March 2005
Volume 1, Issue 2

University of Western Sydney
Bringing knowledge to life

2C 10^{-9}

The title of the newsletter represents the Campbelltown/Camden region as the '2C' and nanotechnology by its mathematical symbol 10^{-9}

in this issue . . .

Nanotechnology – a simple explanation for the 'rest of us'

Manufactured products are made from atoms. The properties of those products depend on how those atoms are arranged. If we rearrange the atoms in coal we can make diamond. If we rearrange the atoms in sand (and add a few other trace elements) we can make computer chips. If we rearrange the atoms in dirt, water and air we can make potatoes!

Today's manufacturing methods are very crude at the molecular level. Casting, grinding, milling and even lithography move atoms in great thundering statistical herds. It's like trying to make things out of LEGO blocks with boxing gloves on your hands. Yes, you can push the LEGO blocks into great heaps and pile them up, but you can't really snap them together the way you'd like.

In the future, nanotechnology will let us take off the boxing gloves. We'll be able to snap together the fundamental building blocks of nature easily, inexpensively and in most of the ways permitted by the laws of physics. This will be essential if we are to continue the revolution in computer hardware beyond about the next decade. Nanotechnology will also let us fabricate an entire new generation of products that are cleaner, stronger, lighter, and more precise.

Can your business benefit from Nanotechnology?

This newsletter attempts to provide you with a 'sneak preview' of the future. If the promise of new and improved products and processes which could lead to greater profits and improved competitiveness for your business excites you, we invite you to join the UWS Nanotechnology Network. This 'partnership' between the University of Western Sydney and local industries could well be the key to your future business growth.

Joining the Network enables you to keep up with developments in this exciting new technology through regular seminars, newsletters, expert speakers and peer forums. Be part of if!

For more information contact Mr Kim Leevers in the Office of Regional Development at the University of Western Sydney on (02) 4620-3729 or visit www,uws.edu.au/nano

Nanotechnology has enabled the development of coatings that can make normal materials ultra-strong.

Nanotechnology is set to change our lives

Less than 10 years ago most people had never heard of the internet and had difficulty understanding the concept. Nanotechnology is at that same stage today, but in the very near future nanotechnology will be part of our everyday vocabulary and everyday lives and we'll all enjoy the incredible benefits. Here are some examples:

What is it?

It's difficult to illustrate nanotechnology because it involves doing things to materials at the molecular scale, but the technology is set to change our lives in the same way as the Internet has change the way we communicate and do business. Nano-materials exploit unusual electrical, optical and other properties because of the precise way in which atoms are arranged.

Strong screws

Nanotechnology has enabled the development of coatings that can make normal materials ultra-strong. The steel screws holding this fractured bone together are coated with a layer of nano-sized diamond crystals a 1000th of a millimetre thick. Bodies are less likely to reject the screws because diamond is a pure form of carbon and so are our bodies.

No more stains?

One of the biggest areas for nanotechnology is in clothing and fabrics. Treated with a nano-scale coating, liquids turn into beads which roll off the fabric. This kind of coating is especially useful for the military and medical professions.

New displays

This electronic Digicharm Tag uses a new display technology called PLEDs. A layer of plastic only a few nanometres thick is between two thin layers of metal. When electricity passes through the plastic it glows. PLED displays have a higher contrast than LCD screens and can be printed onto anything.

Bouncier balls

Ordinary tennis rackets are weakened by tiny gaps between individual carbon fibres. Now rackets can be reinforced with nano-sized silicon-dioxide crystals that plug the holes. Nanotech has also made balls bouncier for longer. Inside, a coating of nano-thin platelets forms a barrier that keeps air in for longer.

Solar cells

Hydrogen Solar's Tandem Cell uses sunlight to split water into hydrogen and oxygen. The cells have nanocrystalline metal particles on their surface, giving them a vast surface area with which to collect the Sun's energy. Currently, it converts just over 8% of the Sun's energy into pure hydrogen. Hydrogen is potentially a clean source of fuel.

Local business harnesses the benefits of Nanotechnology

Jim Walsh driving his Regal City Mini pulled by his Giant Schnauzer, Tom, (first time in harness)

R.J. Walsh & Son Pty Ltd is regarded as the leading manufacturer of harness racing vehicles in the southern hemisphere. Its sulkies are exported around the world. Established in 1961 by the father of current Managing Director, Jim Walsh, the company hopes to soon harness the benefits of Nanotechnology. Jim Walsh explains:

"What prompted you to learn more about Nanotechnology?"
I accepted an invitation to join the UWS Nanotechnology Project as a foundation member. I also received an invitation from a Swedish company, Sandvik, asking me to consider using their nanotechnology based steel, Nanoflex, in my products.

"Tell us about negotiations with Sandvik"
It involved lengthy discussions with Sandvik's New York and Australian branches on issues such as the technology, costings, and availability, but I knew if negotiations were successful it would give my business a significant competitive advantage which would translate into more sales and greater profits.

"How has Nanotechnology changed your business?
It meant re-designing my product slightly to take advantage of the characteristics of Nanoflex (up to six times stronger than T304 stainless steel and more corrosion resistant).

I also organised a consortium consisting of my company, UWS and ANSTO in order to properly research the application of Nanoflex to my products. This increased activity and networking has taken my business to a whole new level which is focused on world markets.

"How will Nanoflex increase your sales?"
Nanoflex is of great interest to me because the customers for my new line of canine sulkies are mostly (80%) women, and they place great importance on light weight and durability. Nanoflex has the potential to deliver both.

The total market for canine sulkies is potentially huge. There are 178 million dog owners in the first world alone. Sales to one in twenty thousand (0.005% – a very modest goal) would equal 8,000 units per annum and sales of $20 million.

"What's next?"
I'm floating my company on the Newcastle Stock Exchange in order to raise the funds necessary to market my canine sulkies world-wide. The sulky design has been amended so that Nanoflex parts can be substituted as they become available, so I'm ready to go as soon as Sandvik can deliver suitable product.

- *Jim and his Regal Mini Sulkies were recently featured on the high profile and long running ABC television show,* The New Inventors.
- *In November 2003, R.J. Walsh & Son won the 'Uniquely Bankstown' award at the annual Bankstown Industry and Export Award – the first such award ever won by a sulky manufacturer in Australia.*

“nanotubes imbue the resultant yarn with properties including electrical conductivity, high strength and a high breaking strain”

Bottle Magic – food protection through smarter packaging

Bottle Magic Australia Pty Ltd, has developed transparent nanoparticle coatings for glass bottles, in conjunction with CSIRO researchers. This revolutionary coating technology screens bottle contents, such as beer, wines, milk, vegetable oils and vitamins from many of the damaging effects of light. It also has the potential to revolutionise the way bottles are produced as the light screen nanoparticle coating can be applied as an anti-scuff scratch resistant coating during the mass production of the bottles. The result is an aesthetically attractive transparent coloured bottle, whilst protecting against harmful UV and blue wavelengths of visible light that damage many bottled beverages and foodstuffs.

How’s it work?

The pigment nanoparticles are made with a proprietary technology that produces an average particle diameter of only 30 nanometres (one nanometre equals one billionth of a metre). The visible spectrum of light spans wavelengths between 400 and 700 nanometres. Bottled beverages and foods are damaged by wavelengths between 200 nanometres (near-ultraviolet) and 450 nanometres (blue). The nanoparticles absorb the more energetic wavelengths between near ultraviolet (200 nanometres) and green (550 nanometres), while allowing harmless yellow to red wavelengths to pass through the coated glass. As a result, it yields the same protection to contents as the traditional amber bottle used for beer, vitamins etc., or blue medicine bottle, while allowing the consumer to see the contents.

Providing a marketing edge

It will allow wine and food companies, cosmetics manufacturers and even pharmaceutical companies that currently must use opaque containers to combine fashion with function in pursuit of a marketing edge.

Bottle Magic will launch the nanoparticle ‘sunscreen’ coatings in the United States, Europe and Australia shortly. For more information visit http://www.bottlemagic.com.au

Smart Cloth for Cutting-Edge Tailors

Clothing that can report the location of an injured miner or automatically contract around a soldier’s wound to prevent blood loss may sound like the stuff of science fiction, but it is not far from reality following the development of a new yarn made from sub-microscopic fibres.

In a breakthrough in the development of ‘smart’ clothing, scientists at CSIRO Textile and Fibre Technology in Geelong and at the University of Texas NanoTech Institute have used Australian wool and cotton spinning know-how to produce a new yarn made solely from carbon nanotubes. These tiny high-tech fibres can be woven into strong, lightweight yarn with some extraordinary properties. The hollow fibres measure about a millionth of a centimetre in diameter, and are ‘grown’ at high temperatures in laboratories.

Ken Atkinson, project leader in textile research and development at CSIRO, says the nanotubes imbue the resultant yarn with properties including electrical conductivity, high strength and a high breaking strain. They can also withstand extreme temperatures while retaining their strength and flexibility.

It is a case of technology boosting the competitiveness of a traditional industry by effectively creating a new product. Researchers say the conductivity and flexibility mean carbon nanotube fibres could act as antennas when woven into fabrics, allowing, for example, wearers to be continuously tracked via a GPS system.

Potential military applications include bullet-proof vests, and material incorporating sensors which would be ‘aware’ when a soldier was wounded and act as electrically driven muscles, contracting around a wound to prevent further blood loss.

The carbon nanotube yarns are an exceptional breakthrough and with some achievable modifications, the nanotube spinning process seems suitable for high-value commercial products.

Professor Bill Price

Nuclear Magnetic Resonance (NMR)

Nuclear Magnetic Resonance (NMR) is a phenomenon which happens when the nuclei of certain atoms are immersed in a static magnetic field and resonate. Professor of Nanotechnology at UWS, Bill Price, explains; “NMR techniques are extremely versatile and have the potential to open many doors for greater innovation and improved research outcomes. NMR allows scientists to non-invasively examine and measure physical, chemical, and biological properties of matter at an atomic level. As a result, NMR spectroscopy finds applications in many areas of science and medicine – for instance understanding the molecular basis of ionic conductivity in battery electrolytes and the investigation of brain diseases. It can even be used to probe the size of fat and oil droplets, and therefore NMR also has applications in the food industry, and numerous other industries.”

The word nuclear in Nuclear Magnetic Resonance really has nothing to do with nuclear reactors or biologically damaging radiation coming from radioactive materials. Rather, it refers to the nucleus of an atom. Nevertheless, in the medical world, the word nuclear is dropped and so Nuclear Magnetic Resonance Imaging (NMRI) is shortened to Magnetic Resonance Imaging (MRI) to avoid confusion or unnecessary fear.

Professor Bill Price says; “Business and industry need to make the effort to find out about NMR and its possible applications in the commercial world. There are business opportunities to be had, just waiting for someone with the foresight and courage to grab them.’

As a result of a successful ARC grant lead by Professor Price, UWS will shortly take delivery of an advanced NMR spectrometer that will give UWS arguably the best facilities for very high resolution MRI (also known as NMR microscopy) and NMR diffusion measurements in Australia and perhaps the southern hemisphere. The spectrometer will be based on an 11.8 Tesla superconducting magnet.

In September, UWS will also host the second ‘UWS Symposium and Workshop on NMR Imaging and Diffusion’. This symposium not only provides a forum for presenting the latest advances in MRI and diffusion measurements, it also disseminates these exciting techniques to those who would benefit from these techniques if only they knew a little more about them.

The Great Debate (Nanotechnology Vs Society)

Nanotechnology has exploded into our lives over the last 5 years, so much so that it is now necessary for science and society to consider the social consequences and ethical issues of nanotechnology.

Scientists have clearly demonstrated the amazing benefits of nanotechnology, but the potential disruption to industrial and social processes and to our lives is so great and so complete that it raises many questions, concerns and issues, which need to be debated and discussed.

We need to be sure that the scientists' roadmap of developments takes into account the public interest and is subject to rigorous ethical debate. This level of debate is essential, since nanotechnology, for example, can provide ‘nanobots’ that can reside in the bloodstream with the capability to search out and destroy the very first cancer cells that otherwise would have caused a tumour to develop in the body. Those ‘nanobots’ could also automatically seek out and replace broken parts of living cells in our body. Nanotechnology can also provide ‘smart’ miniaturised pumps that can also reside in the bloodstream to automatically deliver medicines.

Whilst these concepts have remarkably positive effects for our bodies, we could simply be providing an experimental test-bed

Lu Papi

for nanotechnology devices that may not be able to be controlled. After all, our natural immune system already provides most of the functions that are conceived for the 'nanobots'. What if the medicines to be delivered become obsolete? How do we efficiently collect all the 'nanobots' from the bloodstream and replenish the 'nanobots' with better medicines when and if they become available?

The nanotechnology revolution is potentially as important to the growth of our society as the industrial revolution of the 19th century. However, it's important that the public be involved in the ethical debate to determine the overall value of nanotechnology to our lives. This debate requires a high level of information and understanding, as we can witness by the value of the internet in our daily lives. After all, can you imagine life without the internet these days? Perhaps one day in the not too distant future we'll say the same about Nanotechnology.

Professor Don Martin, Institute for Nanoscale Technology, UTS

Bridging the gap between industry and the University

For the last 4 years I've been working on the development of products involving Nanotechnology. Over the past 12 months I've been assisting UWS to connect with industries that might be interested in the application of Nanotechnology, by acting as a Key Industry Advisor. I am also a member of the UWS Business & Industry Advisory Panel.

My role is to assist local industries to recognise the potential of this emerging technology in their particular fields, and to determine how best to use it.

I have discovered through this process that it is difficult to mesh the differing goals of industry and University. Industry wants to achieve near immediate results that will improve competitive position and the bottom line. The University has a longer term goal to advance the state of our knowledge through rigorous and time consuming scientific work. Larger industries can sometimes afford to dedicate time and money to achieving a 'killer result' further into the future, but small and medium industry can rarely afford such an expense. Also, it needs to be remembered that the University cannot afford to release work which has not been developed using established scientific methods and extensive peer review.

It has been a part of my brief to promote industry generated research, to try and bring these disparate aims closer together. We have had some small but significant successes however there is much more to be done. I continue to look forward to these challenges and continued to be amazed and enthused at the potential applications of Nanotechnology.

Lu Papi
Director, Lu Papi & Associates

Lu Papi & Associates is a flexible, widely networked company specialising in new product development and technology transfer. It has won several awards over recent years, including:

- The Western Sydney Industry Awards 2002: Winner of the Innovation Award for the "Most Outstanding Innovator".
- The Gold Medal at the International Exposition of Inventions in Geneva in 2000

“I’m quietly confident that my dedication will help me to make some great contributions.”

Small thinking answers big problems

Leanne Rose Boag
2nd year UWS BSc (Nanotechnology) student

Nanotechnology appealed to me because I have always been fascinated with the science world and this area has such a broad range of specialisation that I am sure that nanotechnology will be as great if not greater than genetic engineering.

Nanotechnology is so broad in its field that it can be applied to practically anything, from electronics and computer systems to biotechnology and defence. Everything is getting smaller and faster and the technology needs to keep up with the constant demand for efficient equipment and machinery.

Talking to people about what I am studying strikes a great deal of interest - a lot of people still haven’t heard of nanotechnology, but seem very impressed by what it can offer us in the future. Nanotechnology is slowly being introduced to the public through the media and it has also been slipped into the story lines of movies such as “I robot”, “Hulk” and “Minority Report”. The main attraction of nanotechnology is that it offers great solutions to many of the problems we have today such as allowing products to be manufactured at a low cost while also having little to no pollution emissions; and producing versatile and durable products, which provide overall more effective materials.

A small science brings big opportunities

Ivan Siladji

2nd year UWS BSc (Nanotechnology) student

Just one year ago the term ‘nano’ was but a new word in my vocabulary. Now I am on a journey to become an expert in the revolutionary field of Nanotechnology. This journey began here at UWS with my enrolment in the BSc (Nanotechnology) degree. The learning experience to date has been a fruitful one filled with laboratory experiments ranging from thin film development via spin coating to mathematical analyses of nuclear magnetic resonance (NMR) data.

The Nanotechnology Network Meetings run by UWS bring the University, local industry and students like myself together on a regular basis to exchange and share our views, knowledge and involvement in such a fascinating and revolutionary field.

Nanotechnology has the opportunity to change the way we look at medicine, materials science and even the way nature works and how it can be manipulated for the greater good of mankind while maintaining Mother Natures’ way. Although my place in this field is still young I’m quietly confident that my dedication will help me to make some great contributions.

Ivan Siladji

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The UWS Nanotechnology Project

The UWS Nanotechnology Project is a unique attempt to transfer knowledge of the opportunities arising form this exciting and emerging field to industry in the Campbelltown – Camden region. The Project, generously funded through the Federal Government's Department of Transport and Regional Services Sustainable Regions Programme, has endeavoured to identify opportunities within the business community for innovative processes and products, research and development, and business development opportunities.

The details of a recent industry survey will be released after further analysis but preliminary study shows that 51% of respondents to the survey believe that they have gained new knowledge as a result of participation in the Project and 26% have plans to introduce nanotechnology within their companies, compared to the August 2003 survey when only 6% had intentions to utilise nanotechnology.

The Survey also highlights that there is considerable interest in continuing to participate in the Network and that the regular meetings, seminars and email newsletter are the most popular forms for the dissemination of information. A continual plea from industry has been to demonstrate 'relevance' of nanotechnology and to show how industry can take up the technologies. The UWS Nanotechnology Project and education program addresses these issues.

UWS is committed to continuing the Project and the Network. We look forward to continued and expanded support from local industry and government agencies to enable us to maintain this exciting and innovative bringing of knowledge to the industries and communities of Western Sydney.

For more information contact Mr Kim Leevers in the Office of Regional Development at the University of Western Sydney on (02) 4620-3729 or visit www,uws.edu.au/nano