Nanotechnology and Textiles

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Topics covered

Nanotechnology:

- dollars, definitions, details.

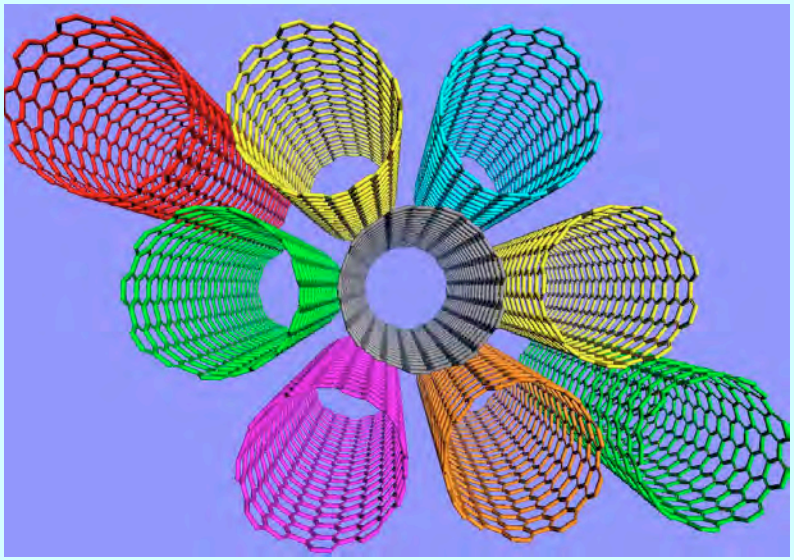
Nanoscience.

Nanomaterials.

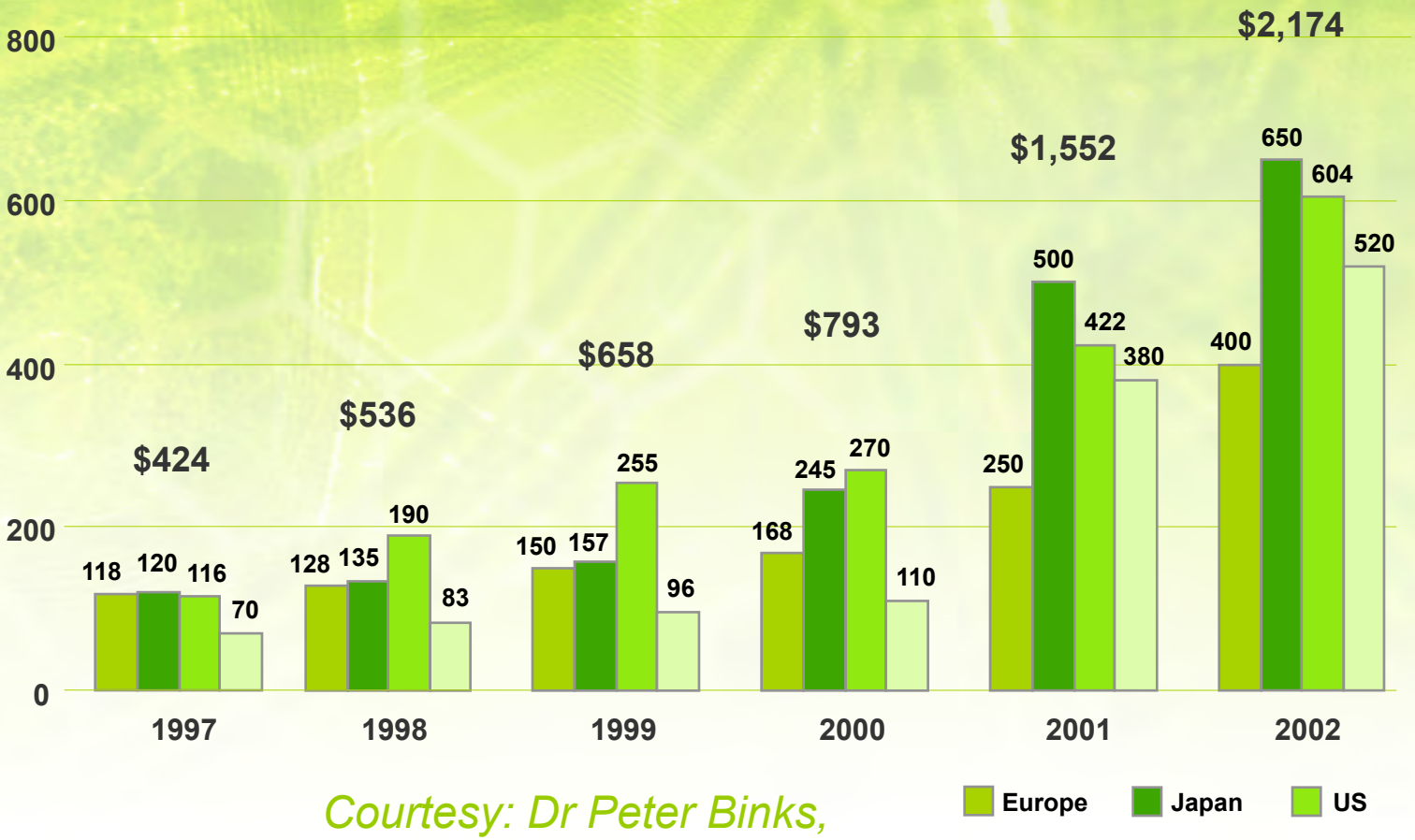
The Lotus effect.

Applications for fibres & textiles.

The future & conclusions.



Nanotechnology – Global Investment



Courtesy: Dr Peter Binks,
CEO Nanotechnology Victoria

nanoVIC
nanotechnology victoria

The Top Nanotech Products Of 2003

Robert Paull, The Forbes/Wolfe Nanotech Report, 12.29.03, 12:16 PM ET

High-Performance Ski Wax

Already in use by the pros on the Canadian National Ski Team, Cerax Nanowax is one of the world's first products made using chemical nanotechnology, which creates "intelligent" surface coatings with multifunctional properties. A polymer just like P-Tex, the material used in ski and snowboard bases, Nanowax produces a hard, fast-gliding surface. The ultrathin coating lasts much longer than

Breathable Waterproof Ski Jacket

Our European readers might have an easier time getting their hands on Oberammergau, Germany-based **Franz Ziener GmbH & Co.**'s newest ski jackets with **Nano-Tex** enhancements. Nanotechnology makes the two-layer laminate windproof, waterproof, breathable and grime resistant--great for those bums who don't get around to washing their jackets until after the season. The result: a jacket with a long, functional life superior to coated jackets and competitive with Gore-Tex products. Don't be surprised to see these über-jackets popping up on haute couture mountains like Aspen, Jackson Hole and Sun Valley.

For more information: http://www.ziener.de

Wrinkle-Resistant, Stain-Repellent Threads

Eddie Bauer's Nano-Care comfort-waist corduroy pants and Kathmandu Tobin shirt.

For the spillers, spotters and stainers among us (you know who you are). Featured in our June 2002 "Nano Product Guide," Nano-Care fabric, made by Emeryville, Calif.-based Nano-Tex, is too exciting not to mention again. Nano-Tex researchers attached molecular structures to cotton fibers, forming a barrier that causes liquids and stains to bead up on the surface and prevent absorption. Treated fabrics are not only wrinkle-proof but

Related quotes

BF	50.11	- 0.39
EK	25.77	- 0.22
GPS;NYSE	0.00	+ 0.00
NKE	71.97	- 1.64
VFC	46.10	- 0.73

Deep-Penetrating Skin Cream

Compared to conventional skin creams that sit on top of your skin, nanotechnology-enhanced cosmetic treatments penetrate deep beneath the surface and affect the base molecular layer. Take Plenitude Revitalift antiwrinkle cream by L'Oréal Paris, which introduced its first nanotechnology product in 1998. Plenitude uses a patented 200-nanometer nanotechnology process to incorporate vitamin A inside a polymer "capsule." The capsule acts like a sponge, soaking up and holding the cream inside until the outer shell dissolves under your skin. L'Oréal reports that of women surveyed who used the Revitalift technology, 80% reported antiwrinkle effectiveness, and 75% said the product was effective in firming skin.

For more information: http://www.lorealparis.co.uk/

World's First OLED Digital Camera

Digital cameras just got better, thanks to nanotech. As we first mentioned in March's "Nanodisplays: DuPont Takes On Kodak," organic light-emitting diodes (OLEDs) are much brighter than the liquid crystals (LCDs) used in many of today's flat-screen TVs and computer monitors. They boast a wider viewing angle than LCDs, which must be viewed head-on. OLEDs don't require backlighting as LCDs do, reducing power consumption. The world's first digital camera with an OLED display, the 3.1-megapixel EasyShare LS633 zoom digital camera by **Kodak** (nyse: EK - news - people), has a

Performance Sunglasses

Next time you buy a pair of shades, you may be investing in nanotechnology. Certain models of sunglasses incorporate technology from Valley View, Ohio-based **Nanofilm**, which uses nanotechnology to produce protective and antireflective ultrathin polymer coatings for eyewear. Founded in 1985 as a spinoff of research on the self-assembly of polymers at Case Western Reserve University, Nanofilm has grown to become one of the largest producers of protective glass coatings in the U.S. To give the glasses antireflection and scratch-resistance functionality, Nanofilm deposits coating layers of 150 nanometers and 20 microns thick, respectively. Then it uses chemical self-assembly to form a polymer coating, three to ten nanometers thin, on the outer layer of the antireflective lenses. This not only seals and repels grime and skin oils but also makes the lenses more responsive.

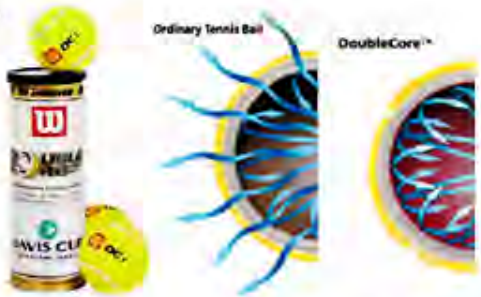
For more information: http://www.nanofilm.cc

Nanocrystalline Sunscreen

Whether you're heading to the islands or the slopes this winter, you may want to slather on a bottle of NuCelle SunSense SPF 30 sunscreen. Its main ingredient is Z-COTE, a substance made with nanotechnology by **BASF** (nyse: BF - news - people). "Nano-dispersed zinc oxide is the basis of Z-COTE," says BASF's **Dieter Distler**. The common SPF (sun protection factor) rating system only rates protection against UVB rays. Zinc oxide provides broad-spectrum protection against UVA and UVB rays, but its characteristic white pasty goop often leaves sunbathers and lifeguards feeling like they're wearing clown makeup. The

High-Tech Tennis Rackets and Balls

Each year tennis racket manufacturers, from **Wilson** and **Prince** to **Head** and **Yonex**, vie to introduce the most technologically advanced and highly engineered products. In the 1970s, it was aluminum; the 1980s, graphite; the 1990s, titanium. Now comes nanotechnology. The 127-year-old French manufacturer **Babolat** introduced the VS Nanotube Power racket in 2002, retailing for $250. The Nanotube Power and VS Nanotube Drive lightweight, oversized-head models are made out of high modulus graphite with carbon nanotubes supplied by France's **Nanoledge**. One hundred times stronger than steel, yet one-sixth the weight, carbon nanotubes increase the rigidity of the stabilizers on each side of the racket's sweet spot. Babolat credits this with increasing torsion more than 50%--and flex resistance upwards of 20%. The result? VS Nanotube rackets are five times more rigid than current carbon rackets and pack significantly more power.



But what good is a nanotech racket without nanotech tennis balls? Regular balls left out of the can become flat and unplayable after two weeks or less. But Wilson Double Core tennis balls, with Hillsborough, N.J.-based **InMat**'s Air D-Fense nanocomposite product inside, remain playable for four weeks. Sure, they cost about $1.50 more per can, but you double the life of the balls for half the incremental cost of a new can of ordinary

Nanotechnology's Disruptive Future

Josh Wolfe, Forbes/Wolfe Nanotech Report, 10.21.04, 12:04 PM ET

How many technologies have really changed our world over the past five years? E-mail, broadband Internet and cell phones would certainly top the list. These three breakthroughs have spawned industries and companies few of us could have predicted.

Experts agree that nanotech will also eventually affect most sectors of business. My affiliated institutional research firm, Lux

Photovoltaic Paint/Liquid Solar Cells

Politicians get a lot of mileage out of pledging to reduce U.S. dependence on foreign oil, but a trio of U.S.-based solar cell startups might actually be able to do something about it. These startups, **Nanosolar**, **Nanosys** and **Konarka Technologies**, and corporate players such as **Matsushita** and **STMicroelectronics** (nyse: STM - news - people) are striving to produce photon-harvesting materials at lower costs and in higher volumes than traditional crystalline silicon photovoltaic cells.

Nanosolar has developed a material of metal oxide nanowires that can be sprayed as a liquid onto a plastic substrate where it self-assembles into a photovoltaic film. A roll-to-roll process similar to high-speed printing offers a high-volume approach that doesn't require high temperatures or vacuum equipment. Nanosys intends for its solar coatings--based on structures called nanotetrapods--to be sprayed onto roofing tiles. And Konarka is developing plastic sheets embedded with titanium dioxide nanocrystals coated with light-absorbing dyes. The company recently scored a coup by acquiring **Siemens'** (nyse: SI - news - people) organic photovoltaic research activities, and Konarka's recent $18 million third round of funding included the world's first- and fifth-largest energy companies, **Electricité de France** and **ChevronTexaco** (nyse: CVX - news - people).

If nanotech solar fabrics could be applied to, say, buildings and bridges, the entire energy landscape could dramatically change. Integrated into the roof of a bus or truck, they could split water via electrolysis and generate hydrogen to run a fuel cell. Who could lose? Certainly current

Biological Electronics

Angela Belcher of the Massachusetts Institute of Technology and **Evenlyn Hu** of the University of California at Santa Barbara were courted by companies like **IBM** (nyse: IBM - news - people), but instead chose to start their own company based on their pioneering research in evolutionary biology. **Cambrios Technologies** was formed in 2003 to apply molecular biology to making materials like semiconductors.

"People question using biological manufacturing for the mass markets, but beer, bread and vitamin B12 are all manufactured by microorganisms," says Chief Executive **Mike Knapp**. "Biological manufacturing on a huge scale is cost-effective and done all the time. Long before it's possible to commercialize the biologically self-assembled Pentium 40, there will be biological components inside your television set or cell phone battery."

Who loses out if Cambrios succeeds? Many of the world's passive (non-semiconductor) electronic component leaders such as Japan's **Murata**, **Kyocera** and **TDK** (nyse: TDK - news - people); the U.S.'s **Vishay** (nyse: VSH - news - people); and active (semiconductor) electronic leaders like **Intel** (nasdaq: INTC - news - people), **Toshiba** and **NEC**

Multifunctional Dendrimers (Combination Disease Imaging and Treatment)

The University of Michigan's **Jim Baker** is one of the pioneers of dendrimer technology, tree branch-like polymers that can have multiple, simultaneous attachments to biological targets (e.g., cell surfaces). What does this mean for you? If dendrimers make it to market for diseases like cancer, you could not only be saving treatment costs by piggybacking multiple drugs on one carrier (the dendrimer), but you will likely be able to image, follow the progress and treat the cancer sooner and more effectively than ever before. Companies to keep an eye on

Regenerative Neurotechnology

Stem-cell research has become a hot button issue, yet one area absent from this political and ethical debate is work being done by researchers at MIT. **John Kessler** and **Samuel Stupp** showed that they were able to cause neural progenitor cells to change into neurons (rather than the scar tissue that causes paralysis) upon spinal injury. What does this mean? Using nanofibers, the two scientists were able to stop paralysis from happening in rats. While this technology will still face the rigorous Food and Drug Administration approval process, these nanoscale fibers could be one of the most life-saving nanotechnologies under development.

Self-Cleaning and Self-Freshening Clothes

Thanks to Greensboro, N.C.-based **Nano-Tex**, nanotech pants have been growing in popularity and availability. While Nano-Tex's stain- and wrinkle-resistant technology, called NanoCare, has been the first out of the gate, its NanoFresh (wicks away odor from sports clothing) will not be far behind.

Also, scientists at the Hong Kong Polytechnic University have been able to build a nano-thin layer of particles of titanium dioxide, a substance that reacts with sunlight to break down dirt and other organic material. This layer can be coated on cotton to keep the fabric clean. Clothes simply need to be exposed to natural or ultraviolet light for the cleaning process to begin. Once triggered by sunlight, clothing made out of the fabric will be able to rid itself of dirt, pollutants and microorganisms. The whole laundry industry--from detergents to stain sticks--will be affected.

Full disclosure: Lux Capital, through its subsidiary Angstrom Publishing, publishes the Forbes/Wolfe Nanotech Report. Lux Capital is an investor in Nanosys, Cambrios Technologies and Lux Research.

Excerpted from the September issue of the Forbes/Wolfe Nanotech

What is nanotechnology?

Nanotechnology

"The design, characterisation, production and *application* of structures, devices and systems by controlling shape and size at the *nanoscale*."

Application: useful and makes money!

Nanoscale: less than 250 nm:

1 nm = 10^{-9} metres

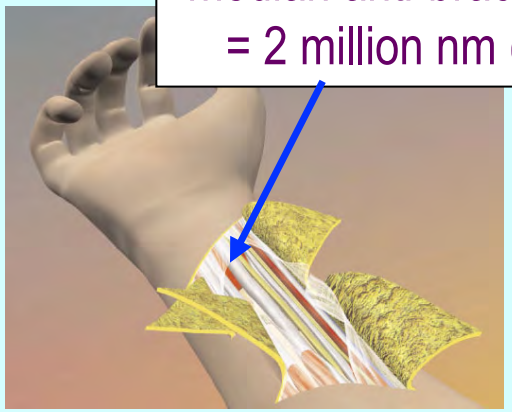
"Any sufficiently advanced technology is indistinguishable from magic."

Arthur C. Clarke, author

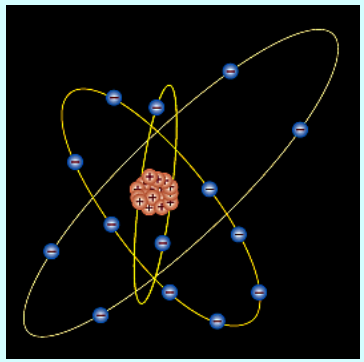
How small is nano?

< 250 nanometres

median anti-brachial vein
= 2 million nm (2 mm)

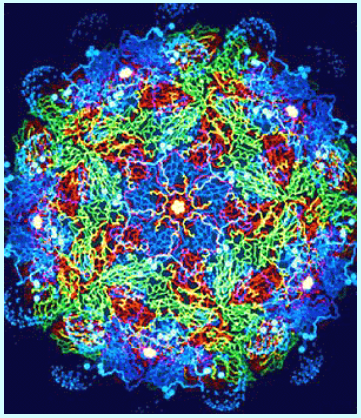


5 million red cells

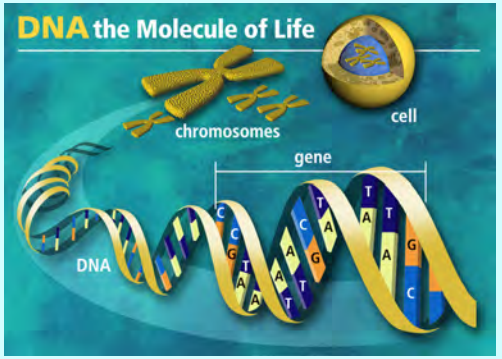


silicon atom = 0.2 nm

cell diameter = 7000 nm



virus particle
= 150 nm



DNA strand = 2 nm

awttc


Could nanobots destroy us?
Civilisation safe as nanobot threat fades
Nanotechnology – changing water into wine
Nanotech may spark fierce ethical row
Herald Sun
THE AGE
animation 1
animation 2

Nanoscience

The research that precedes, and underpins the success of, nanotechnology

"Actual application of knowledge and skills at nanometre scale for production purposes is still only possible to a very restricted extent. Nor will all the nanoscience research that is being carried out lead in the foreseeable future to nanotechnology that can be applied in practice."

Royal Netherlands Academy of Arts and Sciences, Nov 2004

Nanotechnology is not entirely new

Carbon black used to improve wear resistance of rubber.

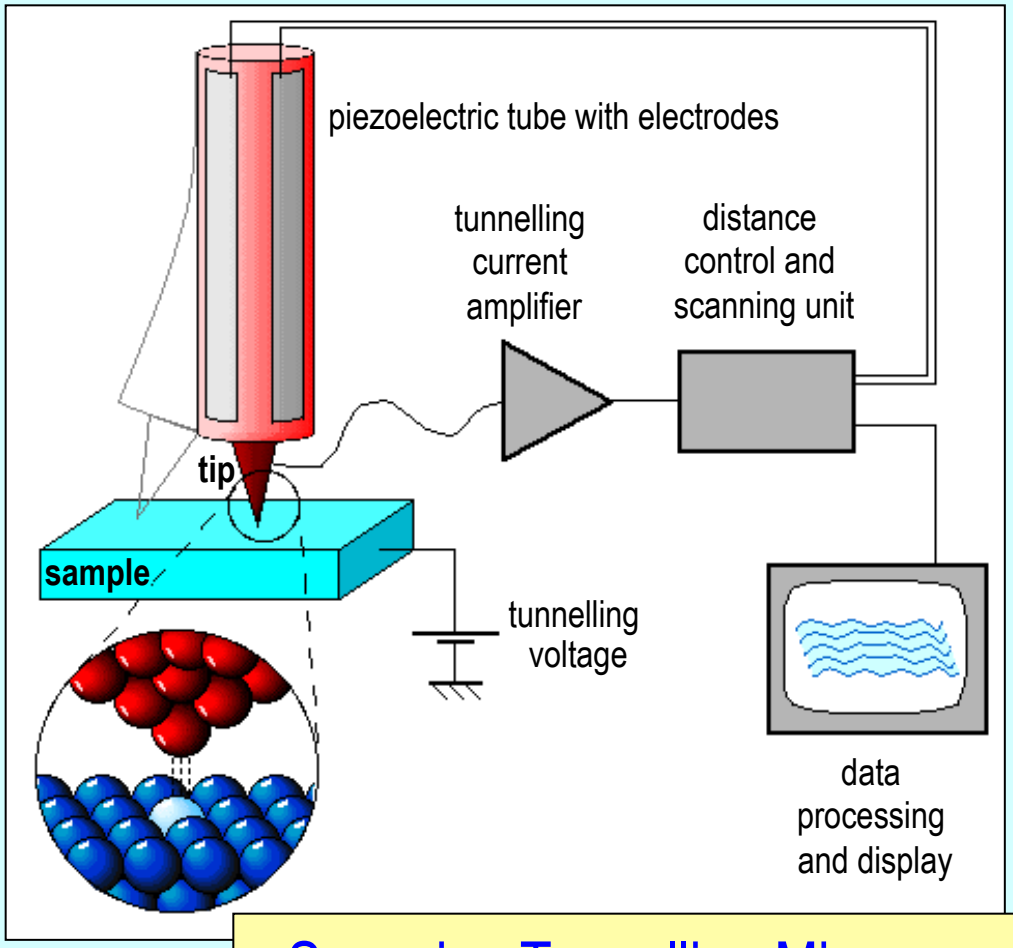
Silver and gold particles used in glass by the ancient Romans.

And Mother Nature has been active even longer:

- fertilisation of an embryo in reproduction;
- metabolic activities within cells;
- milk (a nanoparticle colloid);
- output of volcanoes - nanoparticles.

awttc

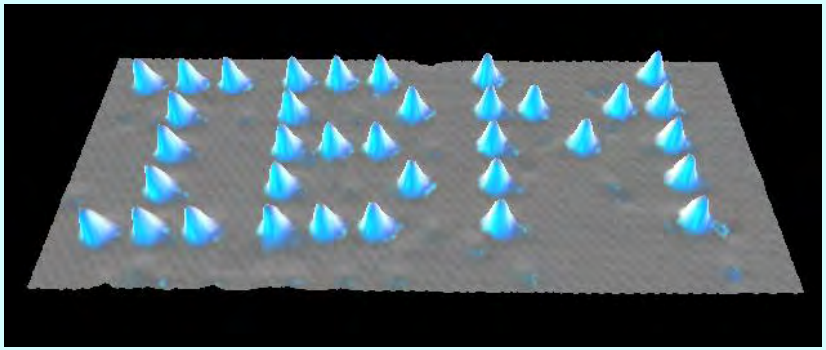
So what **is** new?



Scanning Tunnelling Microscope

The development of techniques such as scanning tunnelling microscopy:

- to observe and manipulate individual atoms.



Eigler & Schweizer, 1990

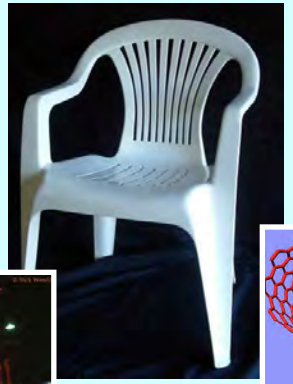
The evolution of materials

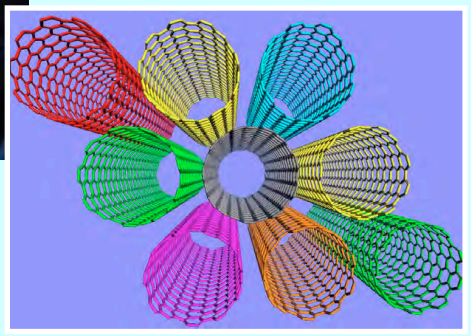
10,000 BC | 1000 BC | 0 | 1800 | 1900's | 2000 | 2010

"*Nano* adds value by adding a nanomaterial to an existing product."

Harper, 2005

stone & wood | iron | cement | steel | polymers | nanomaterials | ?





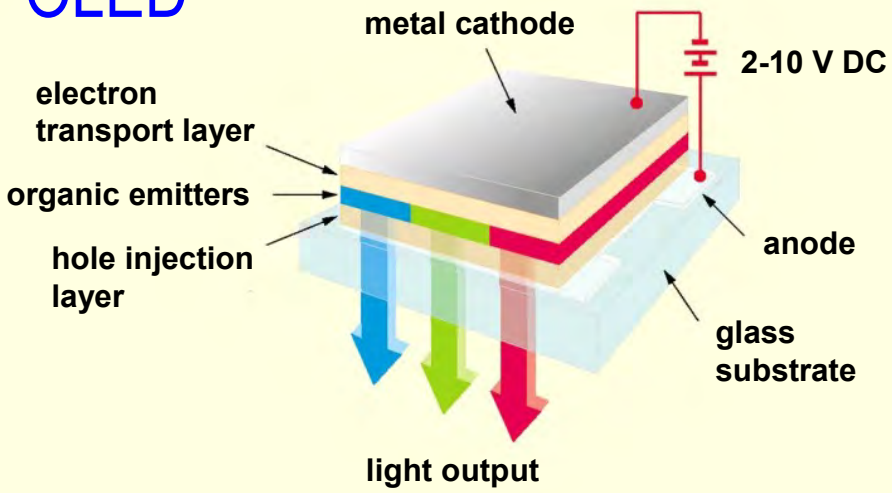
Nanomaterials

Nanoscale in one dimension

Thin films, layers and surfaces:

- computer chips, Organic Light Emitting Diodes (organic polymer films).

OLED



Kodak digital camera

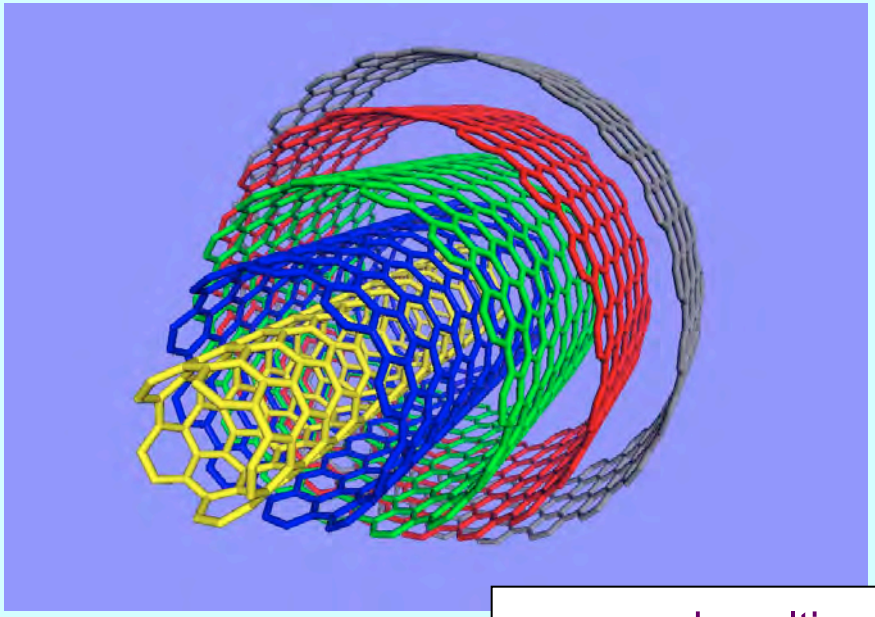
high brightness and contrast, no backlight, low power

Nanomaterials

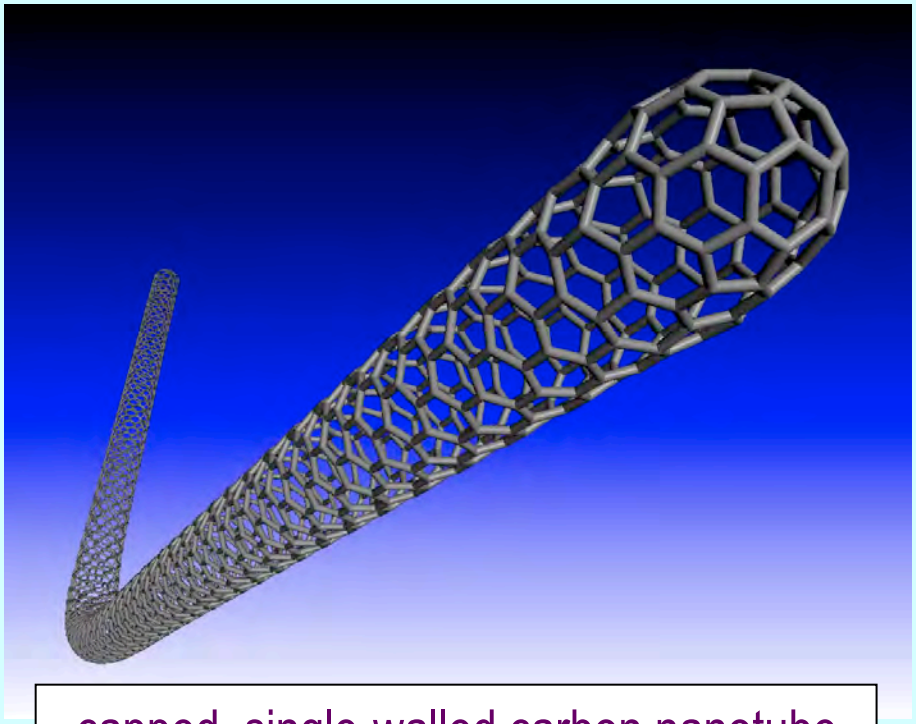
Nanoscale in two dimensions

Carbon nanotubes:

- lattice of carbon atoms rolled into a cylinder;
- tennis racket frames.



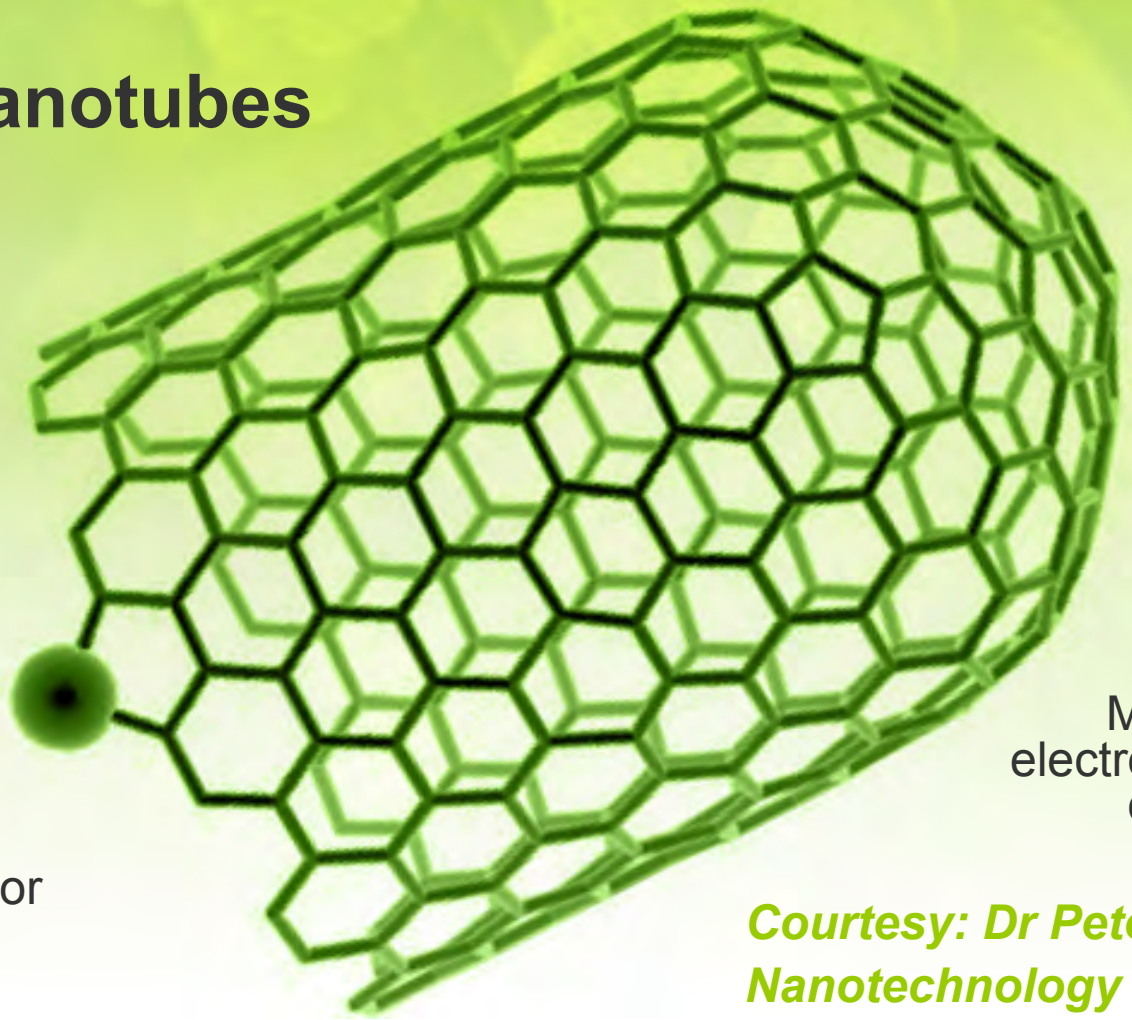
uncapped, multi-walled carbon nanotube



capped, single-walled carbon nanotube

Materials Revolution: Nanotubes

Carbon nanotubes



Excellent field emitter

Superior mechanical properties

Nanotubes can be functionalized

Superior electrical and thermal properties

Mechanical and electronic properties can be tailored

Can be metallic or semiconducting

Courtesy: Dr Peter Binks, Nanotechnology Victoria

Source: NASA – Ames Research Laboratory

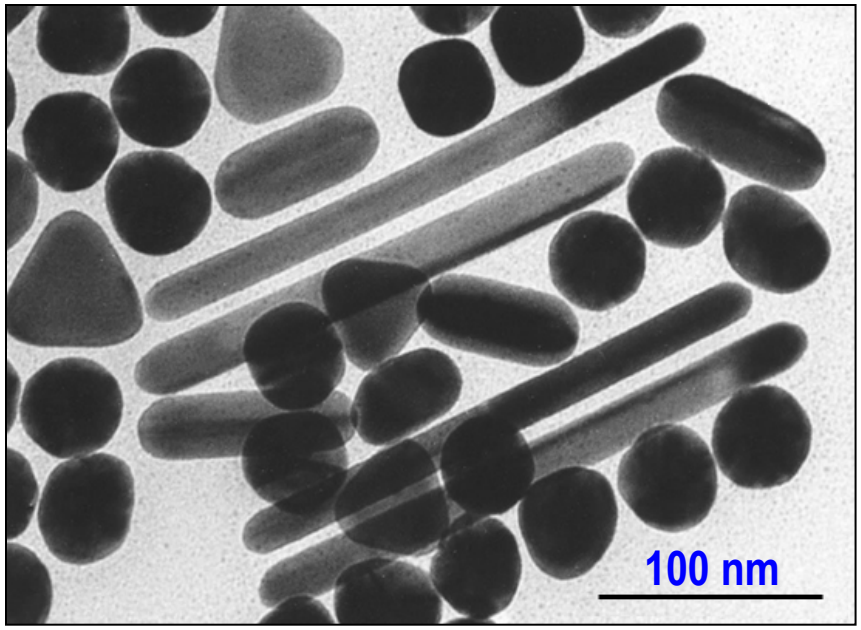
nanoVIC
nanotechnology victoria

Nanomaterials

Nanoscale in three dimensions

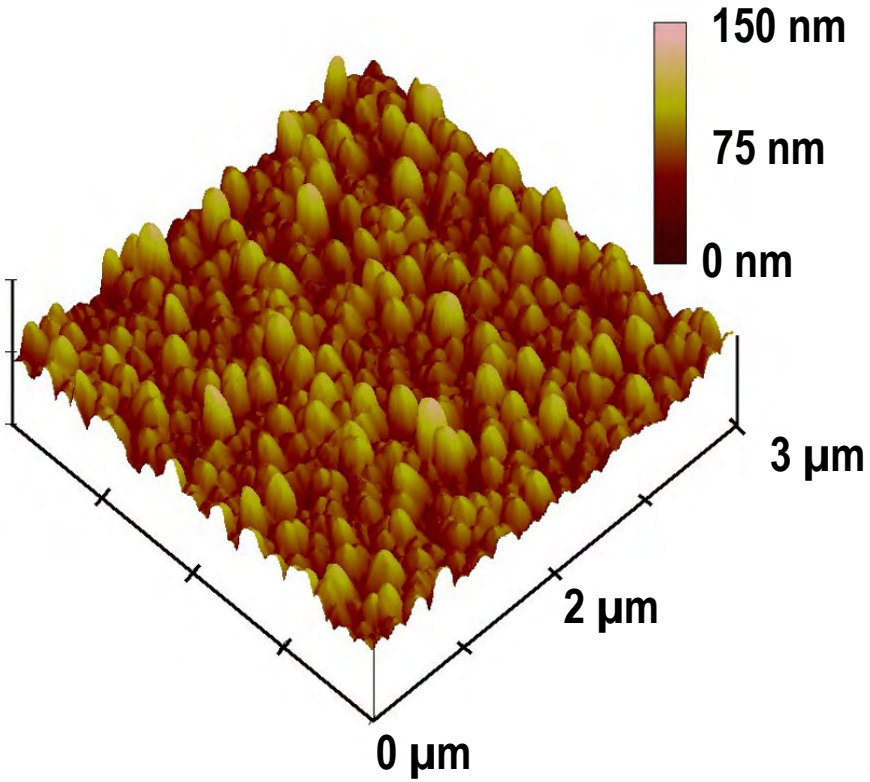
Nanoparticles:

- zinc oxide used as UV blocking agent in sunscreens.

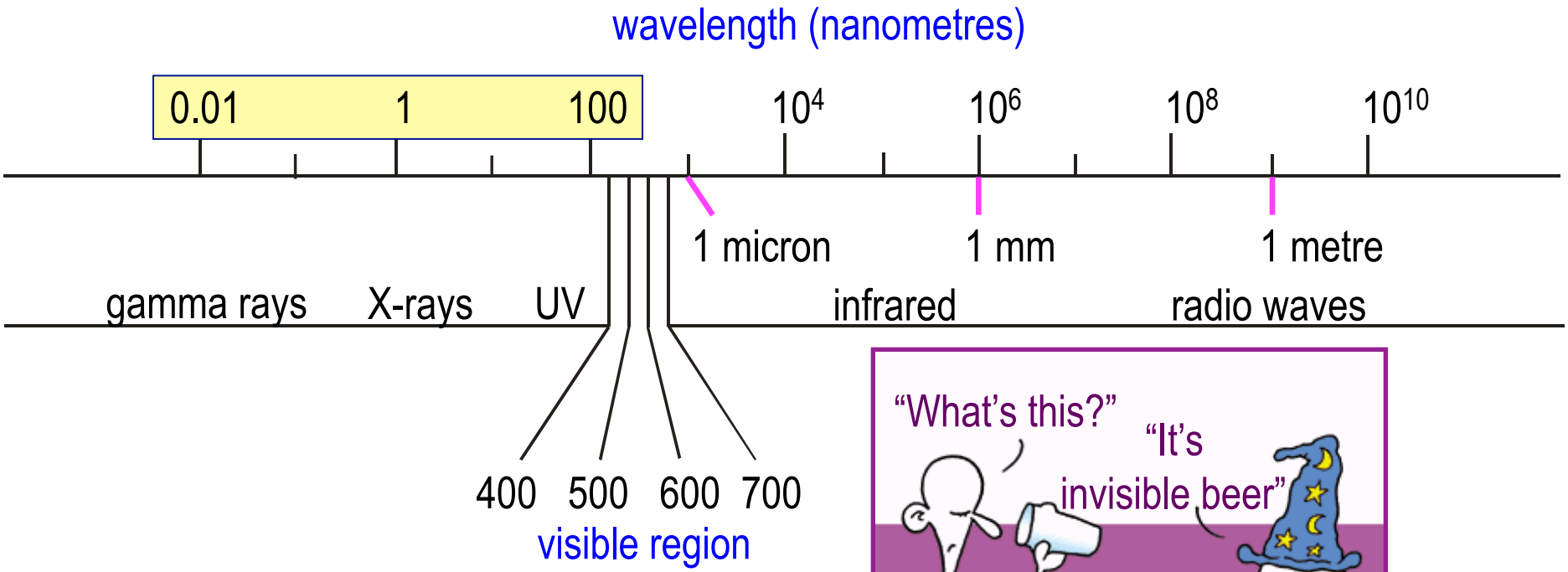


gold nanoparticles grown in solution

gold nanoparticle 'film' on semiconductor base



Nanoparticles - invisibility



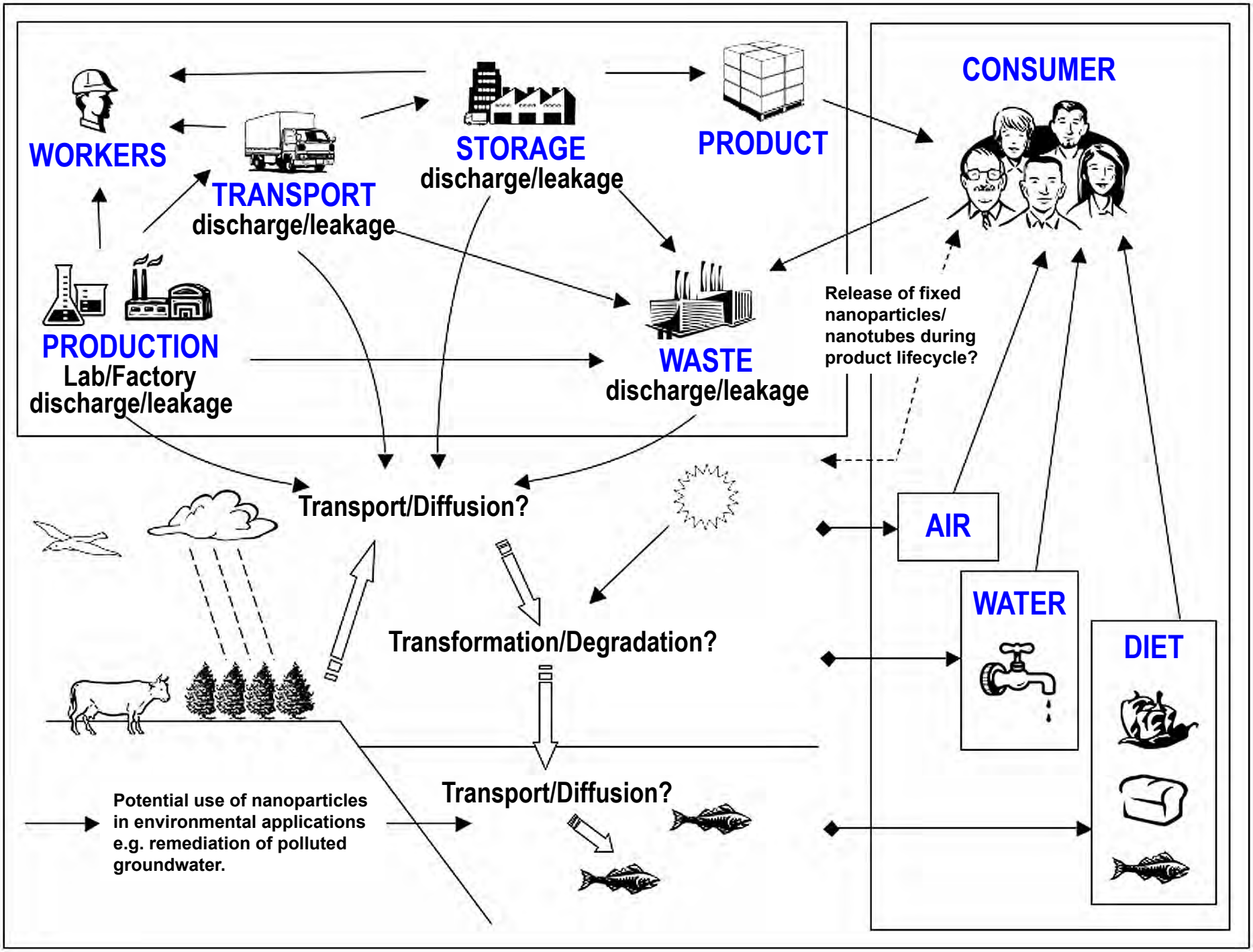
Swiss Re

Nanotechnology
Small matter, many unknowns

Access to target organ through:
touching, breathing and swallowing

Risk Perception

Swiss Reinsurance
Company, Zurich, 2004

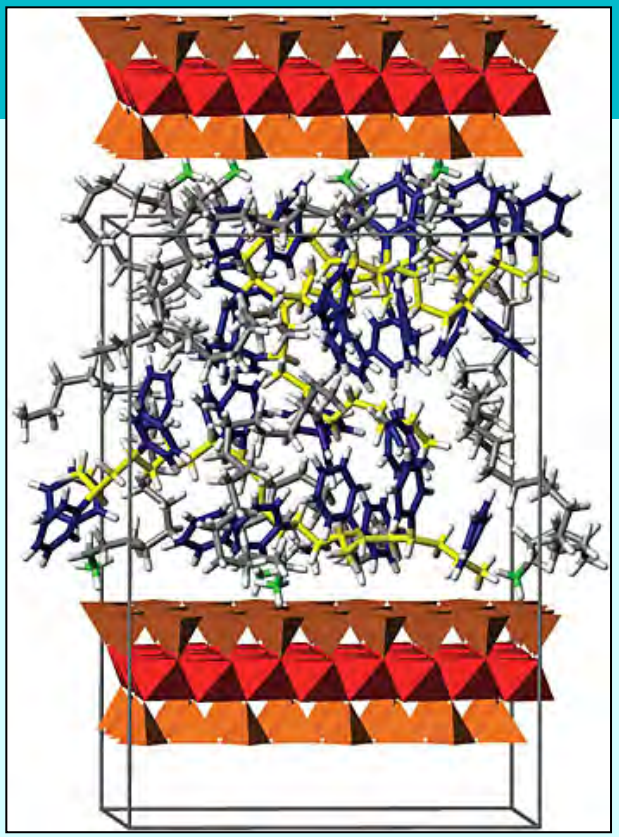

WORKERS
TRANSPORT
discharge/leakage
STORAGE
discharge/leakage
PRODUCT
CONSUMER
PRODUCTION
Lab/Factory
discharge/leakage
WASTE
discharge/leakage
Release of fixed nanoparticles/ nanotubes during product lifecycle?
Transport/Diffusion?
AIR
WATER
DIET
Transformation/Degradation?
Transport/Diffusion?
Potential use of nanoparticles in environmental applications e.g. remediation of polluted groundwater.

Nanocomposites

Formed by integrating inorganic nanoparticles into organic polymers.

Benefits include:

- increased strength;
- increased chemical resistance;
- increased electrical conductivity;
- increased thermal stability;
- decreased permeability to gases, water and hydrocarbons.



Example

Nylon 6 with 3-5% nanoclay:

- softening temperature increased from 60^0C to 140^0C;
- used for timing belts in cars.

Top-down manufacturing

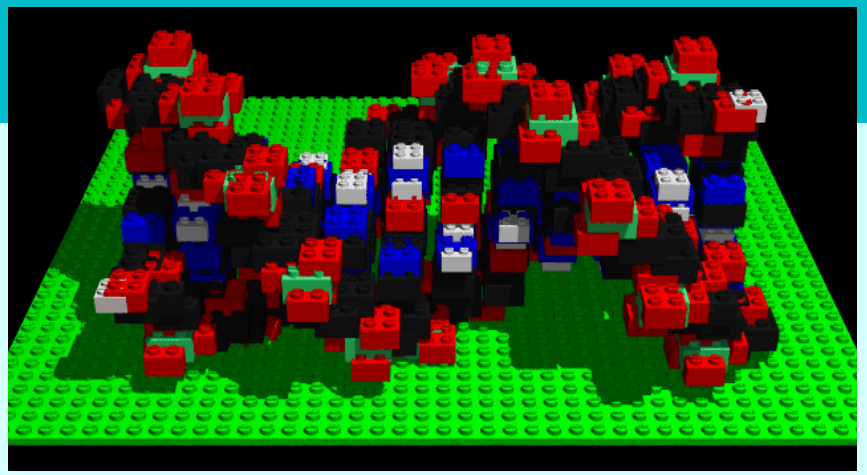
Precision engineering, e.g. high-quality optics

Start with a larger piece of material.

Etch, cut or grind a nanostructure by removing material.

Milling, e.g. nanoparticles

Bottom-up manufacturing



Self-assembly

Atoms or molecules arrange themselves into ordered nanoscale structures, e.g. carbon nanotubes:

- common in nature, e.g. snowflakes and soap bubbles.

Positional assembly

Atoms or molecules are deliberately manipulated one-by-one.

Why are things different in the nanoworld?

Quantum effect

At the lower end of the nanoscale, space available to electrons is restricted:

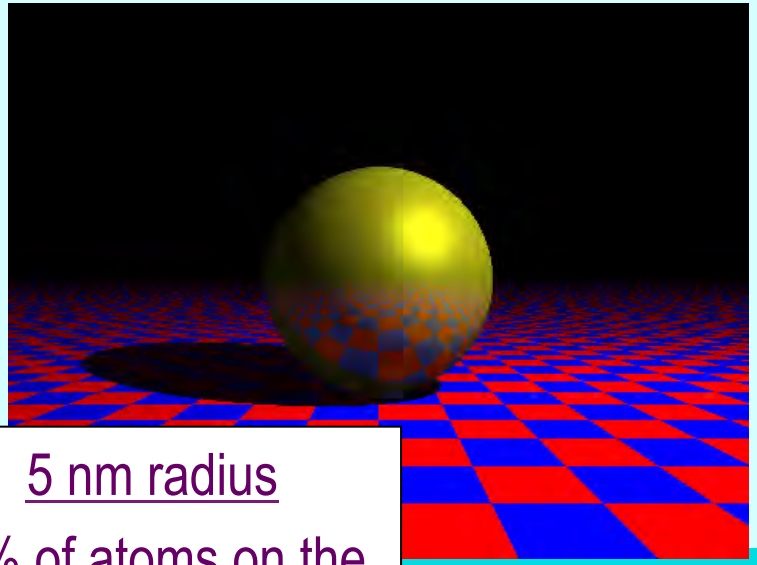
- electronic, optical and magnetic properties different from bulk properties.

light emitted from quantum dots

Increased reactivity

Surface properties predominate and reactivity enhanced:

- ratio of surface area to volume relatively high for nanoparticles.



5 nm radius

50% of atoms on the surface

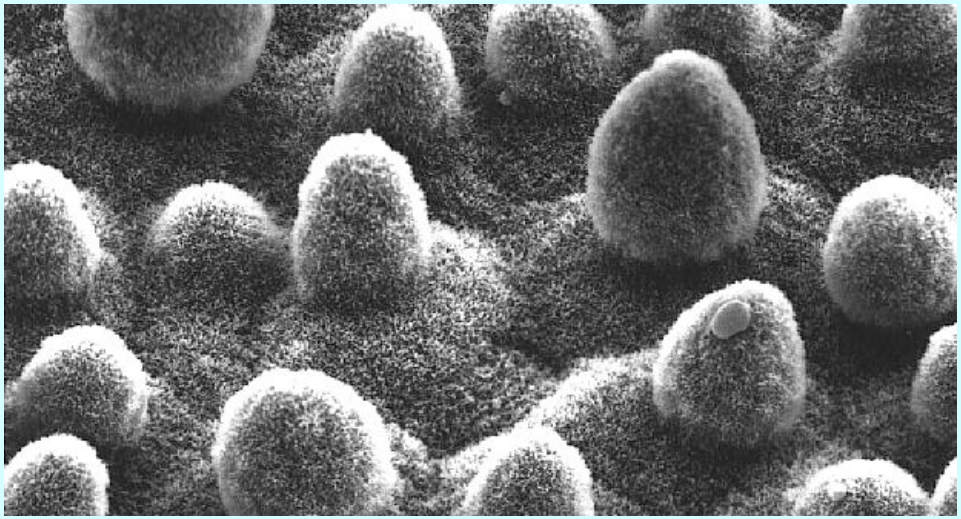
awttc

Nanoscale in Nature - The Lotus effect

"Nanotechnology, like any other branch of science, is primarily concerned with understanding how nature works."

Harper, 2003

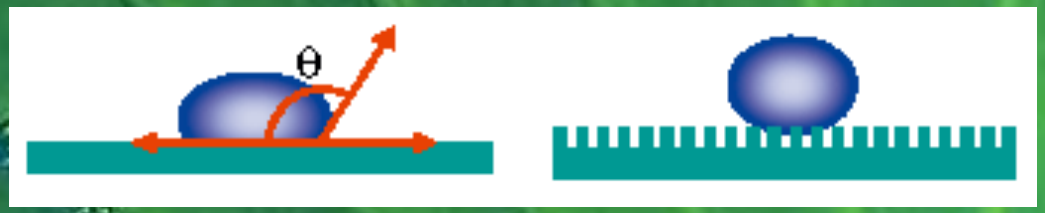
Nelumbo nucifera



protruding nubs: 20-40 microns

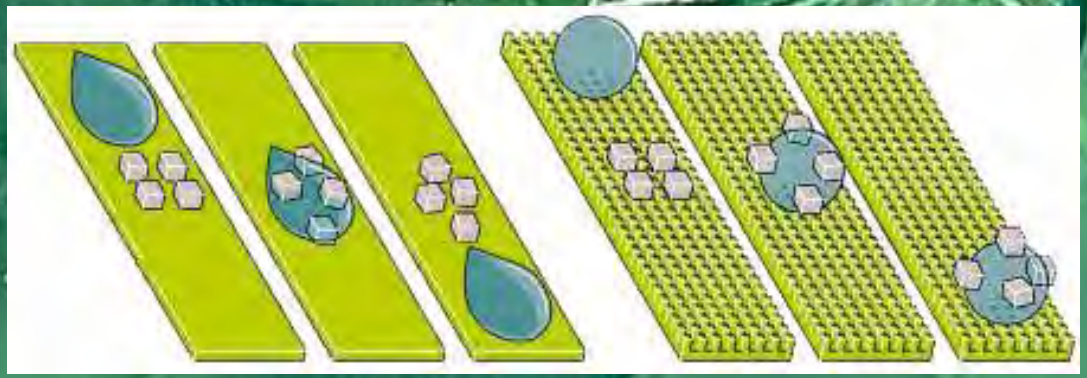
wax crystals: 2-200 nanometres

Lotus leaf



hydrophobic
smooth surface

super-hydrophobic
rough surface



Nanotechnology and textiles

"The textiles industry is likely to be one of the early adopters of nanotechnology products and processes."

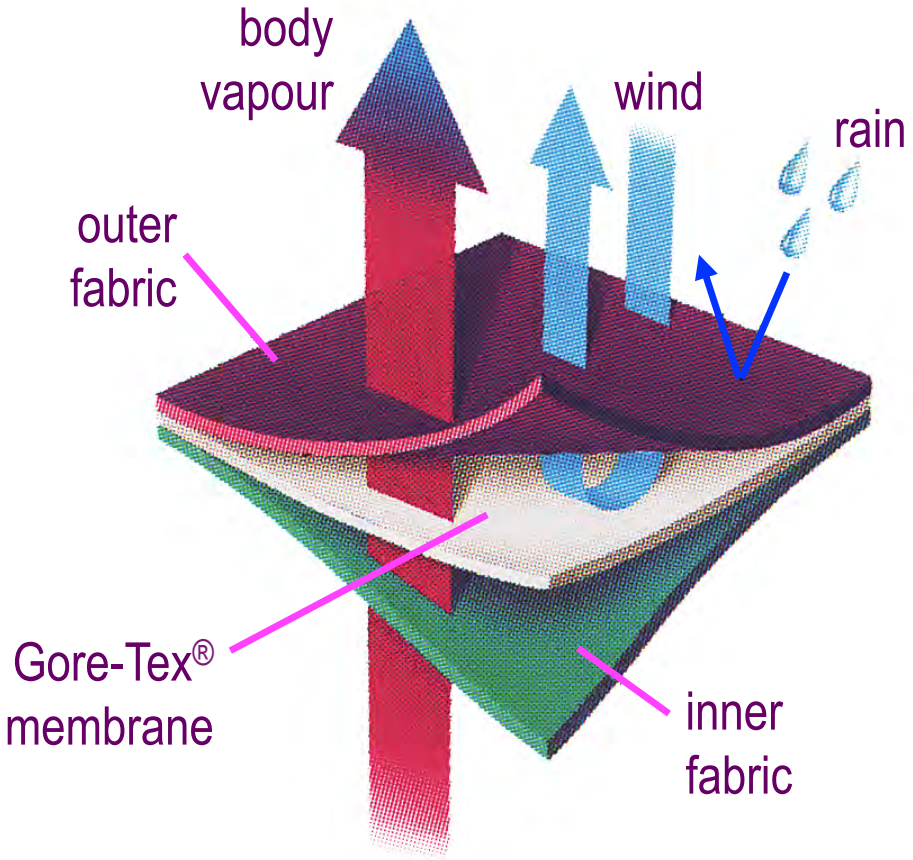
Nanotechnology Victoria

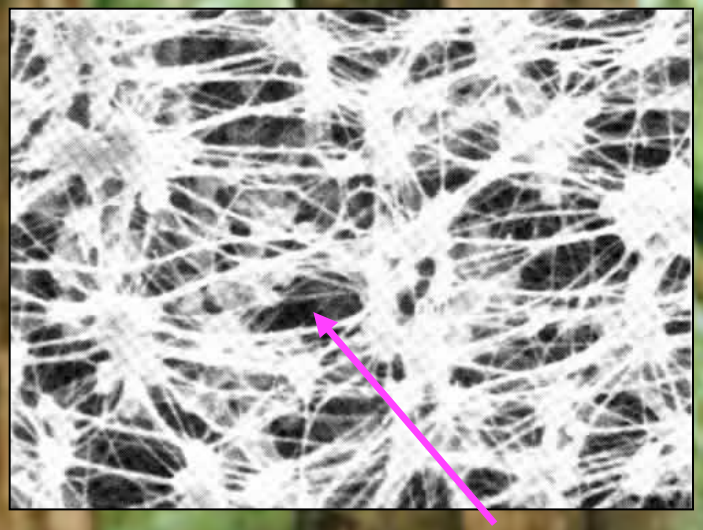
"Nanoparticles have a range of potential applications: in the short term in new cosmetics, textiles and paints."

The Royal Society and The Royal Academy of Engineering, 2004

Nanotechnologies in fibres & textiles

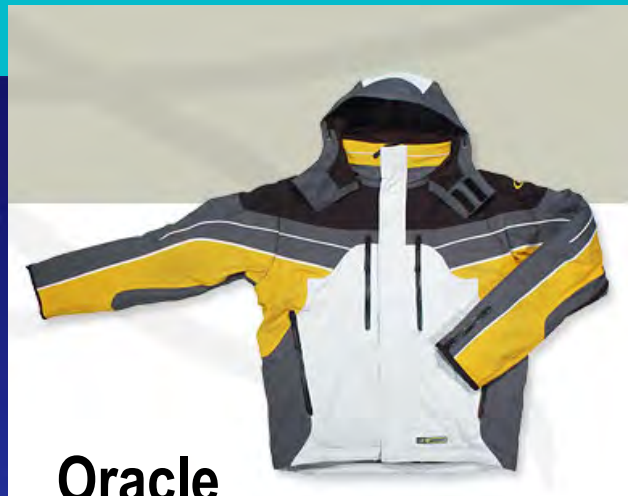
1. Incorporating membranes with nanoscale features into garment structures.
2. Bonding polymeric films with nanoscale features to the fibre surface.
3. Producing fibres containing nanoparticles – nanocomposite fibres.
4. Electrospinning of nanofibres.





Guaranteed
To Keep You Dry
GORE-TEX®
fabrics
GORE
Creative Technologies
Worldwide

Franz Ziener GmbH & Co



Oracle

Waterproof, breathable, soil-resistant.

Use of nanofibres in two-layer laminate.

Nano-Tex™ :: Repels and Releases Stains - Microsoft Internet Explorer

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Address http://www.nanotex.com/products/repels_stains.html Go

THE COMPANY **PRODUCTS** WHERE TO BUY NEWS & MEDIA FAQS CONTACT US

Resists Spills
Repels & Releases Stain
Coolest Comfort

NANOtex™
Fabric to the Next™

"What you don't see makes all the difference"

Water-repellant
Stain-resistant

REPELS & RELEASES STAINS

Sunday brunch is over, and your nephew has just inited you to play a game of touch football. There's no time to change, but that won't stop you.

Your pants are made with NANO-TEX™ fabric that repels and releases stains, so you're protected on defense and offense. Spill resistance keeps stains from soaking in, while stain release allows them to easily come clean. And the best part is that you don't have to sacrifice any comfort to get this peace of mind.

With NANO-TEX™ fabric, your clothes fit your lifestyle, not the other way around. Experience the breakthrough and be ready for whatever's next.

CHARACTERI
SPILL RESISTANCE
DURABILITY
COMFORT
STAIN REMOVAL

History Channel

TechKnowledge

Nanotex
nanowhiskers

nfo
about
Resists
(PDF)

OTHER NANO-TEX FABRICS

RESISTS SPILLS

Internet

start IFC 10th March 2005 Additional Material Nano-Tex™ :: Repels... Adobe Photoshop - [... 4:42 PM

nano sphere®

naturally self-cleaning

a schoeller® technology

Without NanoSphere®

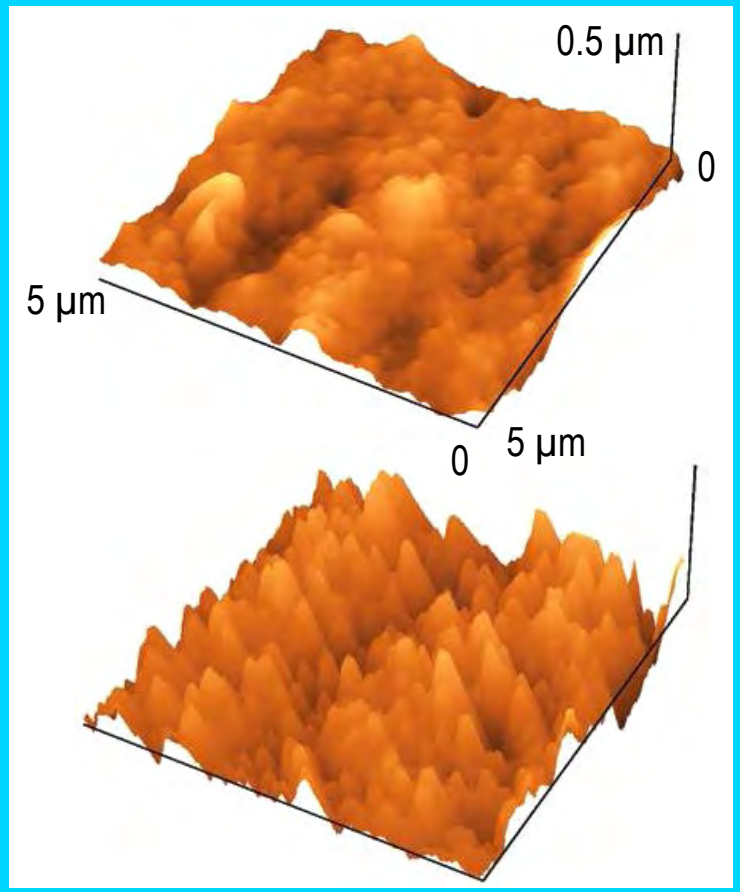
With NanoSphere®

Honey

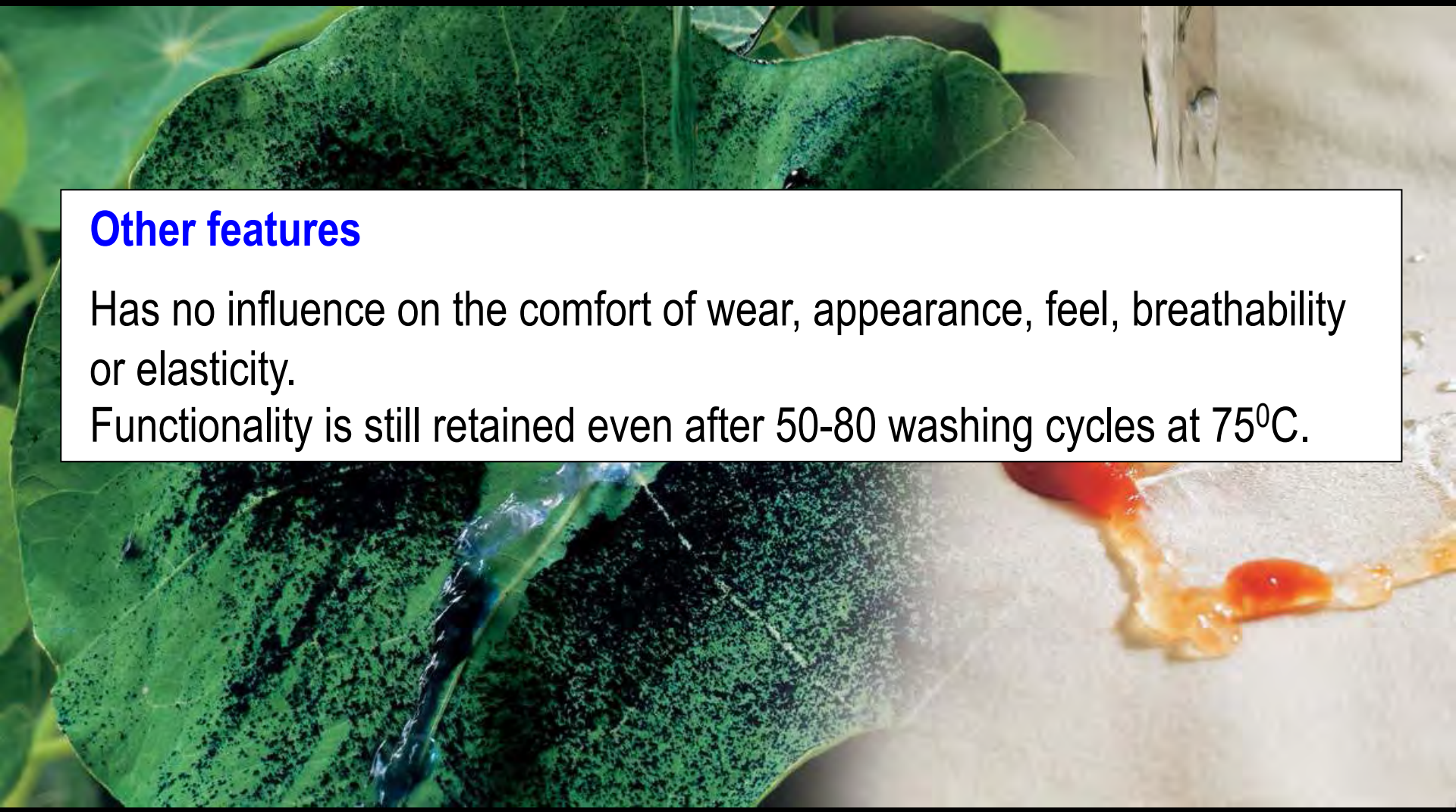
Red wine

Coffee

Fabric treated with NanoSphere®



Lotus leaf



Other features

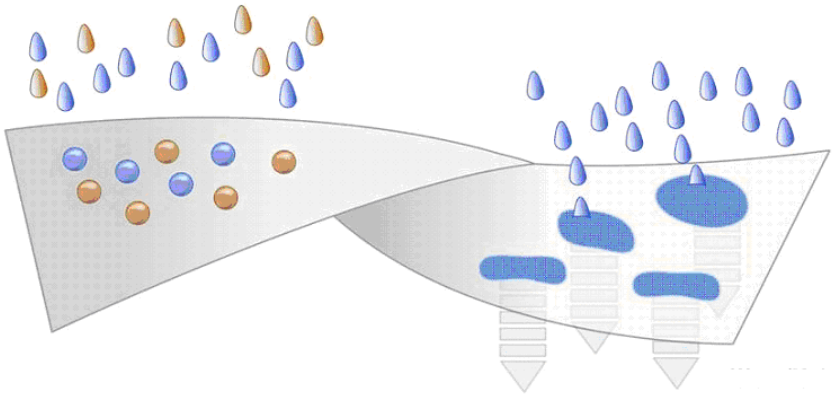
Has no influence on the comfort of wear, appearance, feel, breathability or elasticity.

Functionality is still retained even after 50-80 washing cycles at 75^{0}C.

Sigma Technologies International, Inc.

SIGMA TECHNOLOGIES INTERNATIONAL, INC.

oleophobic and hydrophobic



hydrophilic

DryFab™ Nanolayer Technology

Vacuum plasma treatment.

Application of monomer and polymerisation.

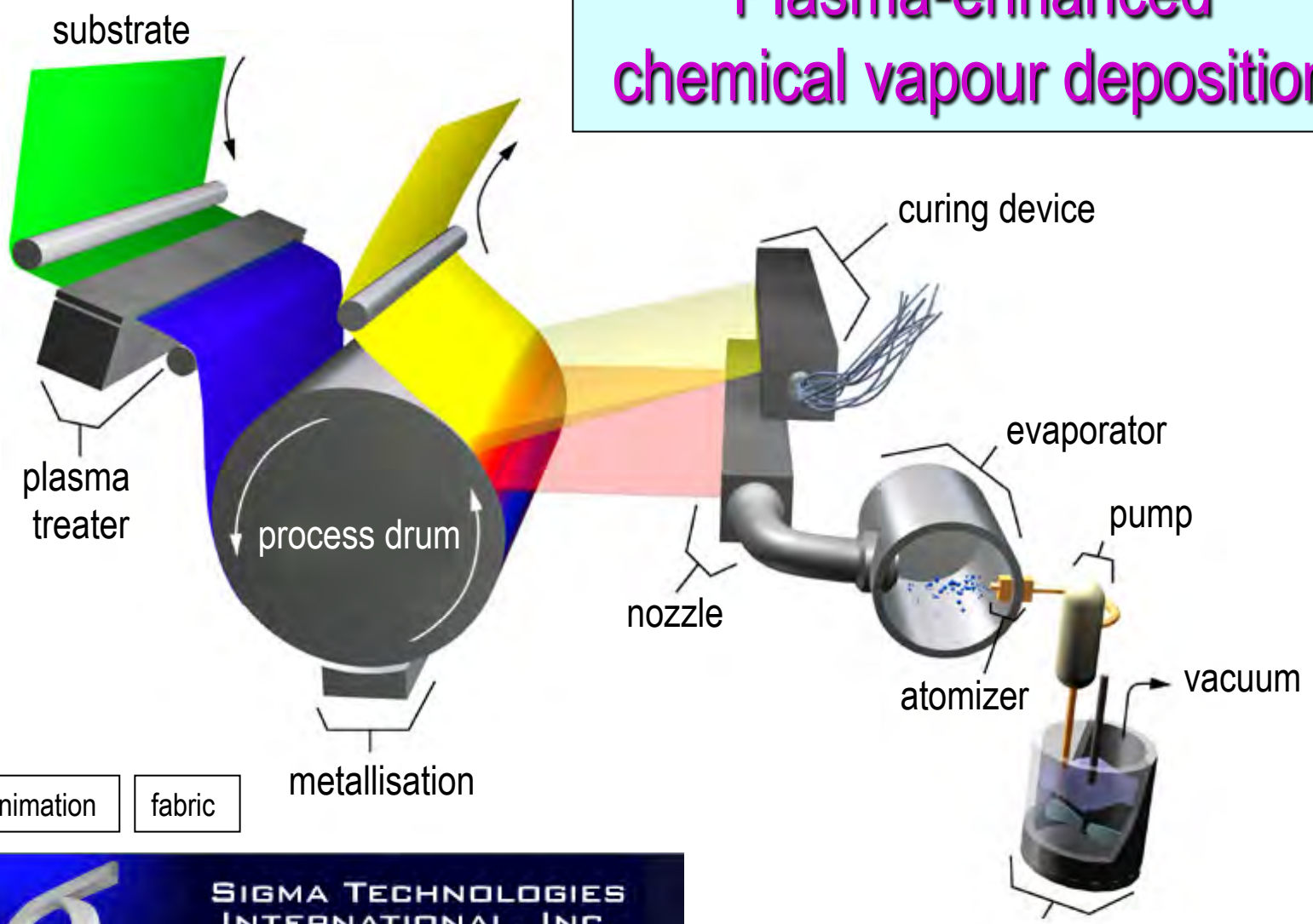
- clear and transparent film
- layer thickness: 20 nm to 1 micron

Variety of substrates.

- film, paper, foil and fabric (continuous)
- glass, metal and plastic (batch)

Atmospheric technology also.

Plasma-enhanced chemical vapour deposition



animation | fabric

SIGMA TECHNOLOGIES INTERNATIONAL, INC.

Plasma-enhanced CVD

Annual global market for technical textiles $150 billion:

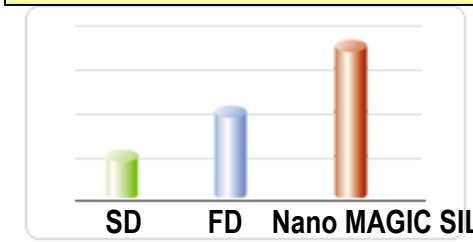
- sports, leisure and casual apparel;
- medical apparel;
- filter media;
- linen and upholstery.

awttc

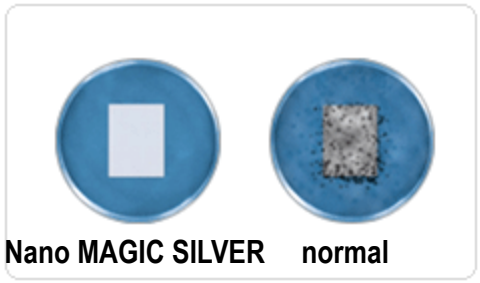
Mipan ‘Nano Magic Silver’

“The Ag fiber keeps you clean and Cares for You”

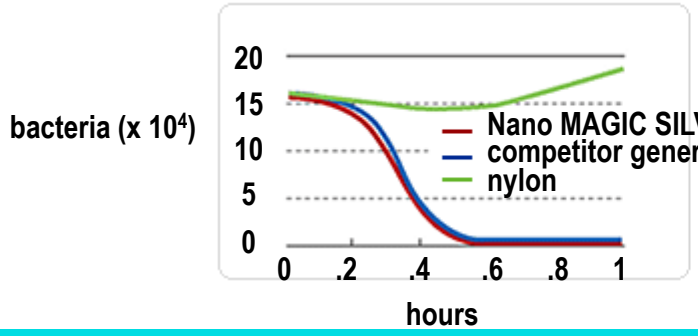
UV protection

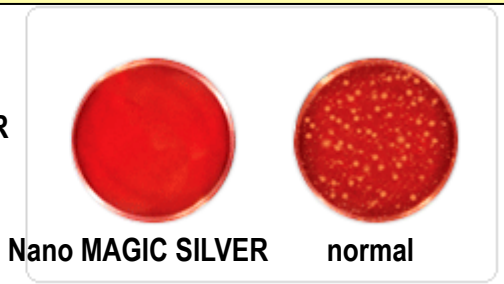


anti-mould effect



anti-microbial effect





SoleFresh™ socks

80% cotton, 20% “elastic” yarn.

0.3% nanosilver (25 - 250 nm).

Properties:

- eliminate foot odour;
- cure athlete’s foot;
- prevent feet infections for patients with diabetes.

£5 for 2 pairs.

Any colour so long as it’s black!

Nanofibres

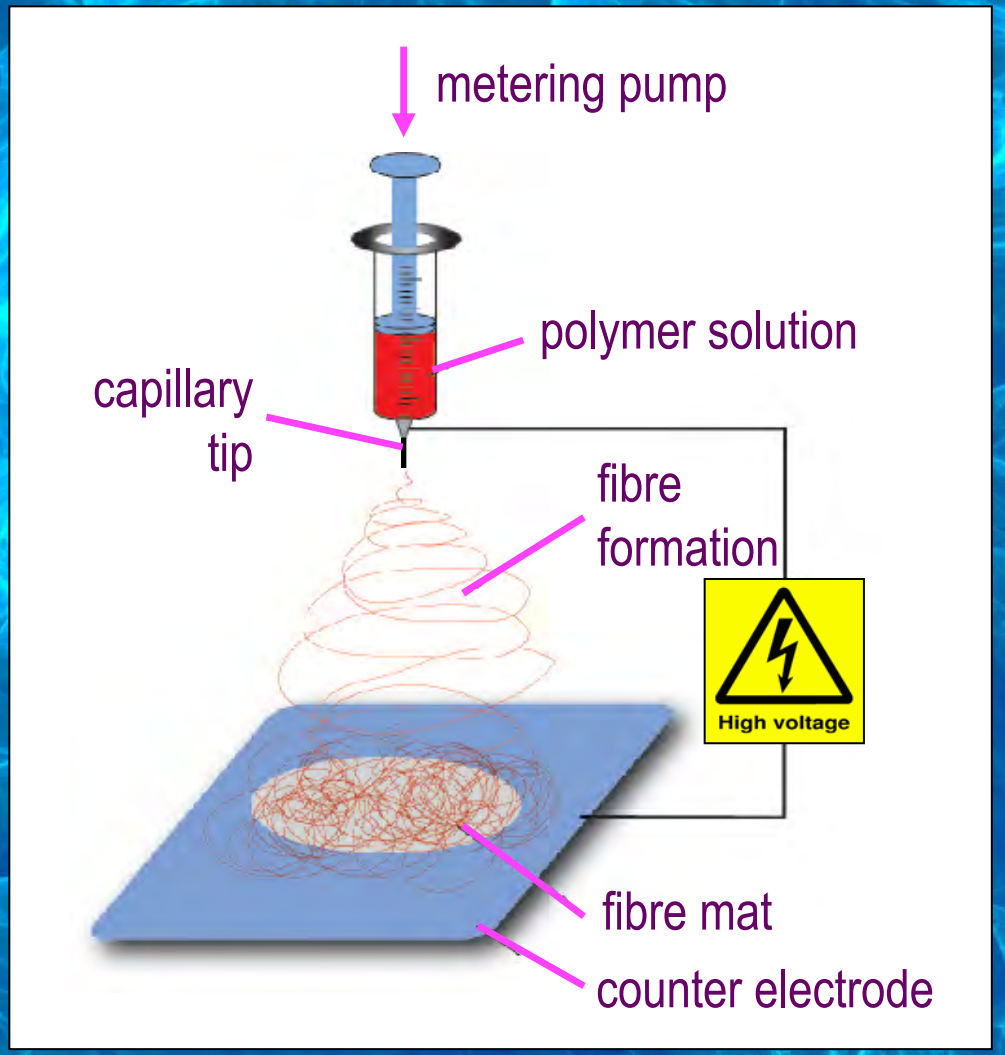
Fibres as fine as 50 - 300 nm:

- large surface area per volume.

Interesting and diverse uses:

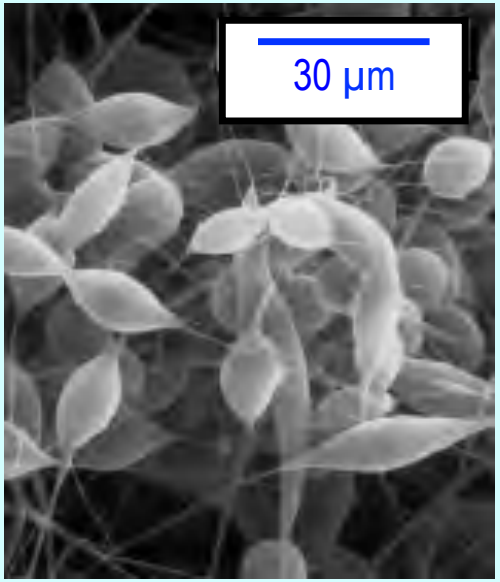
- filtration of sub-micron particles;
- dressing of wounds;
- scaffolds for tissue engineering;
- artificial blood vessels.

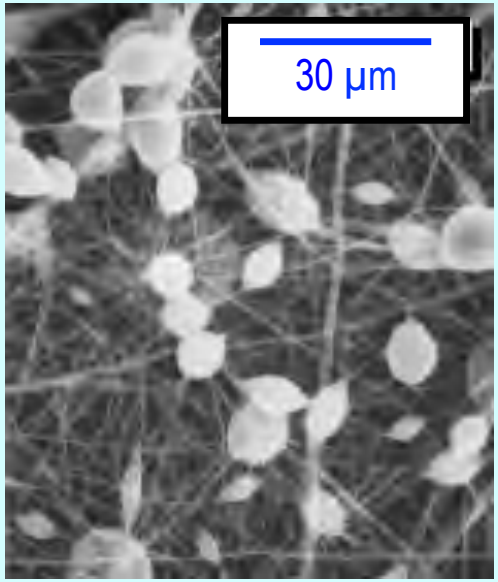
Electrospinning



Electrospinning

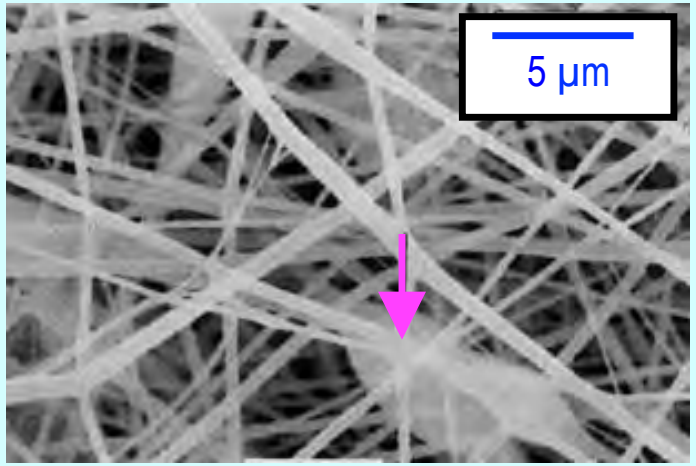
Beaded fibre problem





poly(ε-caprolactone)

K.H. Lee, et al, *Polymer*, **44**, 1287-1294 (2003)



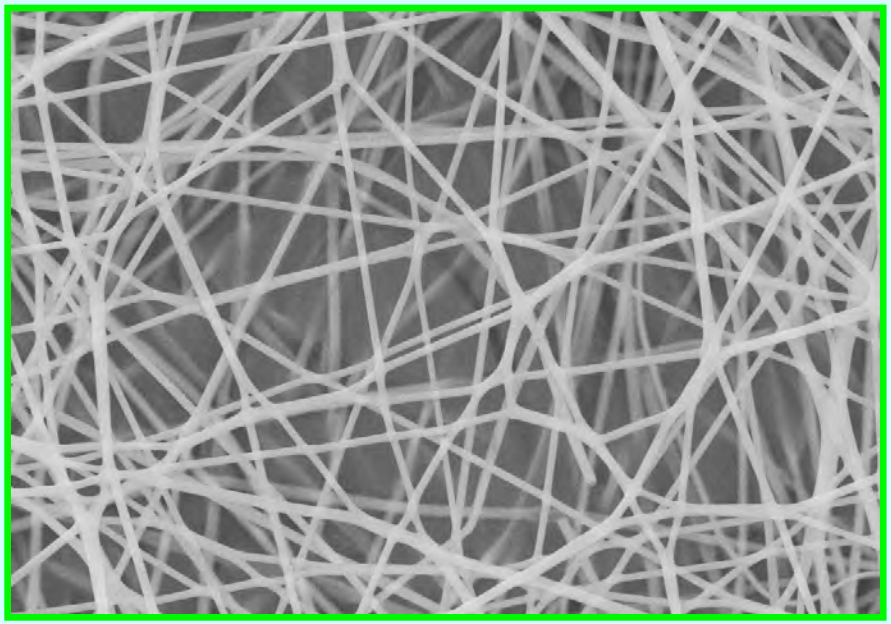
polyvinyl chloride/polyurethane blend

K.H. Lee, et al, *Journal of Polymer Science: Part B: Polymer Physics*, **41**, 1256–1262 (2003)

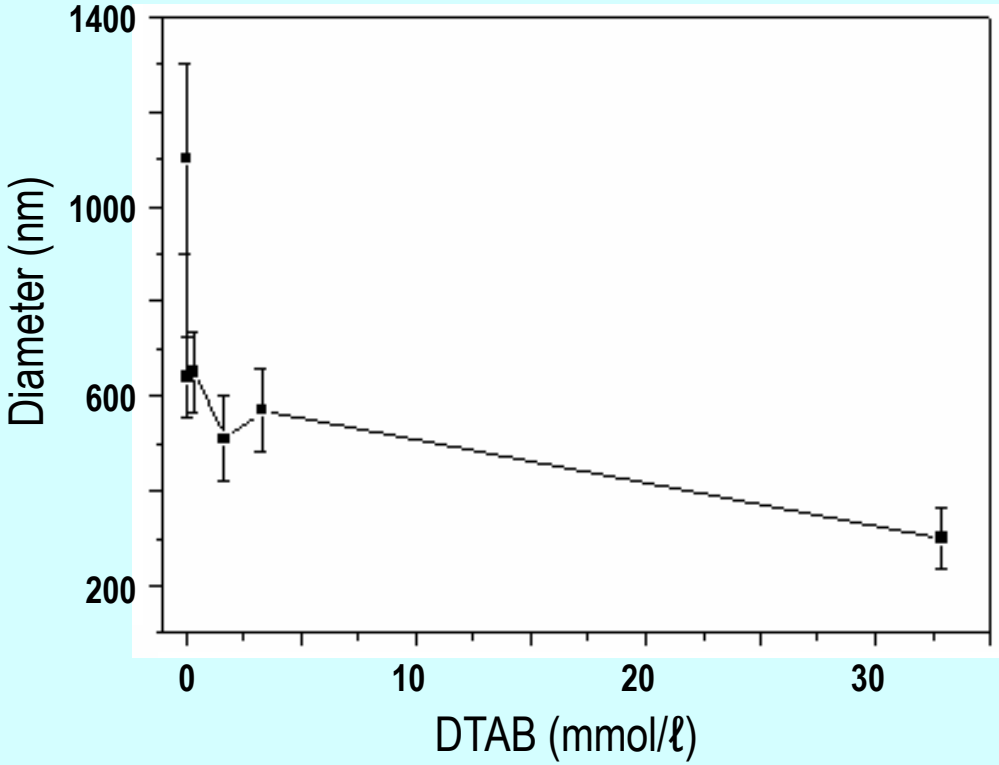
Electrospinning

Research @ Deakin

Use of cationic surfactant for finer and more uniform fibres



polystyrene



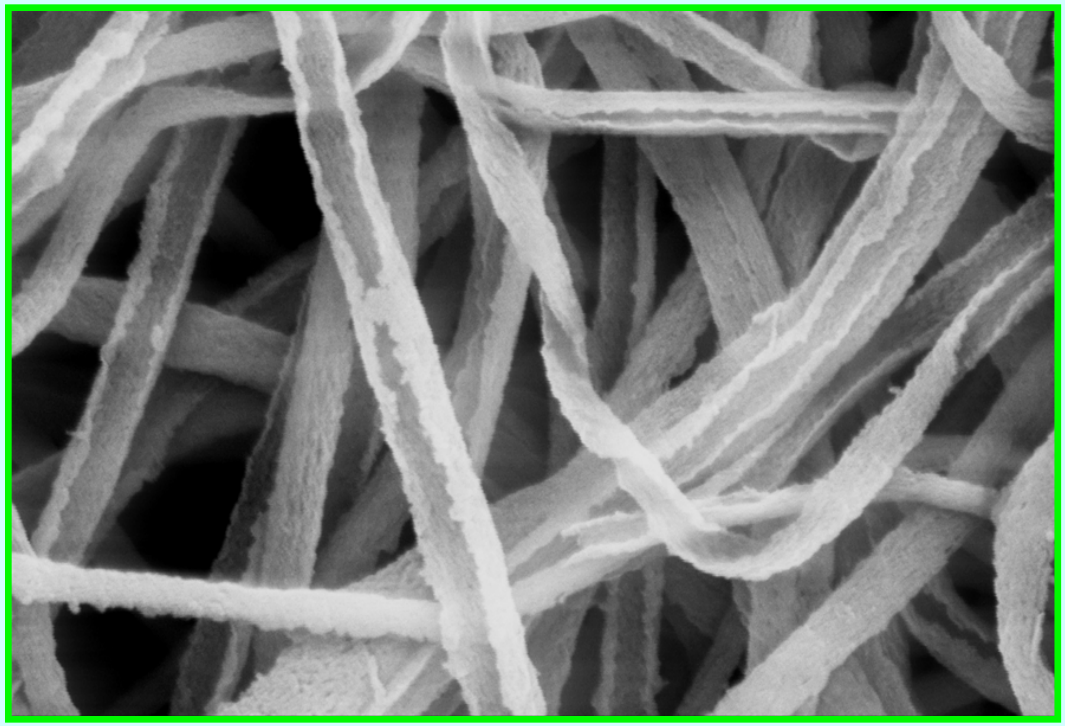
T. Lin, et al, *Nanotechnology*, **15**, 1375-1384 (2004)

awttc

Electrospinning

Research @ Deakin

Spinning of bicomponent nanofibres



polyacrylonitrile/polyurethane

T. Lin, et al, *Advanced Materials,* **17**, 2699-2703 (2003)

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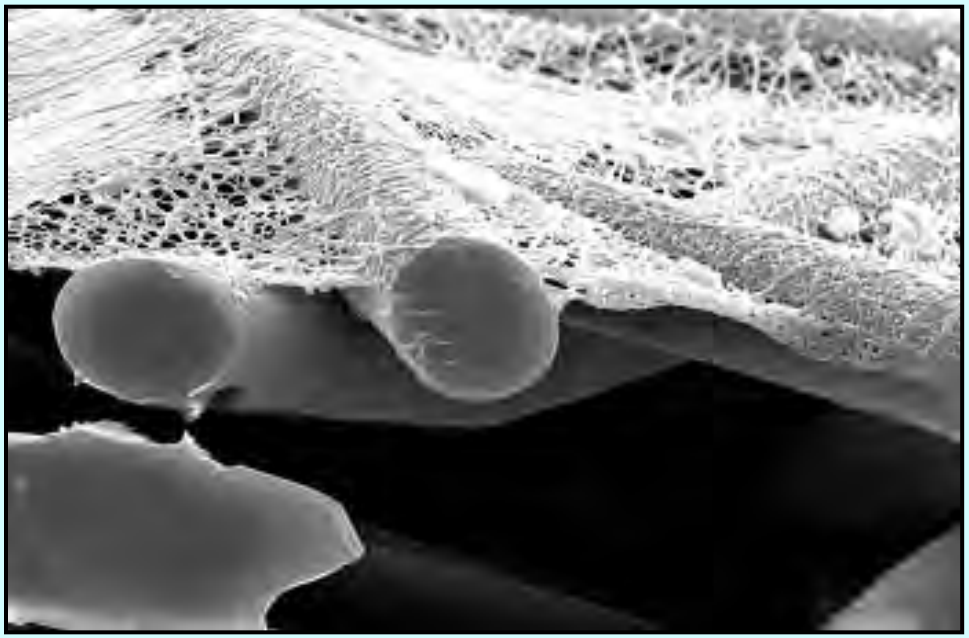
Electrospinning applications - enhanced filtration

Donaldson.



nanofibre web on a nonwoven substrate

commercial air filtration cartridge

awttc

Self-cleaning clothes

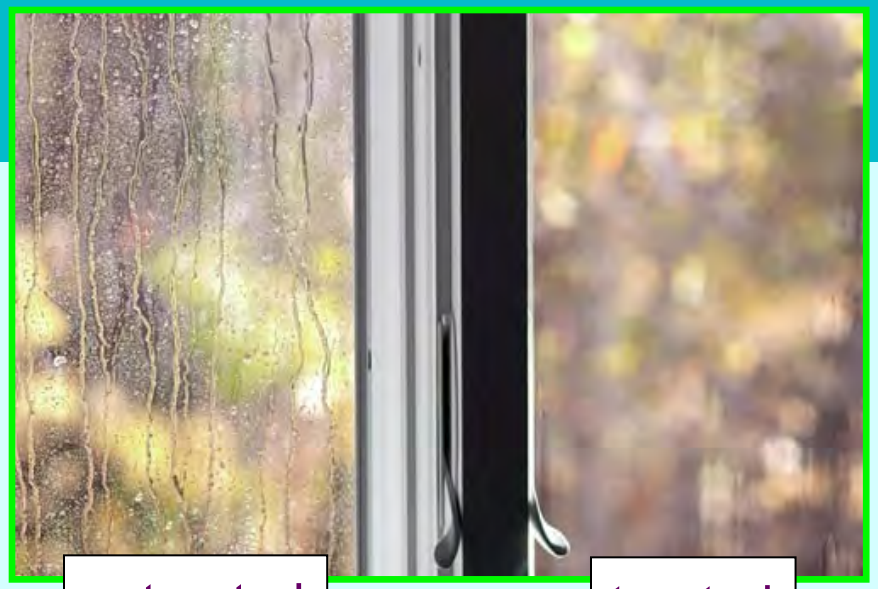
Hong Kong Polytechnic

50 nm layer of titanium dioxide nanoparticles:

- applied by dip-pad-dry process, followed by boiling in water;
- UV light breaks down organic matter.

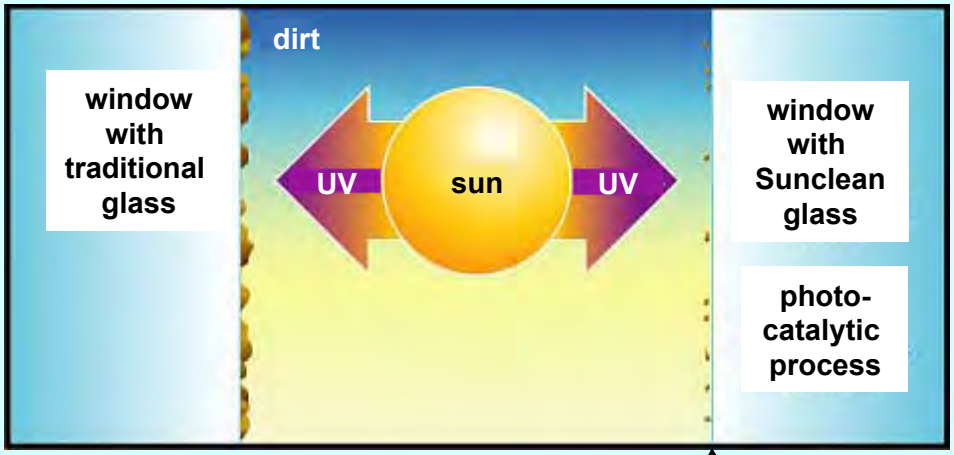
Self-cleaning glass

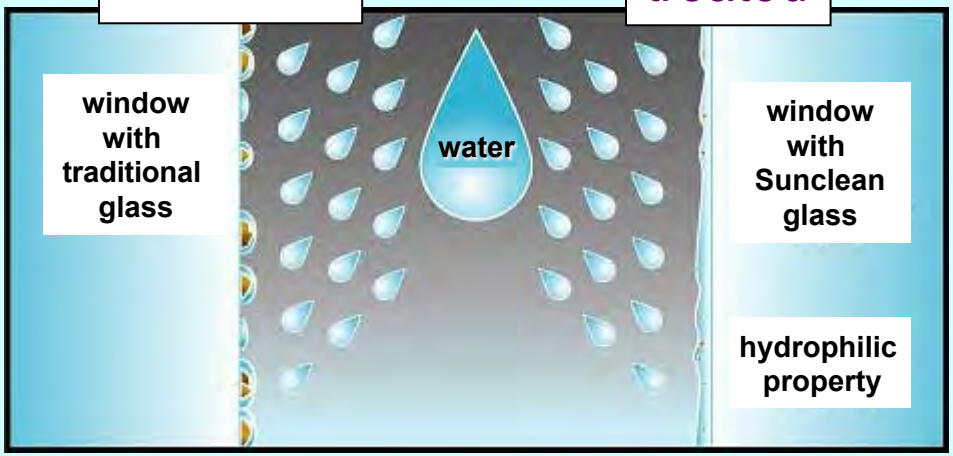
SUNCLEAN™



untreated

treated





15 nm layer of titanium dioxide

awttc

Self-cleaning clothes

Will fiction become reality?

“Self cleaning loo in the pipeline”

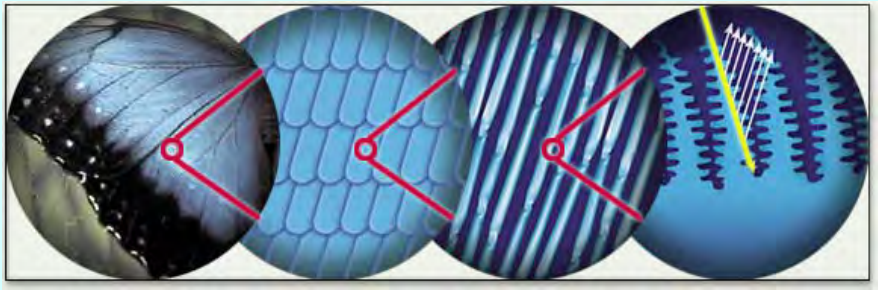
Adapted to work using indoor light

Teijin Fibers Ltd: Luminescent polyester

Polyester core is covered with 60 layers of nylon and polyester.

Layers 70 nm thick, with different refractive indices.

Hue changes according to the viewing angle.



Wing Scales Veins Ridges

Massachusetts Institute of Technology

INSTITUTE FOR SOLDIER NANOTECHNOLOGIES

Enhancing Soldier Survivability

"Dynamic armour that firms up at the sound of a bullet":

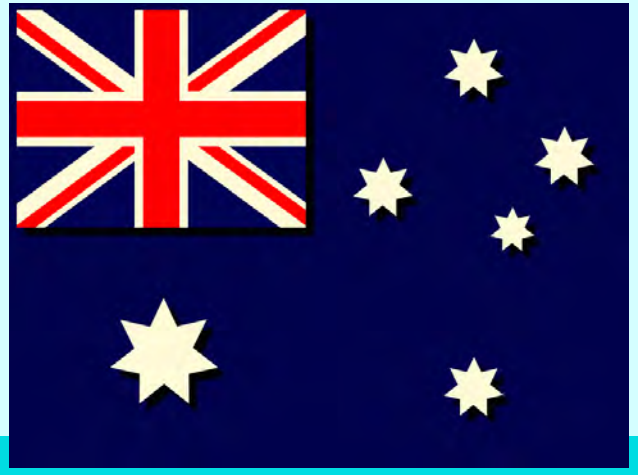
- woven from hollow fibres filled with magnetic nanoparticles;
- 'beads' line up in presence of a magnetic field;
- fabric stiffness increased by a factor of 50.

Micronisers Pty Ltd

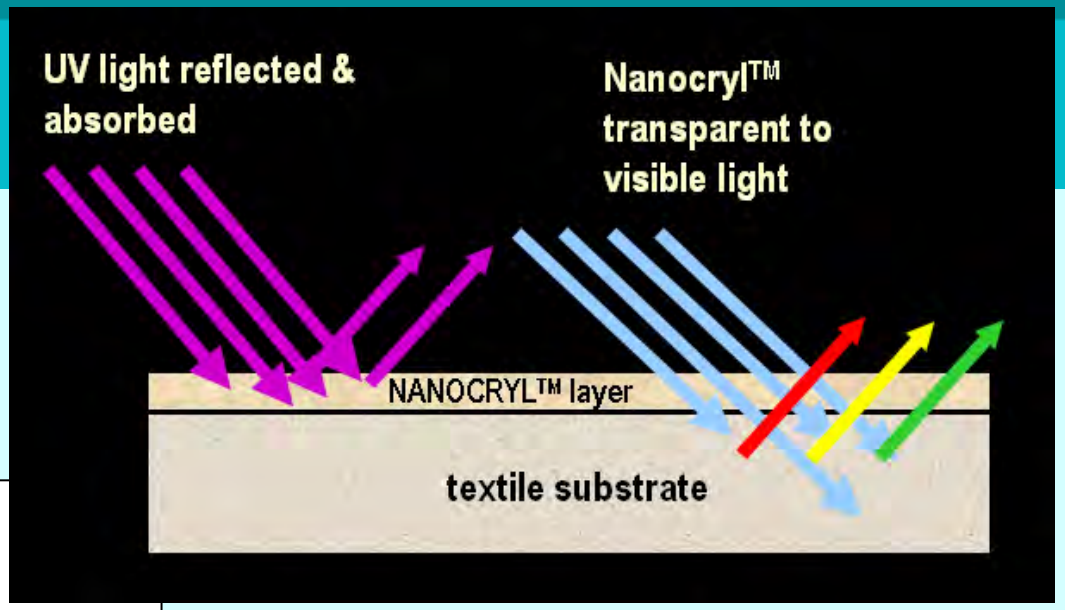
The problem

Colour fading of textiles on exposure to ultraviolet light:

- especially for products such as flags, awnings and car upholstery.



Nanocryl™



Courtesy: Ken King, Micronisers Pty Ltd

The solution

Surface coating containing zinc oxide nanoparticles:

- diameters ranging from 10-50 nm.

Cured resin blocks UV light, but transparent to visible light.

The application

100% polyester screen-printed flag.

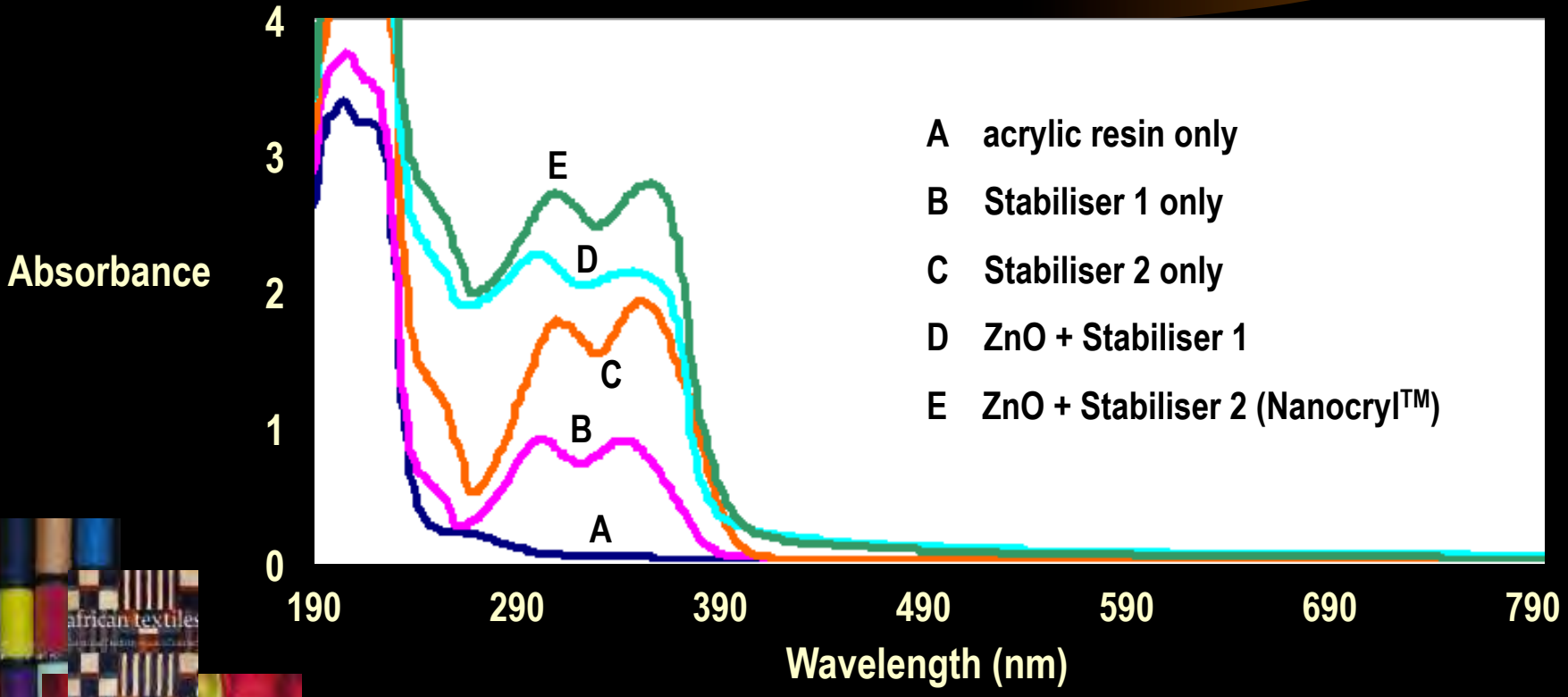
Lightfastness improved by 1.5-2 Blue Scale units:

- 3-5 times increase in lifespan.

Nanocryl™ System

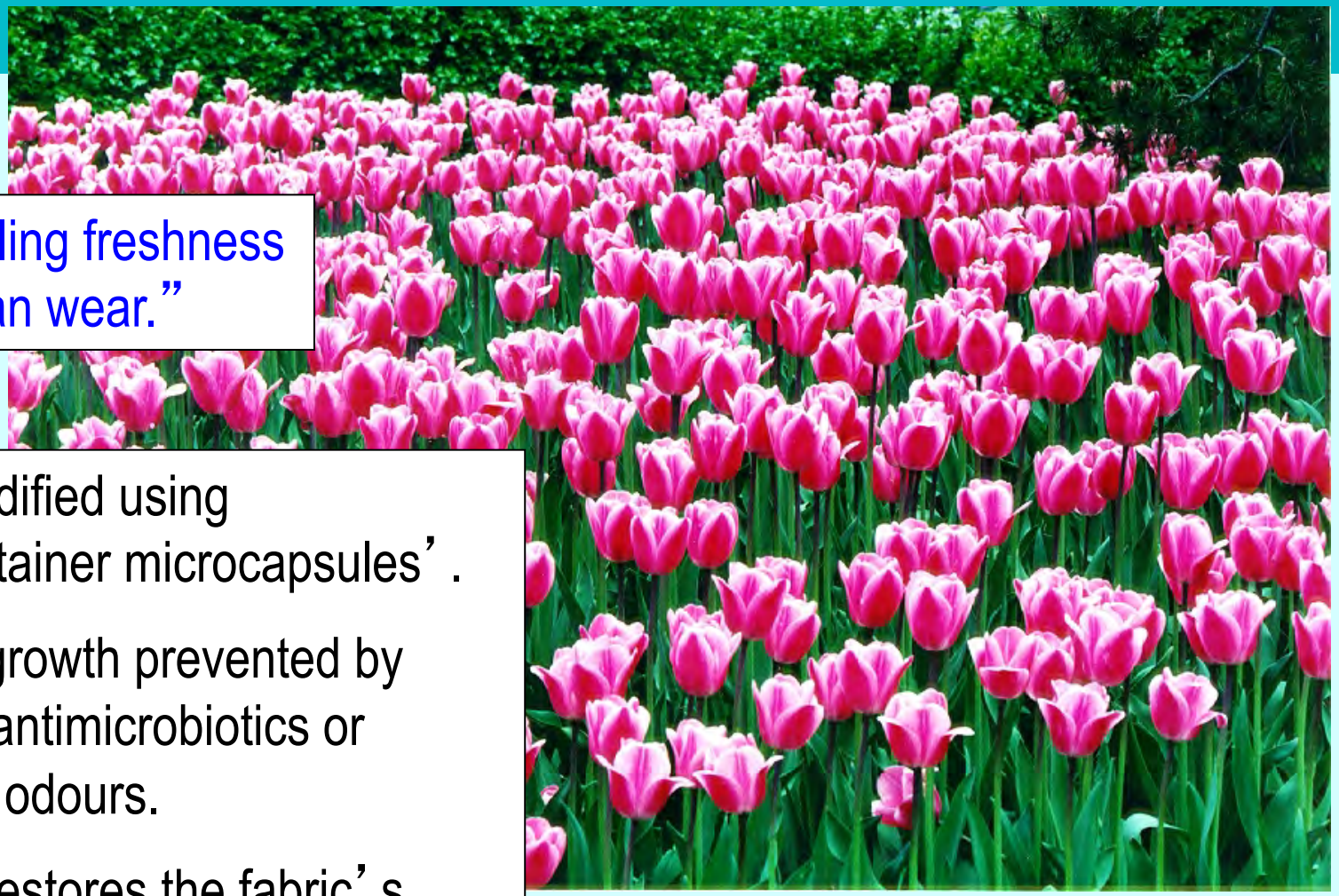
How does it Work?

Absorbance curves for different treatment formulations



Courtesy: Ken King, Micronisers Pty Ltd
Reno Beltrame, Beltrame Consultants Pty Ltd

Ciba



"We're selling freshness you can wear."

Fibres modified using 'nanocontainer microcapsules'.

Bacterial growth prevented by releasing antimicrobiotics or absorbing odours.

Washing restores the fabric's functionality.

Developments in Japan

The Lifestyle Company Kanebo

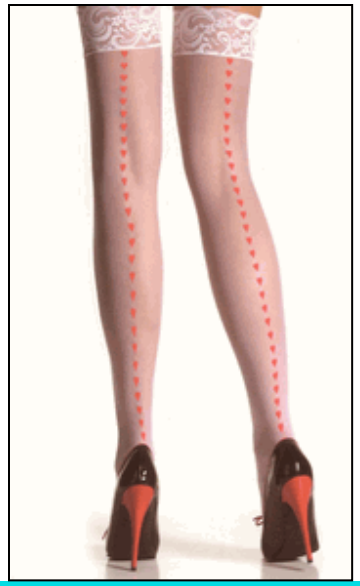
Polyester fibre with high water-absorption properties.

- 50-nanometre film - made up of 20 layers - on outside of fibre
- fibre's ability to absorb water enhanced by a factor of 30

TORAY

Quup - nylon filament yarn with double the moisture uptake.

- "bundles of nylon threads measuring several tens of nanometres".




The Future

Convergence of electronics and textiles

The challenge

To build electronic capability into textiles without compromising the desirable textile properties.

Collie, 2001

A prediction

By 2007, more than 60% of the U.S. population aged 15 to 50 will carry or wear a wireless computing or communications device for at least six hours per day.

Gartner Group, 2001

The evolution of intelligent textiles

Functional

- offer protection from the environment.

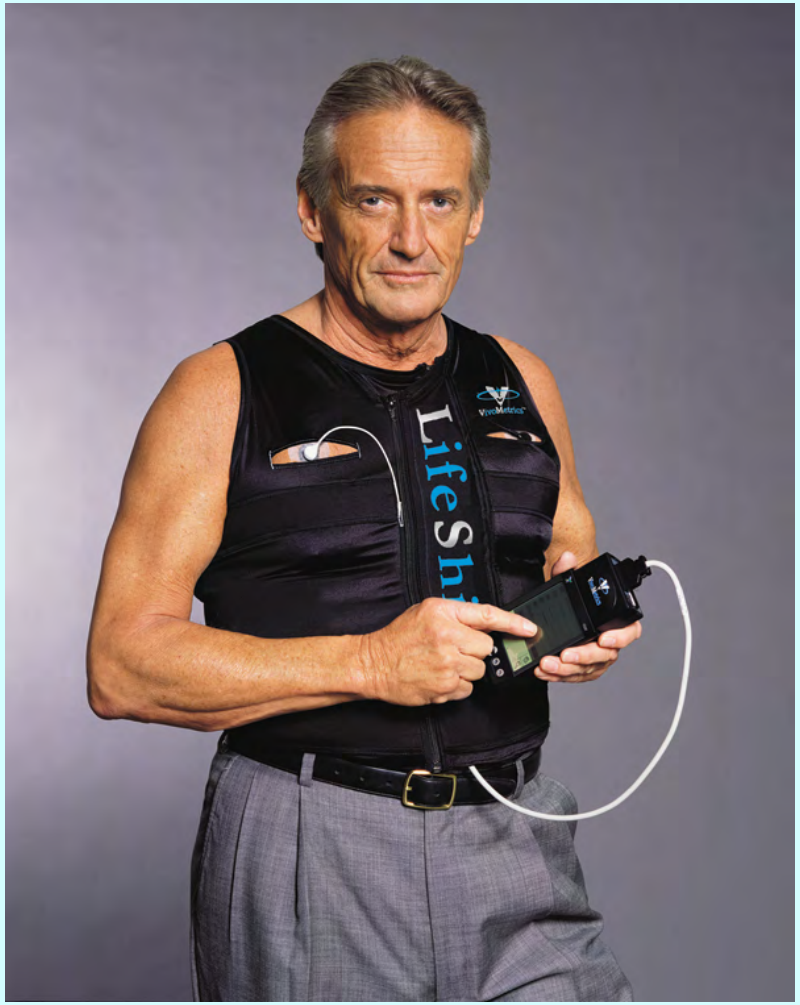
Smart

- monitor changes in the environment.

Intelligent

- monitor changes in the environment;
- react in response to change textile properties.

Smart vest



VivoMetrics®
Continuous Ambulatory Monitoring

LifeShirt by VivoMetrics® for physiological monitoring

Handwashable undergarment into which is sewn an array of sensors:

- monitors, records, analyses and interprets 30+ vital signs.

Intelligent knee sleeve

CSIRO & University of Wollongong

Conventional knee bandage, with a:

- disposable electronic fabric strain sensor;
- signal processing system;
- battery pack.

Used as a training aid:

- provides feedback via an audio tone;
- informs athletes when the knee is bent at a certain angle.

Implications also for rehabilitation.

Photonic textiles

Textiles that contain lighting systems: cushions, rugs and backpacks:

- flexible arrays of LED's.

video

Electronic textiles

First generation

Bulky and rigid boxes connected by wires.

Textile serving merely as a carrier of electronic equipment.

The future

Electronic functions seamlessly integrated into clothing.

Sensors & actuators, displays, circuitry and power supplies:

- flexible, lightweight and durable.

Flexible sensors: SOFTswitch

Combination of conductive fabrics with a thin layer of elasto-resistive composite.

Pressing switch increases conductance.

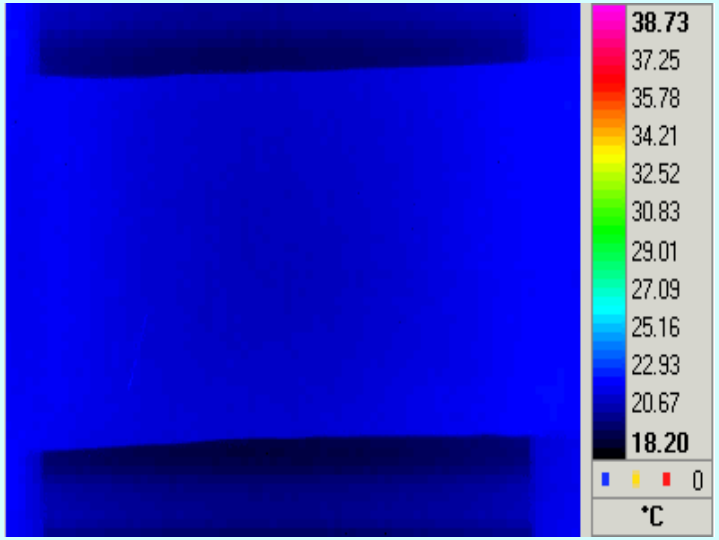
Flexible circuitry: conducting polymers

Plastic materials for conducting electricity:

- polypyrrole & polyaniline.

Other applications include:

- sensors, OLED displays and photovoltaic cells.

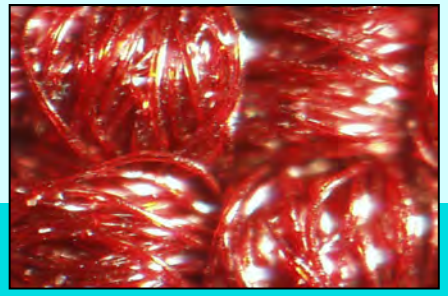


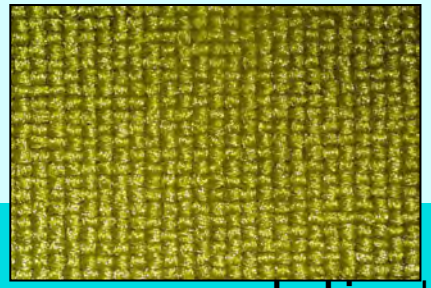
Research @ Deakin

Electromagnetic shielding.

Coloured conductive fabrics.

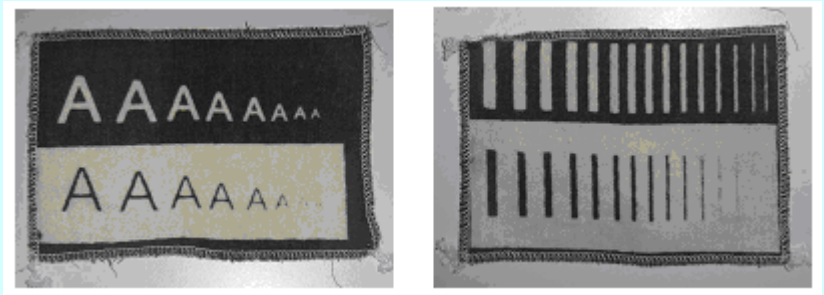
Heat generation.





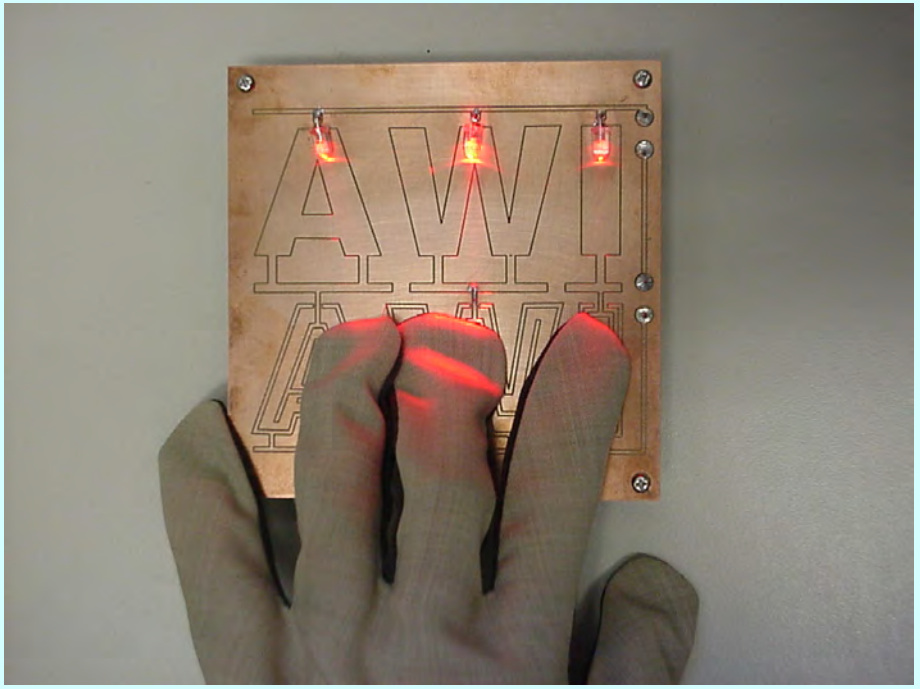
awttc

Flexible circuitry: conducting polymers



patterning

Research @ Deakin



a conductive glove acting as a switch

Flexible power supplies

The biggest challenge!

More efforts made to mount flexible energy supplies onto textiles:

- rather than to invent pure textile power supply.

Thin film solar cells may be important:

- efficiency needs to be improved.

Generating power from:

- body heat, body movement and external electric fields.

"Wearable electronics concept becomes generally accepted."

Conclusions

Adoption of any nanotechnology innovation will be influenced by:

1. price competitiveness;
2. performance improvements;
3. stability, consistency and quality of supply;
4. compatibility with existing industrial processes;
5. sufficient regulatory cover – HSE.

Harper, 2005

"For business, nanotechnology is no different from any other technology: it will be judged on its ability to make money."

Harper, 2003

Wool will benefit if there is a clear competitive advantage for its use.

Acknowledgments

Barry White & Joe Merola: International Fibre Centre
Peter Binks: Nanotechnology Victoria
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Reno Beltrame: Beltrame Consultants Pty Ltd
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Markus Schwarzenbacher: Schoeller Textil AG (Switzerland)
Bill Ware & Doug Neff: Nano-Tex (USA)
Inge van Hout: Philips Research (Netherlands)
Bridget Munro: University of Wollongong
Barry Holcombe: Mehari Consulting