Going for gold, and silver

It is hard to think of a more desirable fibre for today's rapidly growing über-rich: a luxurious Merino wool containing nanoparticles of gold or silver. Yet following extensive research at the Victoria University in Wellington, New Zealand, this dreamlike concept is close to becoming a commercial reality. Our New Zealand correspondent Wendy Mill outlines the development, and explains why the fibre could prove extremely valuable for both the luxury apparel and interiors sectors.

Most people will be familiar with the fairy tale in which the miller's daughter spins straw into gold, but, as far fetched as it may sound, a team of New Zealand scientists have recently come up with a way of turning pure New Zealand wool into gold.

Professor James (Jim) Johnston of Victoria University in Wellington, New Zealand, heads a team of scientists who have developed and patented a process in which pure gold or silver nanoparticles are embedded in New Zealand Merino wool to create a luxury fibre that is already drawing wide international interest from designers and manufacturers.

To understand the process, it is necessary to understand the principles of nanotechnology. A nanoparticle is typically a few tens of nanometres in size (a nanometre is one billionth of a metre or one millionth of a millimetre), and given that fine 20 micron Merino wool is about 1,000 times wider than a gold nanoparticle, it is not difficult to see that this technology is highly specialised.

"Certain metals like gold and silver, when their particles are reduced in size to nanoparticles, behave quite differently in the way they interact with light," explains Professor Johnston. "They scatter light in different colours depending on the nanoparticle size. Gold particles that are about 10-20 nanoparticles give a red-wine colouring, but as you increase the particle size, this spectrum moves towards the blues and purples. With silver, you get yellow-amber and green hues."

Professor James (Jim) Johnston (centre), Kerstin Burridge (left) and Fern Kelly (right). Picture from Robert Cross, Images Services, Victoria University of Wellington.

Professor Johnston says that although the use of precious metals in colouring is not new, it was not until the early 1900's and the emergence of quantum mechanics that scientists could gain a true understanding of the physics of the scattering of light.

"Very small colloidal gold particles were added to the melting of glass centuries ago to create red European cathedral glass," he says. "However, it was not until 1857 that Michael Faraday realised the red colouring in glass was due to the colloidal gold, though he did not know how it was achieved. In 1908, the German physicist, Mie, was instrumental in developing the theory of surface plasmon scattering of light relating to small (nano) particles, but the application of this effect remained dormant until the surgence of nanoscience in about the last decade."

In 2006, Professor Johnston came up with the idea of using gold nanoparticles as a stable colourant for Merino wool. "I saw it as a way to link the high-quality fibre of New Zealand Merino wool with the high premium value of gold for luxury, top-end fashion," he explains.

From there, Professor Johnston presented the idea at the Institute of Nanotechnology conference in London in 2006 where the concept was very well-received. "At that time, we were initially creating the nanoparticles separately and putting them onto the wool fibres, but we found there were issues with that as they could rub off," recalls Professor Johnston.

The world's first nanogold-wool scarf, made from pure New Zealand Merino wool, coloured in Professor Johnston's laboratory at Victoria University of Wellington, spun into yarn by Jo Reeve of Wellington and then woven into the scarf by Janet Clark of Wellington. Picture from Robert Cross, Images Services, Victoria University of Wellington.

As a result, Professor Johnston took the project back to the drawing board and along with his research team of Kerstin Burridge (PhD student), Fern Kelly (PhD student), Daniela Kohler (German Diplom exchange student), Dr Michael Richardson and Dr Thomas Borrmann, of Victoria University of Wellington, he developed and patented a new technology. "This involved putting the gold and silver nanoparticles onto and inside the wool fibre matrix," he says.

Professor Johnston has also been working in association with AgResearch Limited at Lincoln University, in New Zealand, through which the wool is sourced and the finished fibre performance tested.

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Earlier this year, small quantities of the gold and silver infused wool were spun into yarn and woven into scarves, one of which Professor Johnston took to the Nanotech 2008 conference in Boston in early June this year, where he presented the technology. The scarf was also displayed at the stand of the London-based World Gold Council, which had provided finance towards the research.

At the same time, Kerstin Burridge and Fern Kelly gave a joint presentation at the Autex 2008 textiles conference in Biella, Italy, where both gold and silver scarves were shown.

"These were all extremely well-received with a lot of interest from manufacturers and international fashion houses," says Professor Johnston.

Merino wool yarn coloured with gold nanoparticles.

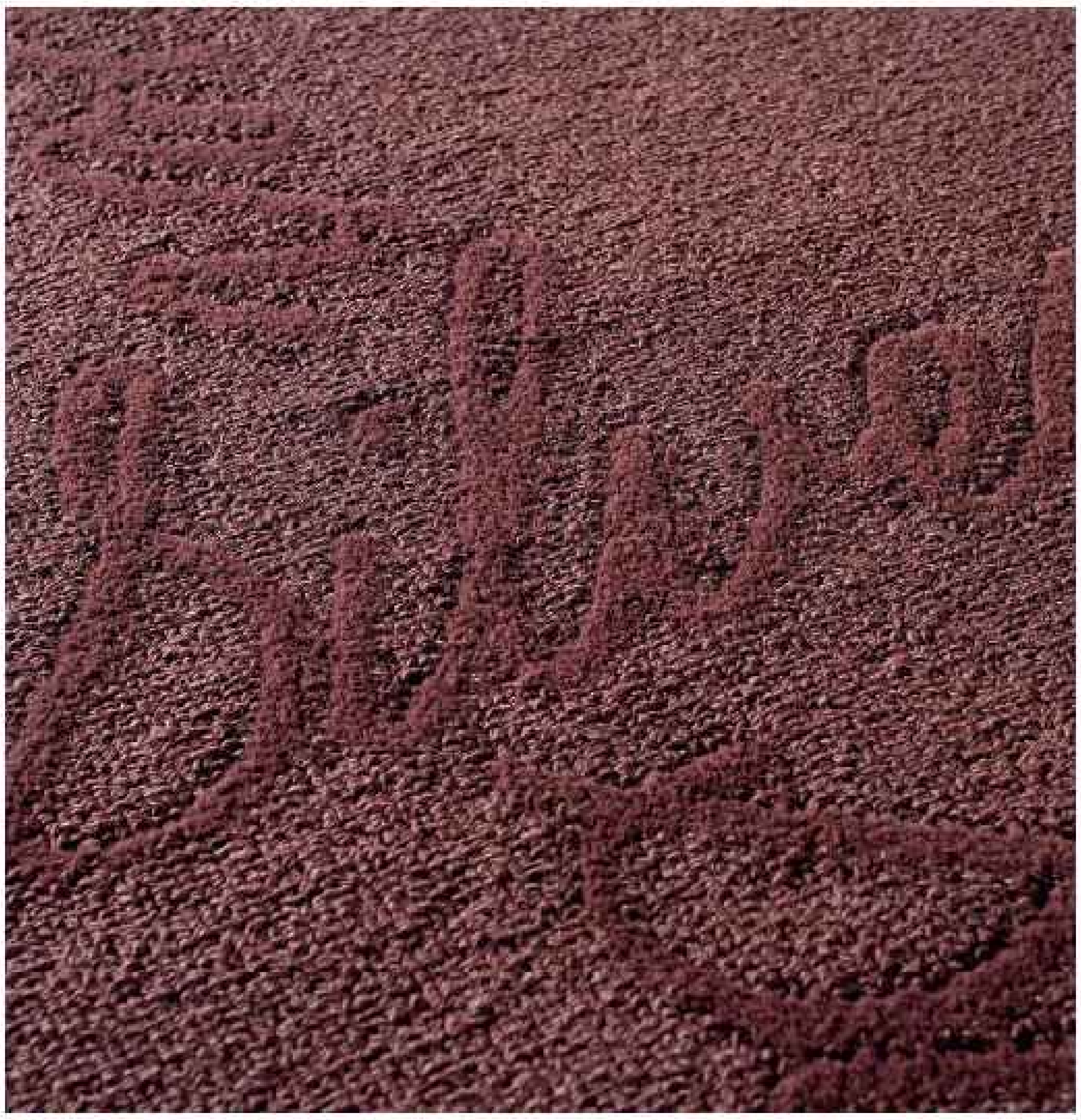
New Zealand Merino wool coloured with silver nanoparticles. Picture from Robert Cross, Images Services, Victoria University of Wellington.

While the scarves were the first garments in the world to feature the nanogold Merino wool technology, Professor Johnston believes the fabric also offers potential outside the luxury apparel market: "We have been working with Wools of New Zealand to explore the use of this nanotechnology in coarser crossbred wools and have made some nanosilver wool with New Zealand carpet wool. The nanosilver wool fibre was woven into yarn by AgResearch and then sent to Wools of New Zealand in Ilkley in the UK, where it was made into carpet samples with yellow-amber or purple tonings."Another exciting consequence of this nanotechnology is that as silver has anti-microbial properties, the nanosilver carpet and textiles are inherently anti-microbial, removing the need to treat the carpet with insecticide compounds to prevent microbial decay. In addition, the gold and silver nanoparticles impart weak electrical conductivity to the fibres. Hence the textiles and carpet possess anti-static features.

"The silver meant we could manufacture more functional carpets and textiles which would lend themselves ideally to such applications as areas of public traffic such as seating and flooring," says Professor Johnston. "The use of gold results in a finished product which combines pure New Zealand wool with pure gold, in a very green process which obviates any environmental problems associated with traditional dyeing processes."

The cost involved places the nanogold fibre at the top end of a niche market and the nanosilver in a high-end market, and following tremendous offshore interest, Professor Johnston suggests that within 12 months, the process could become a commercial reality: "We have been working with New Zealand Trade and Enterprise in London and Milan and although things are commercially sensitive at this time, we are talking to a number of end users about the potential offered by this development. We are also interested in hearing from anyone else who may be interested in this innovation."

Professor Johnston sees the technology, which is owned by Victoria Link Limited, the commercial arm of Victoria University of Wellington, as being a key part of the value chain, and further refinement of the science is taking place with a view to the branding and commercialisation of the product.



A carpet sample made by the UK-based Wools of New Zealand, from New Zealand wool coloured with silver nanoparticles. It is also anti-microbial and anti-static. Picture from Robert Cross, Images Services, Victoria University of Wellington.

"We see it as a key step in taking pure New Zealand wool and colouring it, for carpet, textiles or high-end fashion garments," adds Professor Johnston. "This is very clever technology which does not require a huge, expensive plant and, from a New Zealand point of view, it proves that you don't have to be big to be innovative in the scientific area. I have always worked with the idea of identifying areas where we can produce some pretty smart science and with this technology we are giving the New Zealand wool industry a boost by creating a unique added-value material with its own distinctive properties for high-end markets."