its initiative to identify outstanding individuals and bring them to Victoria for the benefit of the Australian economy. He has been joined by:

- Professor Marcus Pandy, from the University of Texas, who took up the Chair of Mechanical and Biomedical Engineering at the University of Melbourne. Pandy is developing new tools to understand, prevent, and treat joint disease; and,
- Dr Gareth Forde who has relocated from Cambridge University to join the Monash University Department of Chemical Engineering. He is working on the manufacturing technology needed for a new generation of DNA-based vaccines and gene therapy products.

For further information visit [www.veski.org.au](http://www.veski.org.au).



Photographer: Michael Silver

## Serendipity at work

One day, in the course of their studies into the venom of the poison arrow frog, Professor Andrew Holmes and his team produced an intermediate molecule that did a strange thing—it spontaneously joined together into a long chain known as a polymer, a plastic.

Holmes said, normally this sticky mess would have gone straight into the laboratory rubbish. But, quite by chance, he happened to talk about his experience in the tearoom with a colleague from outside his field, a distinguished professor of physical chemistry.

His colleague said he ought to follow the polymer up, as those compounds have interesting properties to do with light.

Holmes followed his advice, applied for funding and received a grant from the British Technology Group. At the time the program director suggested he talk with a physicist, Dr Richard Friend, who had become interested in the emerging field of the electrical properties of plastics.

In the first ever collaboration between physics and chemistry at Cambridge, Holmes and Friend set to work. It soon became evident that another similar compound was of far greater interest than Holmes' initial polymer. But the real breakthrough came one day, as one of the group was testing the capacity of this new plastic to conduct electricity. When he put an electric current across a thin film, the polymer began to glow green.

That light-emitting plastic became the basis of NASDAQ-listed company Cambridge Display Technology, which now employs more than 130 people. The company has developed durable forms of the plastic which can emit light in many different colours, and can be used to make large, energy efficient, flat panel displays which are viewable from almost any angle in broad daylight.

The Japanese consumer electronics company, Seiko-Epson has already developed a way of using inkjet technology to print these light-emitting plastics onto screens. Besides TV and computer screens, the light-emitting plastics are already being used in displays on electronic devices, and in advertising. They could also become the basis for portable "roll-up" displays, Holmes said.

In search of further collaborative work at the interface with biology, Holmes began working with researchers at the Babraham Institute near Cambridge on inositol phosphates, molecules within cells which control the responses to external stimuli.

They activate the proteins involved in such key activities as cell division, communication and apoptosis or programmed cell death. So they are significant players in diseases such as cancer, diabetes and Alzheimer's.

The researchers have been able to develop compounds to mimic these natural signalling molecules. And, by attaching these molecules to tiny

plastic beads, the team has been able to "fish" for the intracellular molecules with which they interact, and thus to study how controls function at the molecular level.

For instance, Professor Holmes wants to continue working on the electronic activity of plastics because he believes that there is a long way to go.

The argument is simple. If you can pump electricity into plastics and stimulate them to emit light, what about reversing the process—pumping light into receptive plastics and producing electricity? "It's not as simple as that, but it does show potential," he said.

The research group has developed such light-absorbing plastics and made solar cells, which can provide a low voltage power source.

Even if inefficient, an inexpensive version of such cells could be significant, because the plastics can be used to coat all sorts of surfaces, such as walls or the casing of electronic devices, to provide useful back-up power.

Professor Holmes and his team can bring both experience and useful technology from their earlier work, to any collaboration. For instance, they have been studying the potential application of supercritical carbon dioxide to biotechnology.

At high pressure above 31 °C, carbon dioxide behaves as a gas-like liquid and can be used as a solvent. There are several advantages in doing so. For instance, it is non-toxic. Substances can be brought out of solution instantaneously, often in a useful powder form, simply by releasing the pressure—and the solvent itself disappears into the atmosphere. There are also reactions it is difficult to pursue or control any other way.

In fact, Professor Holmes considers supercritical carbon dioxide so useful he is working on a whole production system which employs it.

"We have made polymers in CO<sub>2</sub> and we have made small molecules in CO<sub>2</sub>, and polymer supports which could eventually become new methods for separating materials.

"So our dream is that we could have an integrated process. We could flow the reactants in one end of this massive support. The chemistry would happen on the support at the beginning. The second phase would be separation, and the final phase would be precipitation, and control of the form of the product. We've filed a lot of patents in that area," he said.

As someone who is sold on collaboration as the way of the future for research, Professor Holmes is also well aware of the challenges. "One pre-condition is a real will to collaborate, and that means making sacrifices," he said.

He said there is no room for *prima donnas*, people who want to take the credit for everything and be principal author on scientific papers all the time. "You must passionately believe that there is better value in working together, than in individual rewards," he said.