Nanoparticles for Textiles and Clothing
Actual Status

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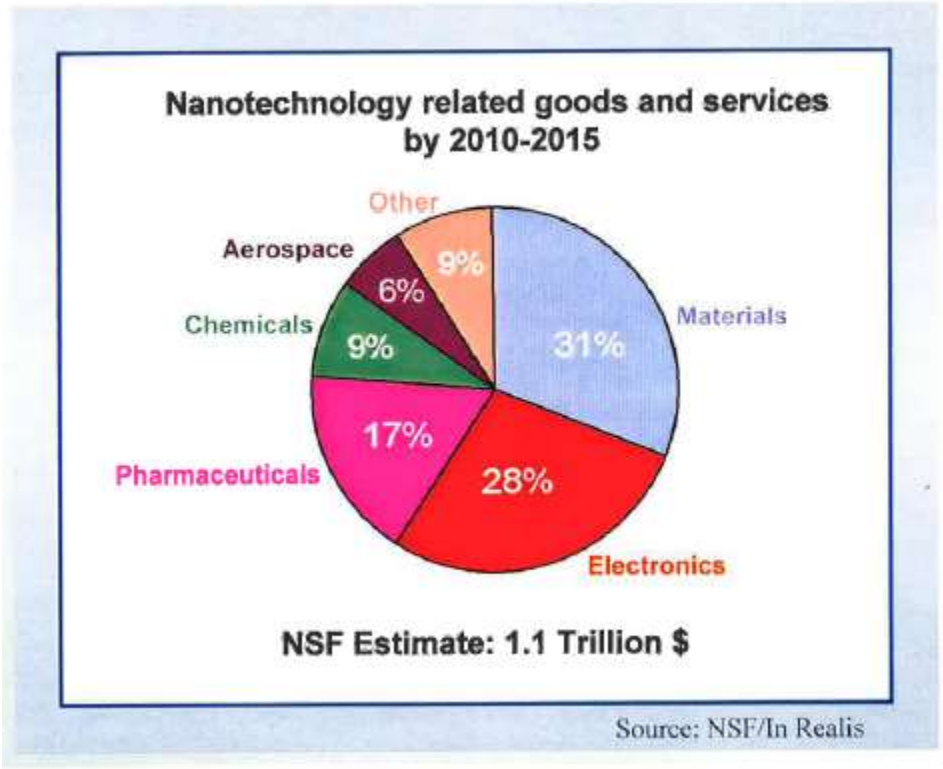
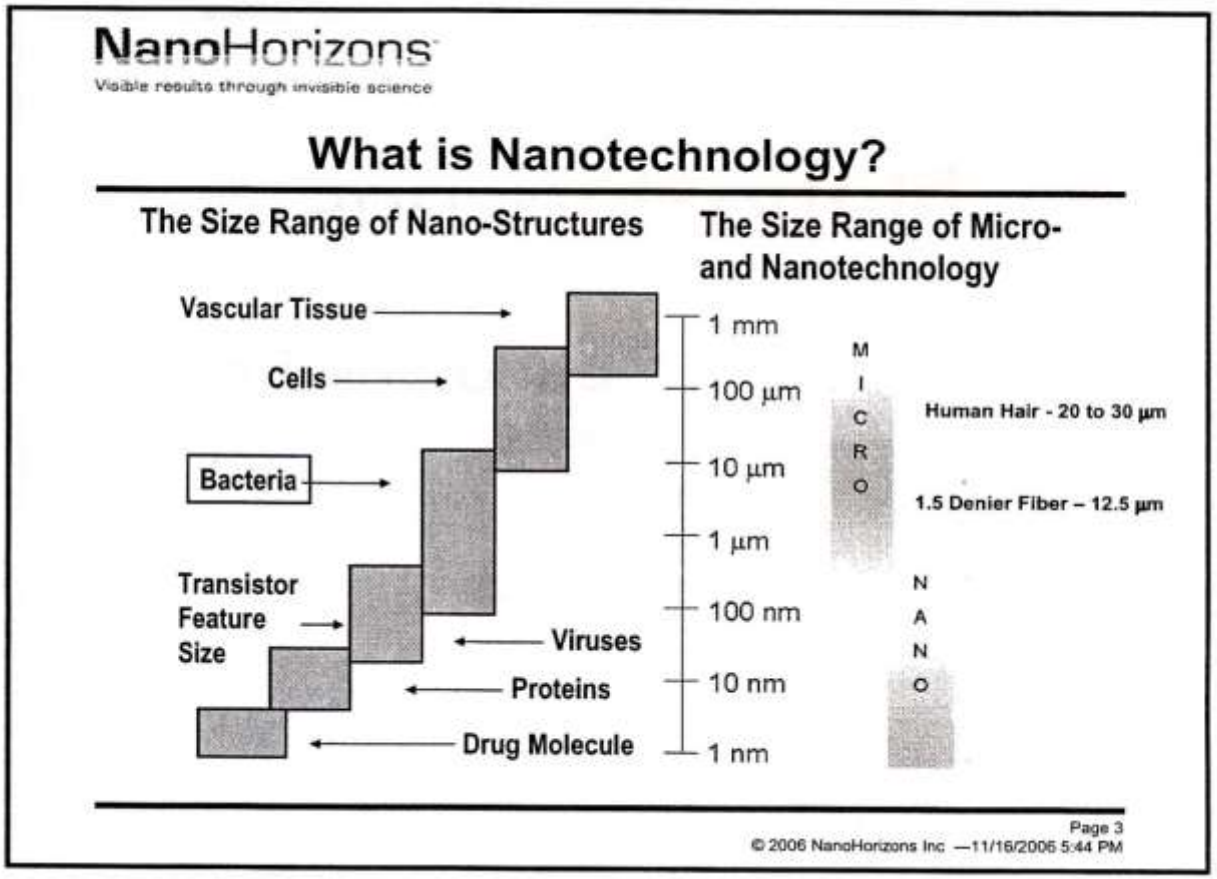
http://match.UGent.be

During the last 15 years, the fields of nanoscience and nanotechnology have expanded internationally and their growth has perhaps been more dramatic than in most other fields. They have been transformed into an intense and highly competitive research arena, encompassing practically all disciplines that include theoretical and experimental physics, inorganic, organic and structural chemistry, biochemistry, biotechnology, medicine, materials science, metallurgy, ceramics, electrical engineering, electronics, computational engineering and information technology.

The Oxford Handbook of “Nanoscience and Technology”, Vol. I to III, A.V. Narlikar and Y.Y. Fu (editors), Oxford University Press, 2010


Nanotechnology related goods and services by 2010-2015
Other
9%
Aerospace
6%
Chemicals
9%
Materials
31%
17%
Pharmaceuticals
28%
Electronics
NSF Estimate: 1.1 Trillion $
Source: NSF/In Realis


NanoHorizons
Visible results through invisible science
What is Nanotechnology?
The Size Range of Nano-Structures
The Size Range of Micro- and Nanotechnology
Vascular Tissue
Cells
Bacteria
Transistor Feature Size
Viruses
Proteins
Drug Molecule
1 mm
100 µm
10 µm
1 µm
100 nm
10 nm
1 nm
MICRO
NANO
Human Hair - 20 to 30 µm
1.5 Denier Fiber – 12.5 µm
Page 3
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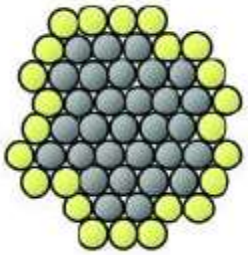
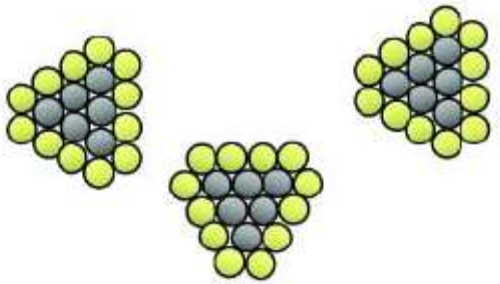
Nano-activity



54 atoms

<u>24</u> atoms at the surface
30 atoms internally



54 atoms

<u>36</u> atoms at the surface
18 atoms internally

Supramolecular vision

Nano-activity

Based on fundamental laws of Physics and Chemistry

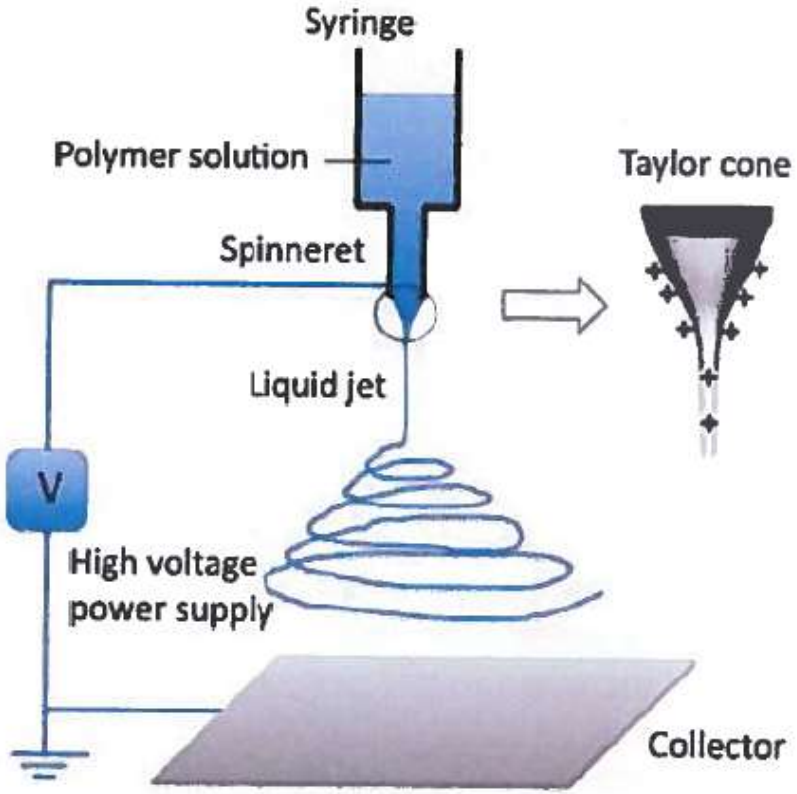
Schrödinger equation

→ Quantum mechanics

(Quantum Size Effects : QSE)

Nanotechnology and Textiles plus Clothing

1. Nanofibres
2. Nanocoatings
3. Nanoparticles in bulk of textile materials
4. Nano and intelligent textiles



Electrospinning setup

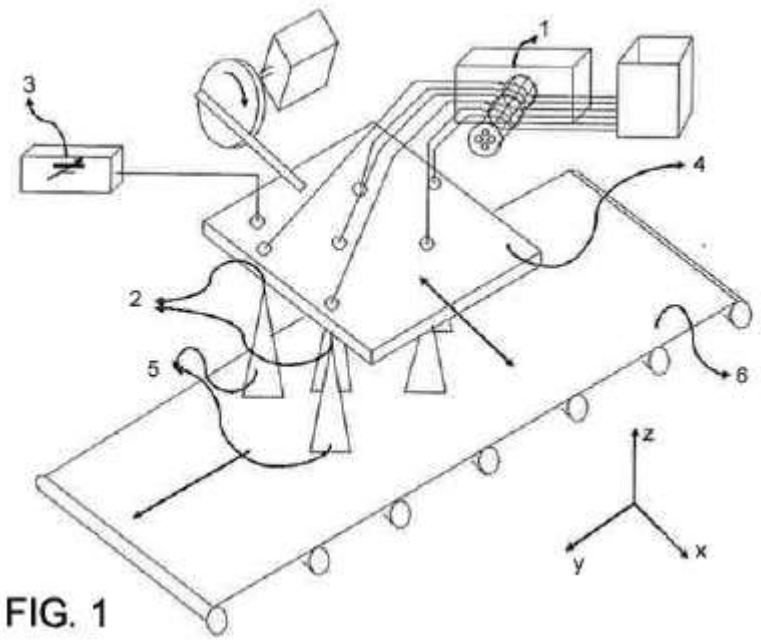


FIG. 1

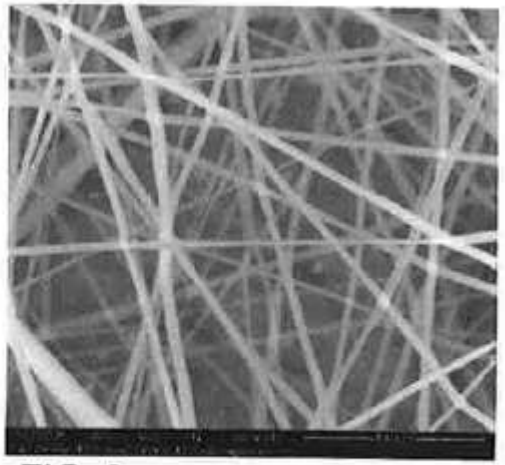


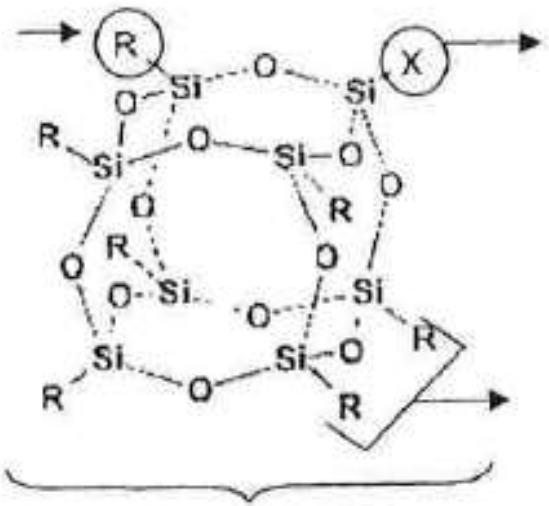
FIG. 2

Fig. 1 : semi-industrial production unit
Fig. 2 : SEM-picture of nanoweb

Functionalities

- **Repellency : oil, water, stain, …**
  → self-cleaning, e.g. PAN fibre with TiO_2 particles (SELF CLEAR)
- **Fire / flame resistance ; thermostability**
- **Antimicrobial protection**
- **Strength and stiffness**
  flexibility ?
- **Ballistic protection : body armour, e.g. shear thickening fluids based on TiO_2**
- **UV-protection**
- **Radiation protection**
- **Multi-terrain camouflage**
- **Others : antistatic, abrasion resistance, comfort (cooling), detoxifying, dyeing, etc.**

Un-reactive groups that drive the solubility and compatibility

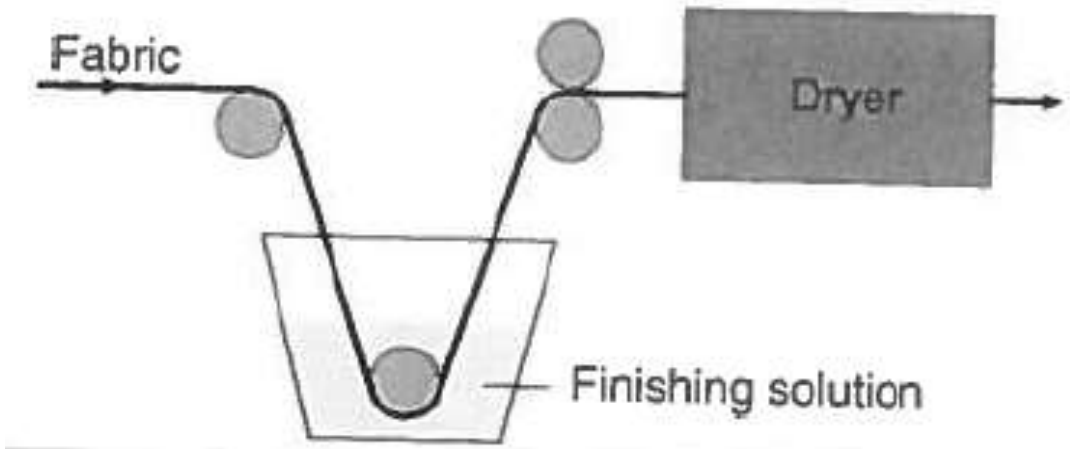


One or more functional groups in order to produce polymerization or grafting processes

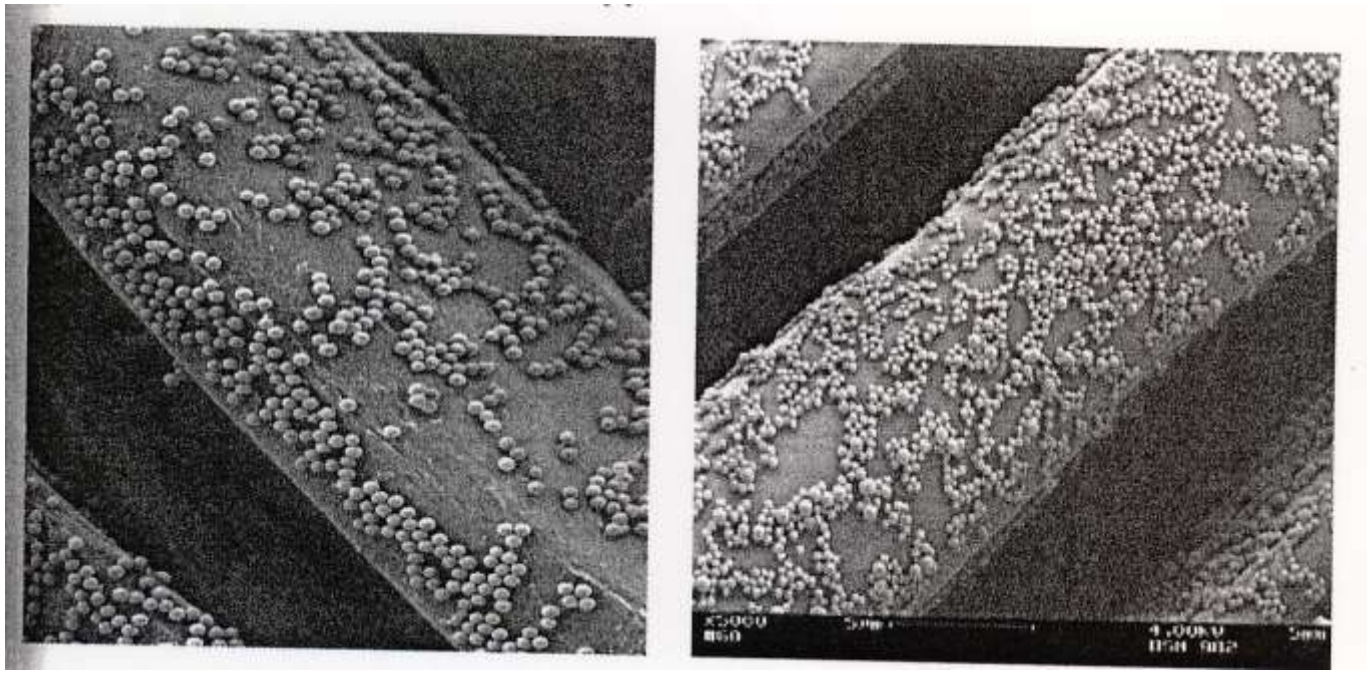
Nanometric sizes
Bond distance Si-Si= 0.5nm
distance R-R= 1.5nm

Organic-inorganic hybrid, stable chemical and thermally

POSS

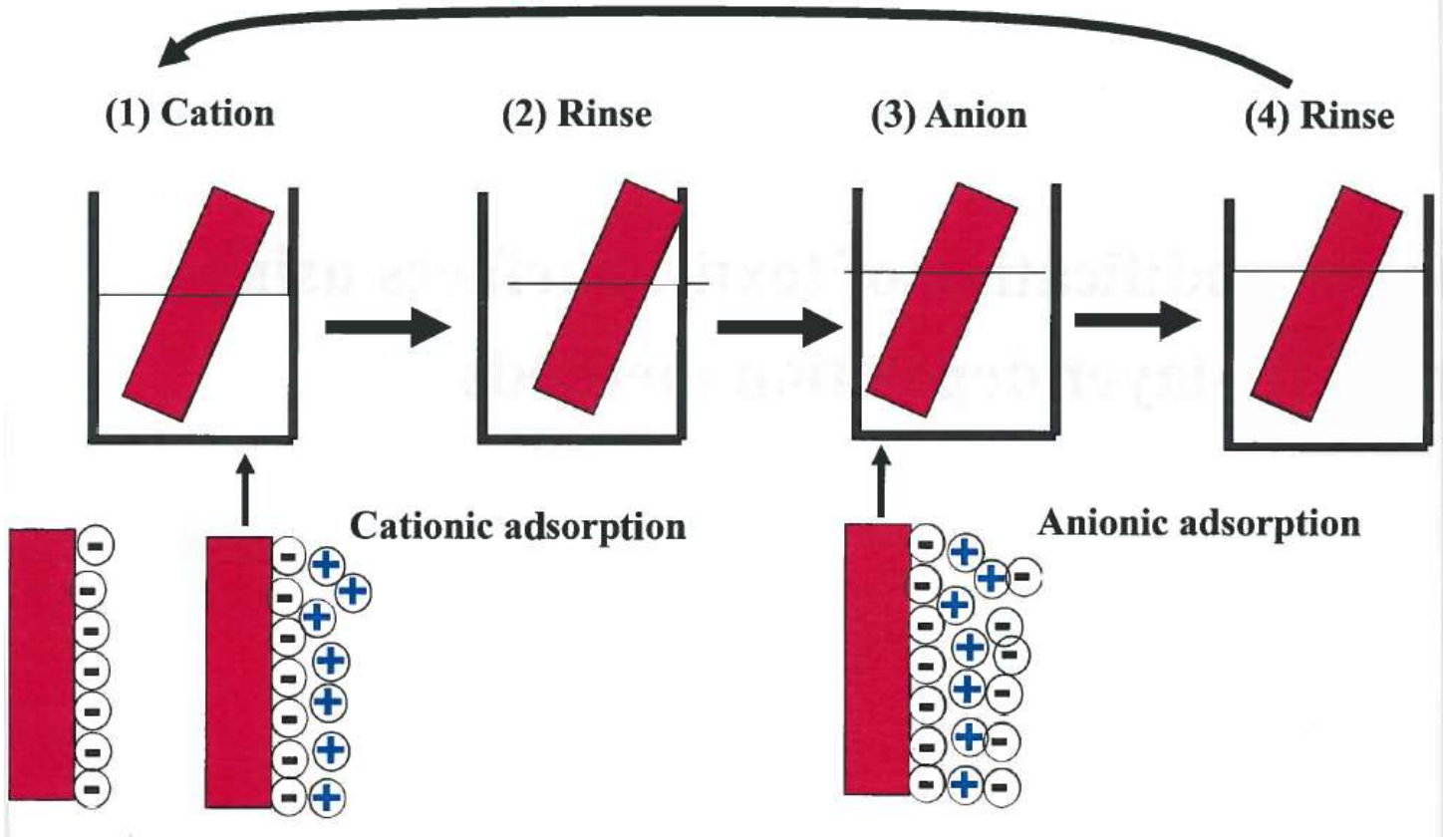


Padding process



PET-fibre + nanocoating

Different techniques of surface modification of textiles:



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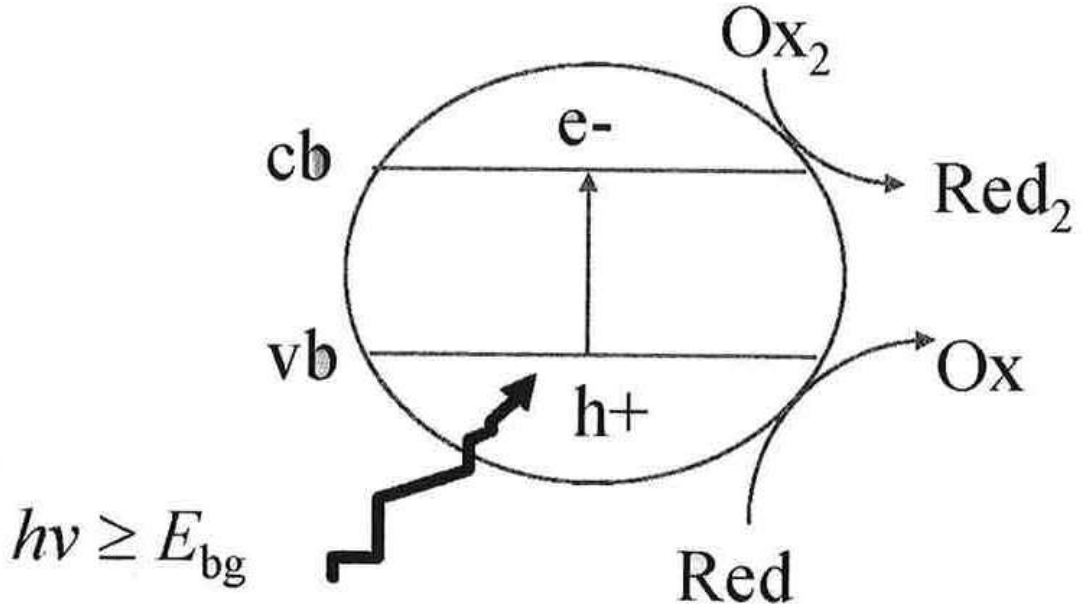
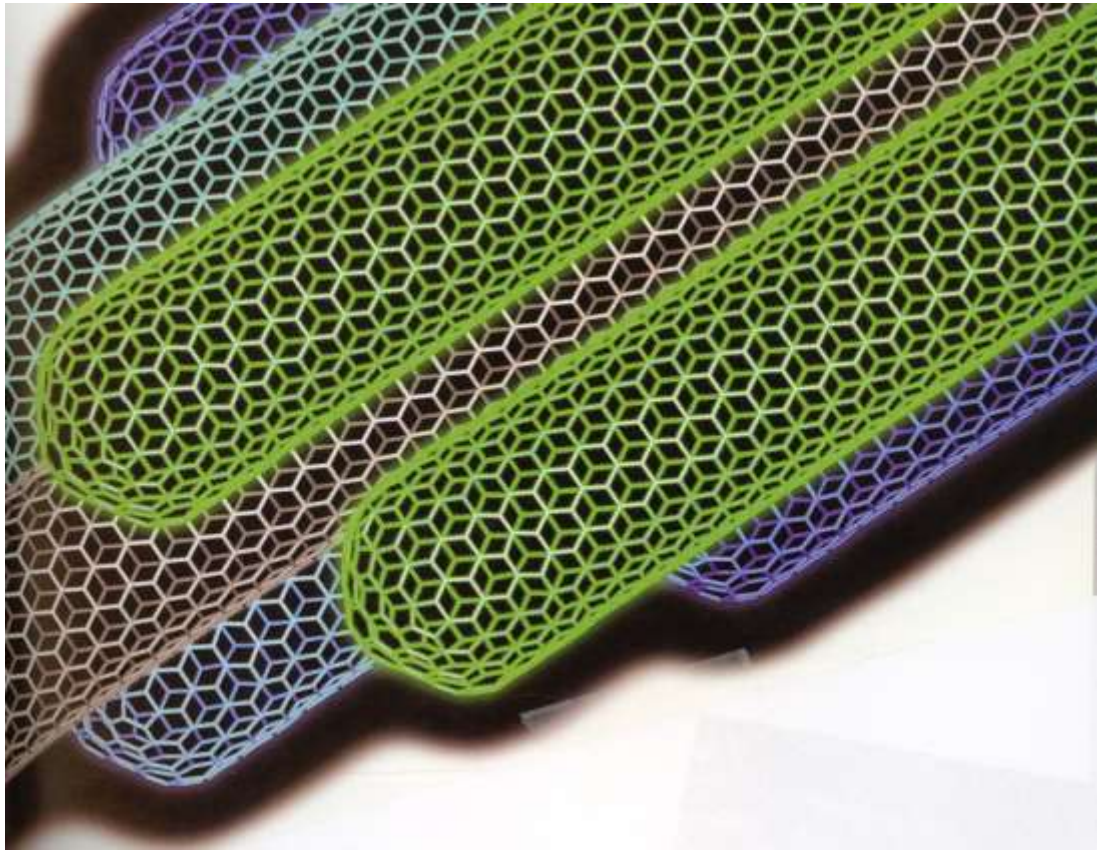
Lee Jeans NANO-CARE

-Lee Jeans *Performance Khakis*, casual clothes save the guesswork of stain removal

-"NANO-CARE" is a chemical process undertaken at the molecular level. Spilled liquids bead up and wipe away easily. For tougher stains, one wash removes any remnants.

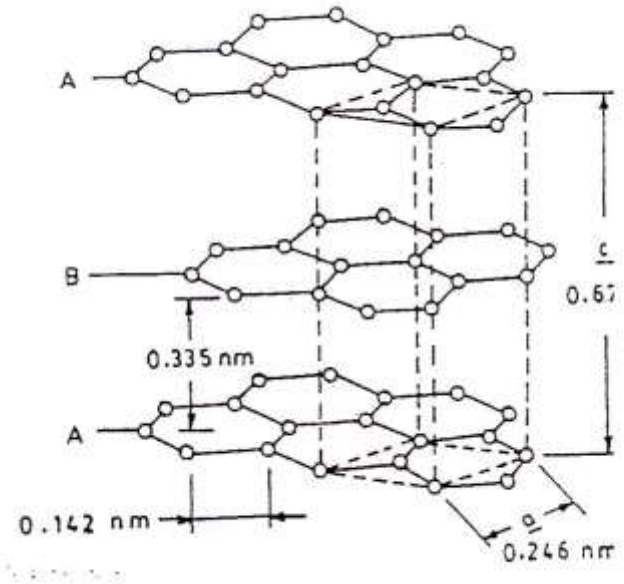


Catalytic Self Cleaning



CNT

Carbon nanotubes



Graphene layers : 6-membered rings

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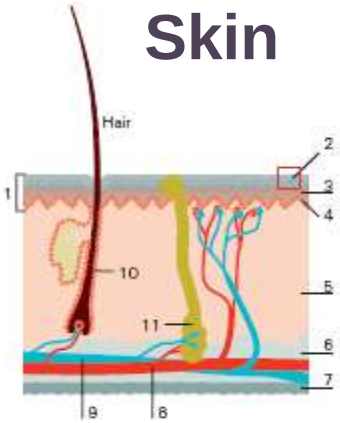
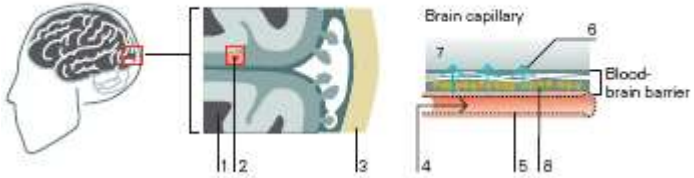
Safety and nanotechnology : Penetration of nanoparticles

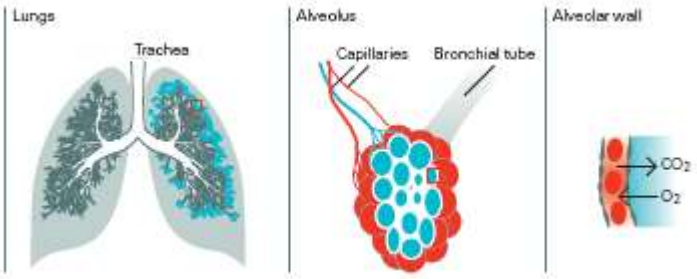
Skin



Brain



Lungs



Cyto(Toxicity)

Dermale exposure :

- **passage through healthy skin is not taking place to a significant extent**
- **diseased skin?**

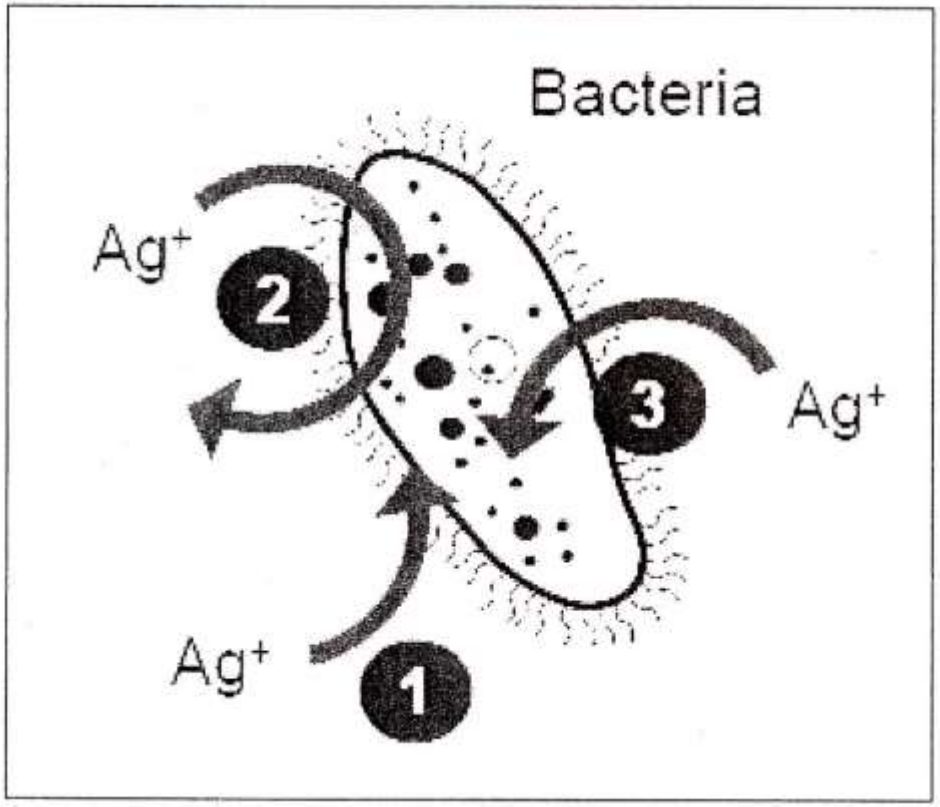
Respiratory exposure :

Can be problematic, particularly at size in the range 15 – 25 nm

“No nanoparticle is safe until proven otherwise”

Hazards?

- **oxidative stress : production of superoxide radicals**
- **cell death (apoptosis)**
- **cytokine-mediated inflammation (particularly with TiO_2)**
- **frustrated phagocytosis → mesothelioma**
- **multifocal granuloma formation**
- **fibrosis and carcigonesis**
- **cardiovascular impacts**
- **genotoxic effects.**



Ag ions and bacteria

<u>Nanomaterials</u> :
benefits may overweigh risks but caution / concern is needed !?

Labelling is recommended

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THANK YOU