Physics Researchers Take Nanotechnology to the Big Time

Internationally renowned for their research breakthroughs in the field of printed electronics technology, UCT physics professors Margit Härting and David Britton, together with the University, are busy spinning out a company and are also in the process of establishing a UCT-based centre for innovation in the nanosciences and technology.

The research partners only began working on printed electronics technology in the solid-state and materials physics group in the early 2000s, but they made groundbreaking advances right from the outset.

Among the first was the production of semiconducting inks using silicon nanoparticles – an innovation that now underpins the rest of their work. They later became the first scientists in the world to deposit silicon nanoparticle-based ink onto paper and other substrates at room temperature, and have it work as a semiconductor.

This April the UCT colleagues walked away with one of the world's most prestigious academic awards – the Academic Research & Development Award – which they received at the IDTechEx Printed Electronics Europe Awards 2010, in Dresden, Germany, for this technology.

Their innovation allows electronic ink to be printed onto a substrate (the material on which an electrical circuit is built) where it works as a semiconductor that can carry electrical charges. An important aspect of the innovation lies in the fact that they have produced silicon nanoparticle-based inks without the need for the usual high-temperature processing – and they've been able to achieve this at an extremely low cost. Using a novel printing technique, the researchers are able to print "electronic ink" onto substrates like paper, producing semiconductors with a performance quality comparable to silicon thin film transistors.

The scientists describe their method of fabricating silicon nanoparticles as "a lean process, using inexpensive material." By using renewable substrates and non-toxic materials their technology is also biodegradable and environmentally safe. They point out that when silicon is burned it produces sand, which can be safely used in landfills.

This technology has infinite applications they explain. "The commercial potential is dangerously broad," comments Härting wryly.

"Producing inks from silicon nanoparticles presents a new way to produce electronic devices. Therefore printed silicon could become the universal platform for disposable electronics, and could lead to a countless new product designs and applications," says Härting.

"It could bring inexpensive, ubiquitous electronics in terms of electronics in packaging, electronics in clothing, electronics in rooms, in furniture, electronics in documents, flexible displays and much more," says Britton.

They illustrate this point by using imaginative examples such as the construction of paper-thin solar panels, the creation of animated billboard posters which could light up or feature video footage, and the production of 'smart fabrics' that is used in sportswear to monitor muscle fatigue during training sessions.

One application which could have a significant impact locally is using solar cells as charging units for portable electronics. ***"In an African context, a lot of people have cell phones, but don't have regular access to electricity," explains Härting. The researchers say that organic solar panels could be used to charge cell phones and other low-power household devices in rural areas that have no access to the electricity grid."***

Echoing the sentiments of several other inventors at UCT, Härting and Britton say their location in Africa served as a boon in many ways. "In a so-called First World environment, you see things differently," she says. "You go into the stream where everybody else is going. In another environment there are no such influences, and you can go for your own idea."

As postgraduate supervisors the researchers have created a network of UCT alumni throughout Africa. In partnership with the United States Agency for International Development, they're hoping to collaborate with some of their former students and other researchers at universities in Rwanda and the rest of Africa.

Their work has been funded by the Department of Science and Technology through the Innovation Fund. The team is also working in conjunction with the US Agency for International Development (USAID) on its programme for higher education development in Africa.

"This programme funds projects in Africa that build up capacity for research and development, as well as encourage entrepreneurship and innovation," says Britton.

In addition to all this work, they are well on the way to launching the Nanosciences Innovation Centre – the first of its kind in Africa – which will be based at UCT.

"It's going to concentrate on basic research and on innovation," explains Britton.

"If you take the innovation chain, starting with fundamental research, then basic research, then applied research, then development, then innovation and commercialisation, the Centre will focus on the 'middle bit' – basic research to innovation," elaborates Härting.

"This Centre will be of enormous long-term benefit to the university and the country," adds Britton.

The scientists warn that innovation is a complex environment to operate within.

"You have to be extremely careful when going into innovation – you must have an excellent overview and a comprehensive understanding of the environment in which you are going to be operating", caution the professors.

They refer to the 'ecosystem' in which they are working. They have to keep abreast of the work that their counterparts, as well as people in affiliated industries, are conducting.

"While we're working on our aspects, other people are working on displays, other people on new substrates, other people on power supplies, and each of those has to fit together, if you're going to actually have the interconnected world that you want," Britton maintains.

"This is not only printed silicon alone, you have to see this in the bigger picture – you can make a circuit, but a circuit has to be powered, and a circuit has to give out a signal," says Härting.

"And it has to have a market!" interjects Britton. "It is also essential to go and talk to the commercial and industrial communities. So you have to go to the industrial and commercial conferences, not just the scientific conferences."

Understanding of the market is even more important at the point when one is about to spin-out a company, they say.

"When potential funders, like venture capital funders, want to talk to us we have to present our technology in a framework that it can be easily understood, and which makes sense in the economic and social environment," observes Härting.

Patent title and Inventors	Granted Regions	Pending Regions
Britton, D.T., Harting, M. A Thin Film Semiconductor Device and Method of Manufacturing a Thin Film Semiconductor Device.	ZA	US, JP, EP
Britton, D.T., Harting, M. Doping of Particulate Semiconductor Materials.	ZA	US, KR, JP, IN, EP, CN
Britton, D.T., Harting, M. Semiconducting Nanoparticles with Surface Modification.	ZA	JP, IN, EP, KR, US, CN
Britton, D.T. Harting, M. Odo, A.E. Thick Film Semiconducting Inks	–	IN, EP, US, KR, ZA, CN, JP
Britton, D.T., Harting, M. Method of Producing Stable Oxygen Terminated Semiconducting Nanoparticles	–	PCT
Britton, D.T. Harting, M. Odo, A.E. Inkjet Printing of Nanoparticulate Functional Inks	–	PCT
Britton, D.T., Harting, M., Jickerson, J.H. Nanolabelling of Metals.	–	PCT