# Current-carrying Holes Win *Australasian Science* Prize

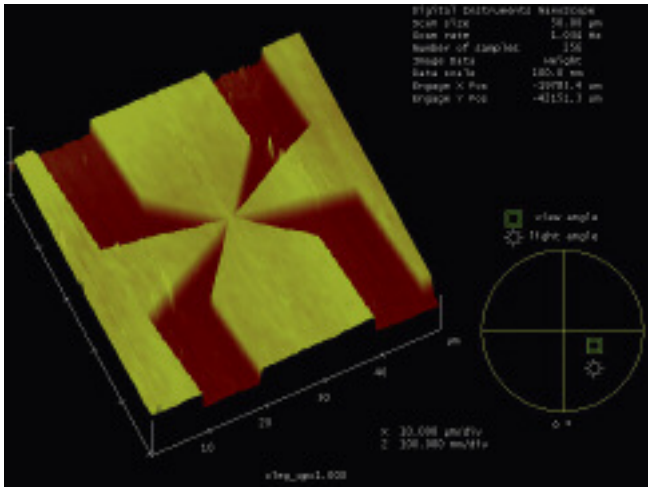
The 2006 *Australasian Science* Prize has been awarded to A/Prof Alex Hamilton of the University of NSW School of Physics for his work controlling the spin properties of holes in semiconductor nanostructures (*AS*, September 2006, p.6). His work is a step towards building spin-based transistors and electronic circuits for faster and more energy-efficient computers.

Hamilton and his team have found ways to manipulate the magnetic "spin" of holes in semiconductors. Since these holes can be used to carry current just like electrons, this may make it possible to have transistors that switch on and off magnetically, a far faster and more energy-efficient process than the present electrical methods.

Prof Michael Kelly of the University of Cambridge described Hamilton as "a truly world-class researcher with an international reputation as an acknowledged expert in the fields of quantum electronics, nanoscale semiconductor device fabrication and ultra-low temperature measurement". He noted that Hamilton's achievements required skills in very diverse fields, ranging from mathematical calculations to precision nanofabrication and measurements using very low temperatures and high magnetic fields.

According to Kelly, Hamilton has a string of world firsts, of which the work previously covered in *Australasian Science* is just one example. Another achievement Kelly highlighted was the coupling of two quantum transistors, where the electrical current in each one is confined to move in a thin layer only 20 nm thick.

Hamilton says this work came from noticing that "in circuits we treat transistors as if they are independent of each other. However, when you put them very close together they start to interact. We pushed it to extremes, putting two hole transistors a few tens of nanometres apart."



**An atomic force microscope image of hole quantum wires fabricated at UNSW.** Image: Dr W. Clarke and O. Klochan

Hamilton compares the holes in the transistors to marbles rolling on a sheet of glass. "When the sheets are brought very close together, a marble on one sheet is closer to a marble in the other than to its neighbours on its own sheet."

In a strong magnetic field the holes ended up interacting attractively, rather like the Cooper pairs that make superconductors possible. "Unfortunately they're not superconductors as the two holes travel in opposite directions, so there is no net flow of current," Hamilton says. Nevertheless the behaviour is still like a superfluid, and provides new tools for investigating how normal fluids become superfluids.

Kelly also praised Hamilton's work on cryogenic measurement techniques, developing systems to measure the behaviour of individual electrons in devices cooled to one-tenth of a degree above absolute zero on microsecond timescales. Hamilton says that these extreme temperatures are used to remove the thermal effects that otherwise get in the way of observing the quantum behaviour of the circuits.

The announcement of the *Australasian Science* Prize capped a good week for Hamilton, who had just shared in a $1.3 million Australian Research Council grant with colleague Dr Adam Micolich to conduct studies of quantum dots. Hamilton compares these to "artificial atoms", where electrons are confined into dots only a few hundred nanometres in diameter so that their behaviour can be observed.

Hamilton considers the prize "a wonderful recognition of the work the group has been doing and of basic, fundamental science". He hopes it will raise awareness that "Australia is making an international contribution to basic science".

When he was informed that the 2001 *Australasian Science* Prize winner, Prof Mandyam Srinivasan of the Australian National University, had just won the 2006 Prime Minister's Prize (see p.12), Hamilton said: "I'll try not to let the side down, but really, I'm just happy with this."

## PAST WINNERS OF THE PRIZE

- 2005 Alexander Argyros, Dr Martijn van Eijkelenborg and Dr Maryanne Large (University of Sydney) for developing polymer optical fibres that perform competitively with silica fibres.
- 2004 Prof Levon Khachigian (University of NSW) for developing DNA drugs with potential in cancer treatment.
- 2003 Prof Mark Rowe (University of NSW) for determining how sensations are processed and transmitted in the brains of mammals.
- 2002 Dr Mark Hindell (University of Tasmania) for research on the behaviour of southern elephant seals and other marine predators.
- 2001 Prof Mandyam Srinivasan, Dr Shaowu Zhang & Dr Javaan Chahl (Australian National University) for extending knowledge of the behaviour and intelligence of bees to artificial intelligence.
- 2000 Dr Charlie Veron & Dr Mary Stafford-Smith (Australian Institute of Marine Science) for the discovery of 169 species of corals and documenting all known species in *Corals of the World*.