

Panorama des usages des nanotechnologies, Enjeux industriels, économiques et sociétaux



E. Gaffet

Institut Jean Lamour – UMR 7198 CNRS / Université de Lorraine



Elu à l'Académie Européenne des Sciences (2003 -)

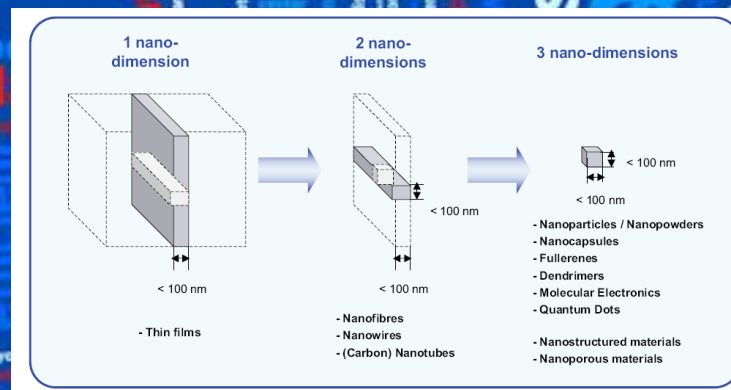
Président du Comité Scientifique « NanoSciences & Nanotechnologies » / ANR (France)

Président et membre Groupe d'Experts ANSES (France) (2005 – 2012 et pérenne 2012 – 2015)

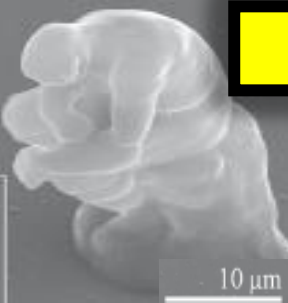
Membre du Haut Conseil de Santé Publique (France)

Membre SCENIHR (Europe) – Nanodéfinitions , NanoMédecine

Président - OCDE / WPMN - Physico – Chemical NanoCharacterisation Community of Practice



Concilier Recherche, Innovation & Sécurité Sanitaire



4 Décembre 2013



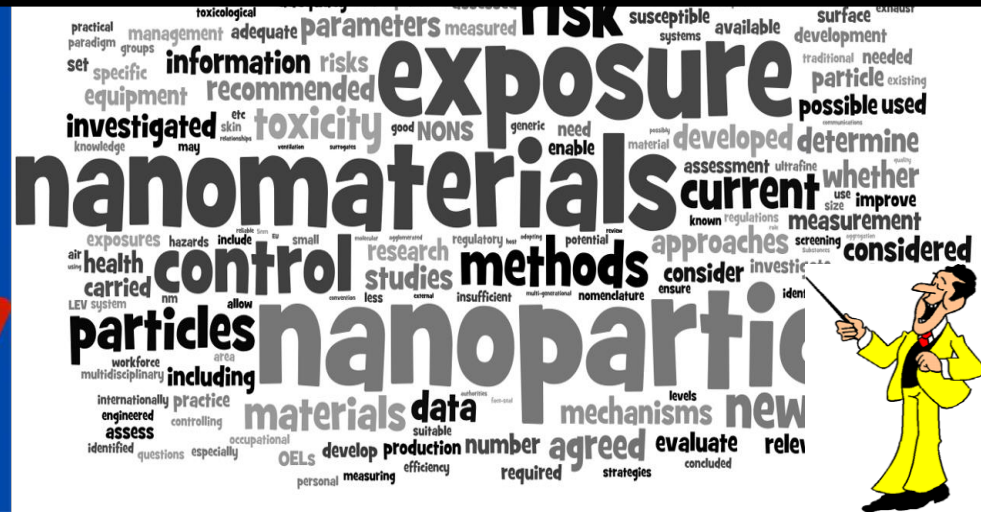
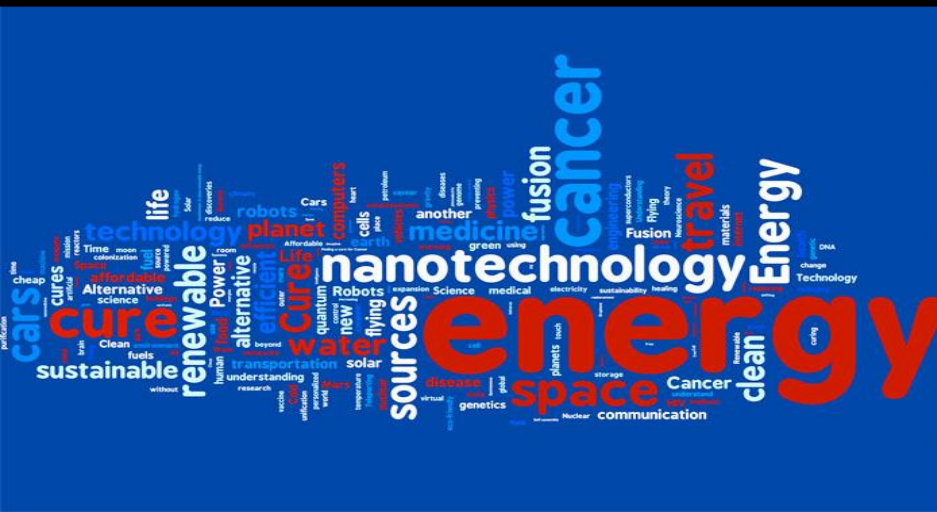
i) Définitions, Markets, Properties, Applications
Définitions, Perspectives, Propriétés, Applications

ii) Real Risks, Perceptual Risks, Regulations

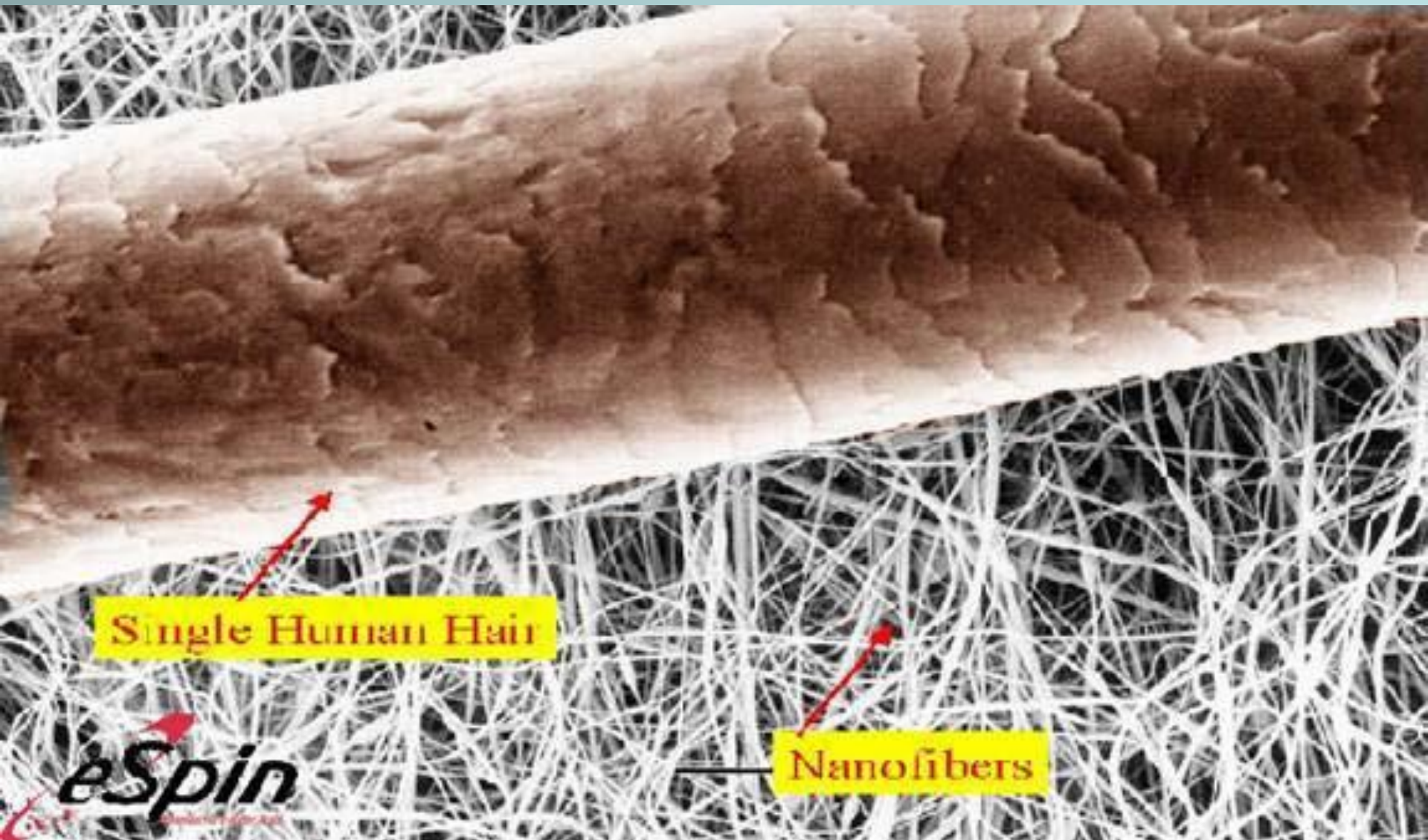
Risques réels, perçus, réglementation

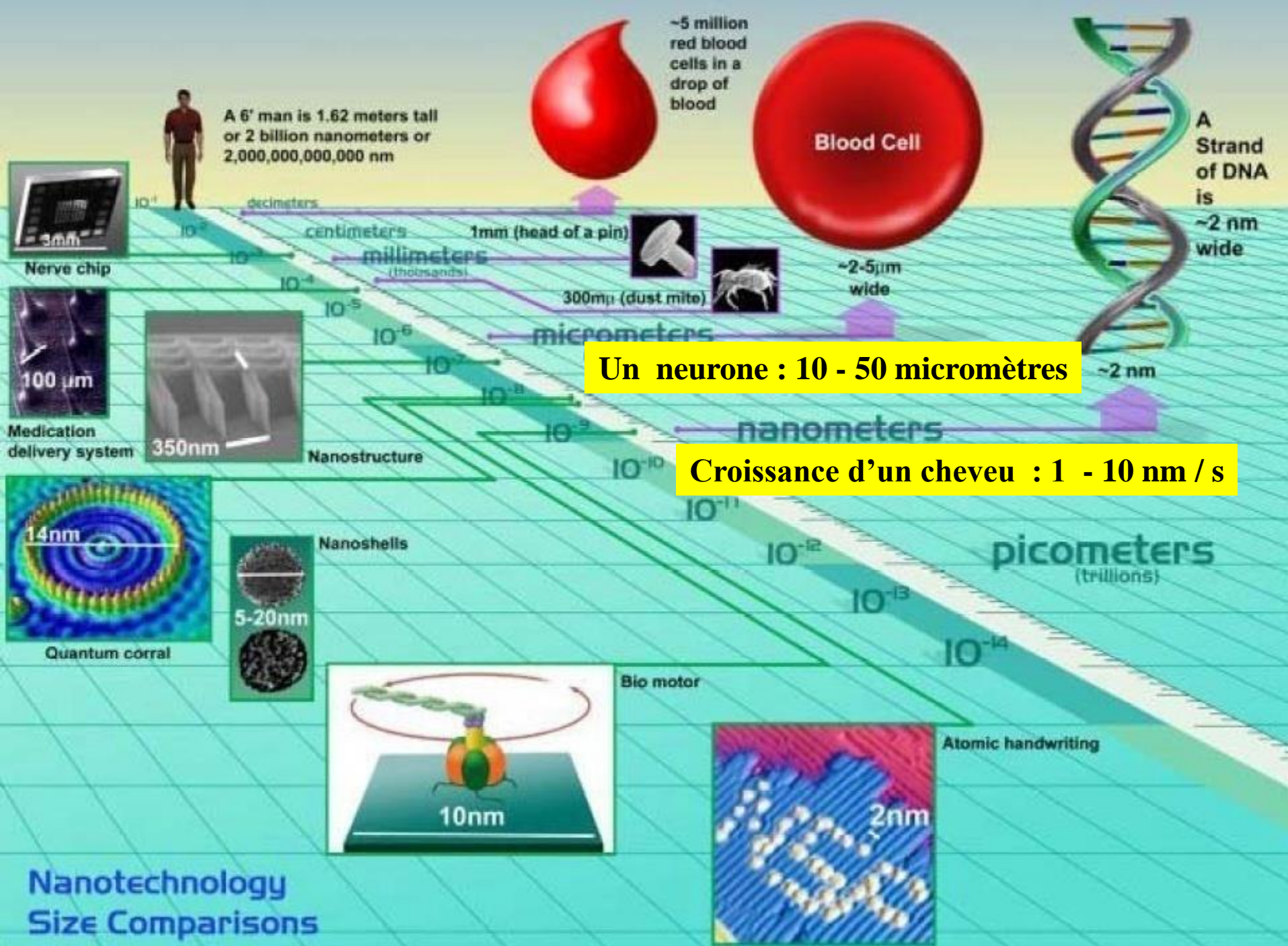
iii) NP Hazard (Eco/Toxicity)

iv) Benefits / Risks analyses



Cheveu : 80.000 nm







Needs for standardization (June 2008)

1. To support commercialisation and market development
2. To provide a basis for procurement through technical requirements, and quality and environmental management
3. To support voluntary governance structures and appropriate legislation and regulation

Challenges: currently there are:

- *No internationally agreed terminology/definitions for nanotechnology(ies).*
- *No internationally agreed protocols for toxicity testing of nanoparticles.*
- *No standardized protocols for evaluating environmental impact of nanoparticles.*
- *Existing “methods of test” might not be suitable for nanoscale devices and nanoscale dimensions.*
- *Measurement techniques and instruments need to be developed and/or standardized.*
- *New calibration procedures and certified references materials are needed for validation of test instruments at the nanoscale.*
- *Multifunction nanotechnology systems and devices will need new standards.*

Partial solutions

- *Some existing standards are or might be applicable e.g. for chemical analysis and imaging (ISO TCs 201 and 202) and particle detection/sizing (ISO TC 24)*

TECHNICAL SPECIFICATION

ISO/TS 27687

Nanotechnologies — Terminology and definitions for nanoparticles

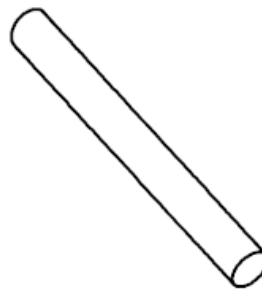
*Nanotechnologies — Terminologie et définitions relatives
aux nanoparticules*

26 Septembre 2008 !

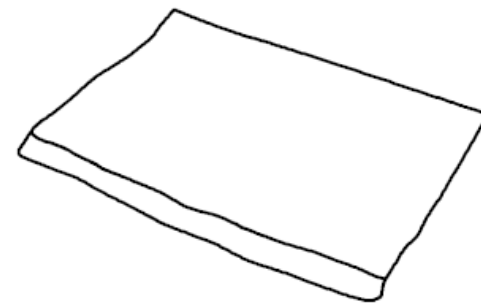
This document is concerned with the definition of terminology and definitions for these small objects. These objects come in several different shapes as illustrated in Figure 1:



a) particle



b) rod

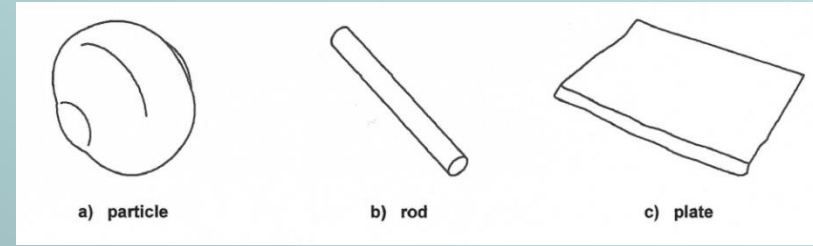
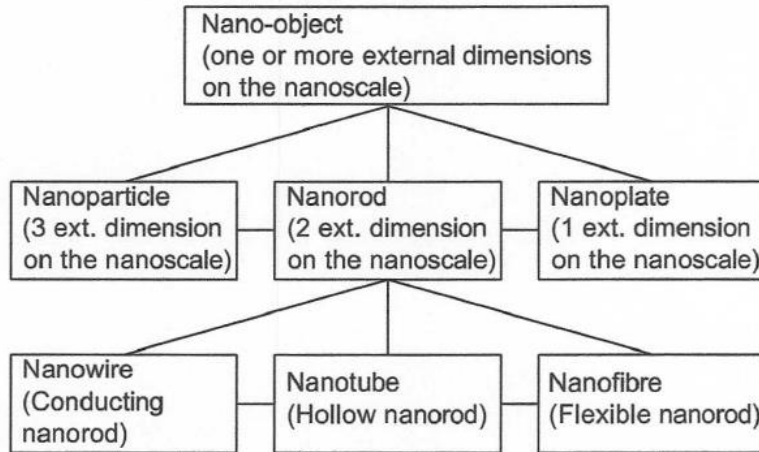


c) plate

Et !! Aggregates / Agglomerate !!!

Figure 1 — Schematic diagrams showing some shapes for nano sized objects

Nanotechnologies – Terminology and definitions for nanoparticles



size range from approximately 1 nm to 100 nm

NOTE 1 Properties that are not extrapolations from a larger size will typically, but not exclusively, be exhibited in this size range. For such properties the size limits are considered approximate.

NOTE 2 The lower limit in this definition (approximately 1 nm) is introduced to avoid single and small groups of atoms from being designated as nano-objects or elements of nanostructures, which might be implied by the absence of a lower limit.

Terms concerning assemblies of particles

4.1 Agglomerate : collection of loosely bound particles or aggregates or mixtures of the two where the resulting external surface area is similar to the sum of the surface areas of the individual components

NOTE 1 The forces holding an agglomerate together are weak forces, for example Van Der Waals forces, as well as simple physical entanglement.

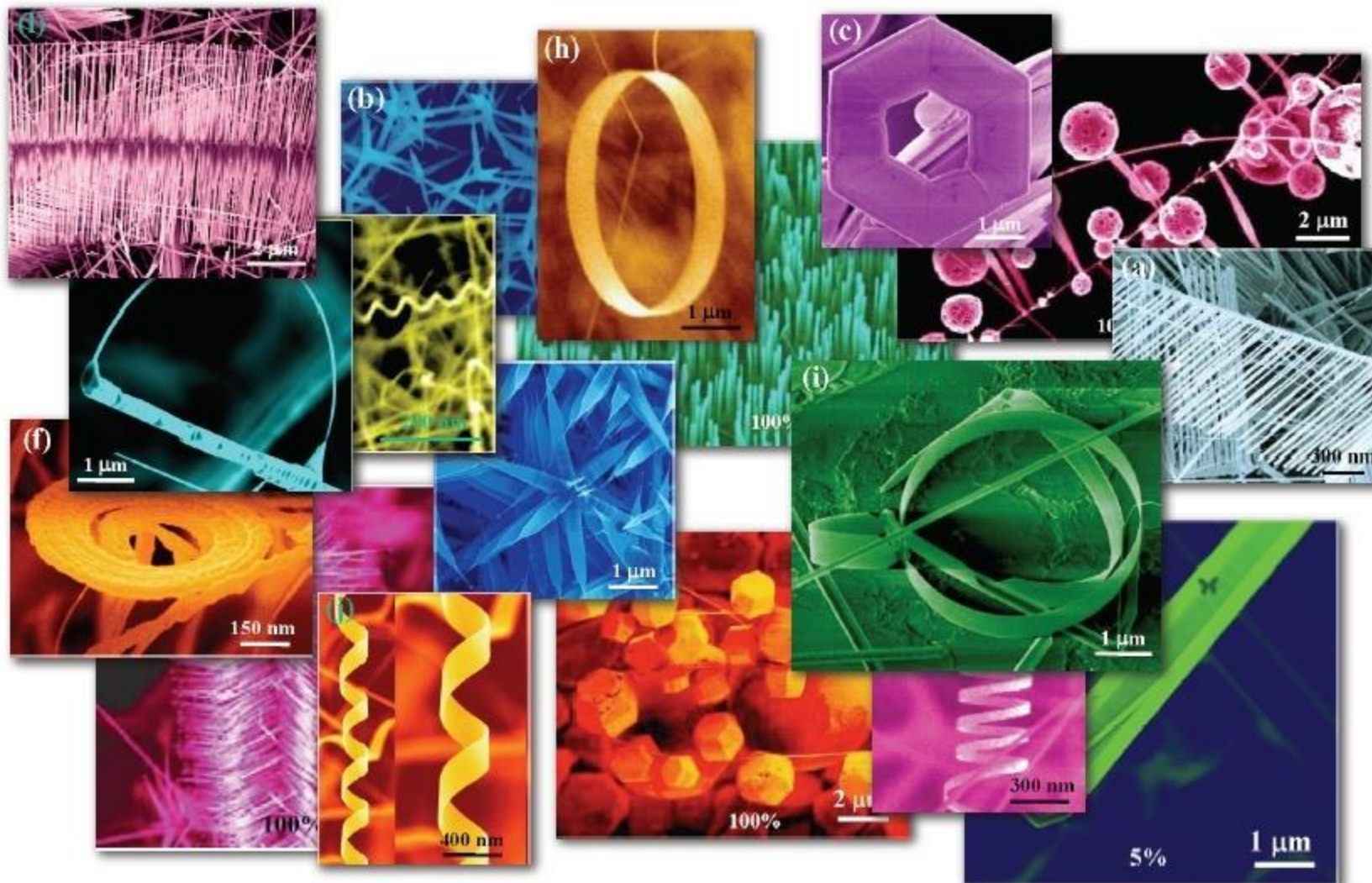
4.2 Aggregate : particle comprising strongly bonded or fused particles where the resulting external surface area may be significantly smaller than the sum of calculated surface areas of the individual components

Whereas physical and chemical properties of materials may change with size, there is no scientific justification for a single upper and lower size limit associated with these changes that can be applied to adequately define all nanomaterials.

- There is scientific evidence that no single methodology (or group of tests) can be applied to all nanomaterials.
- Size is universally applicable to define all nanomaterials and is the most suitable measurand. Moreover, an understanding of the size distribution of a nanomaterial is essential and the number size distribution is the most relevant consideration.

The Significance of Structure

ZnO: One chemistry, many shapes - Courtesy of Prof. Z.L. Wang, Georgia Tech



Particle Number = Fonction of the dimension

1 gramme d'oxyde de Titane

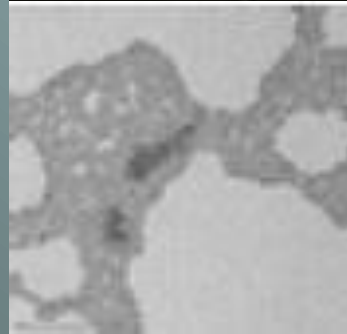
Bulk Scale
Dimension millimétrique
 $\varnothing = 1\text{mm}$
54 particules



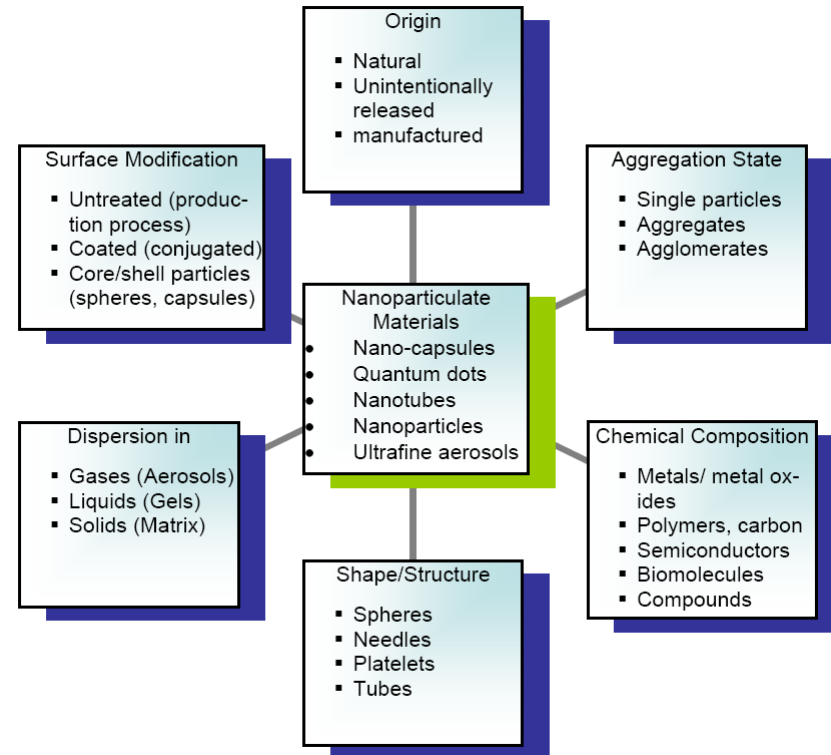
Micrometer Scale
Dimension micronique
 $\varnothing = 1 \text{ micromètre}$
10.000.000.000 particules
(10 milliards)



Nanometer Scale
Dimension nanométrique
 $\varnothing = 10 \text{ nanomètre}$
 10^{16} particules
(10 Quadrillions ou 10 Millions de Milliards)



1 gramme de nanoparticules d'oxyde de Titane – 100 m²



If only 2 grams of 100 nm diameter NPs were to be evenly distributed there would be enough to provide every human worldwide with 300,000 particles each (Hardman 2006).

Size Distribution

Nanometer Scale

Dimension nanométrique

$\varnothing = 10$ nanomètre

10^{16} particules

(10 Quadrillions ou 10 Millions de Milliards)

Distribution de taille ?

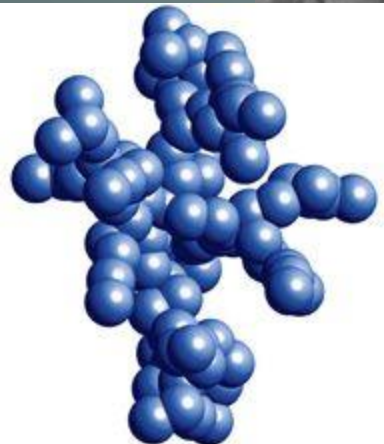
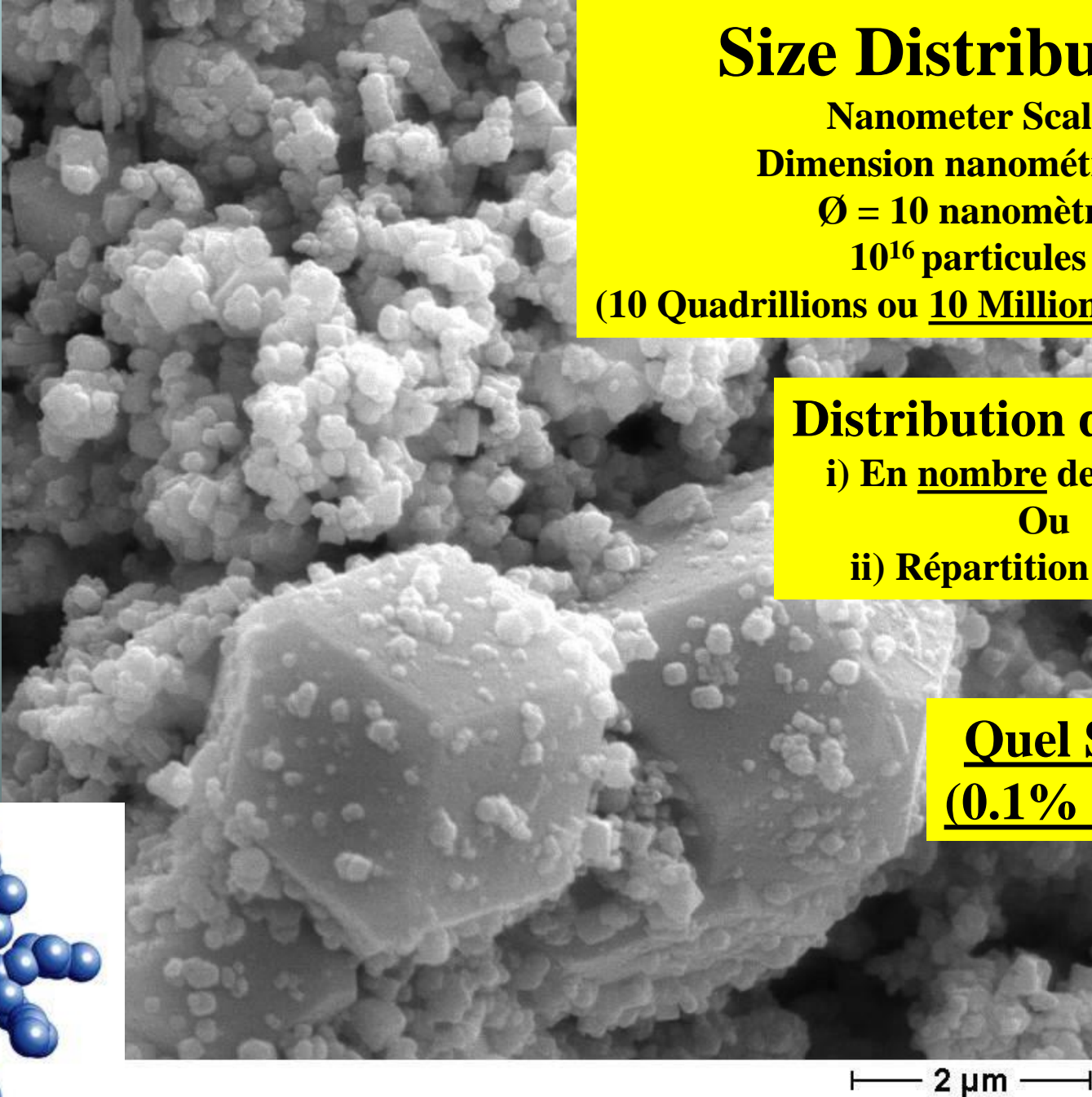
i) En nombre de particules

Ou

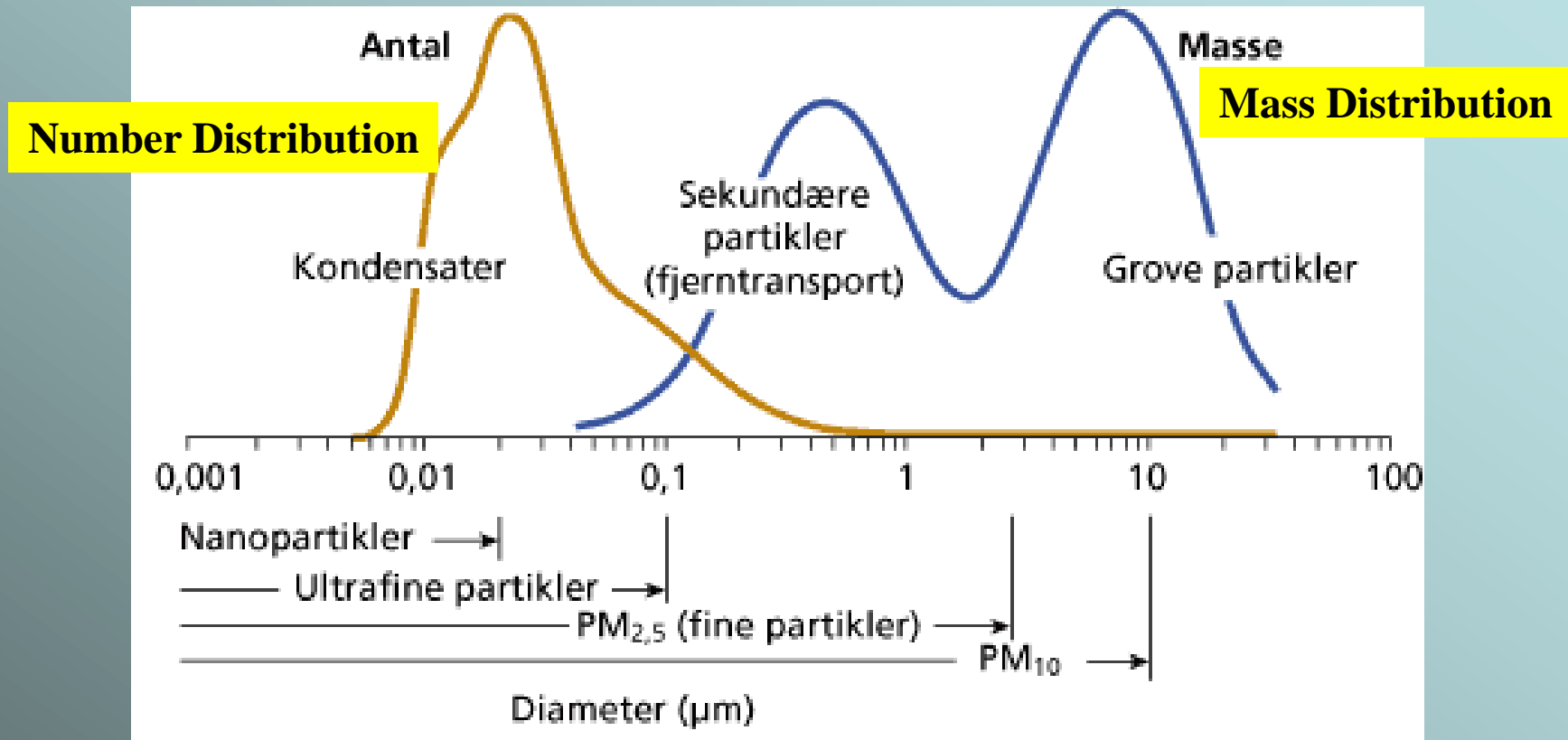
ii) Répartition en masse

Quel Seuil ??

(0.1% , 10% ?)

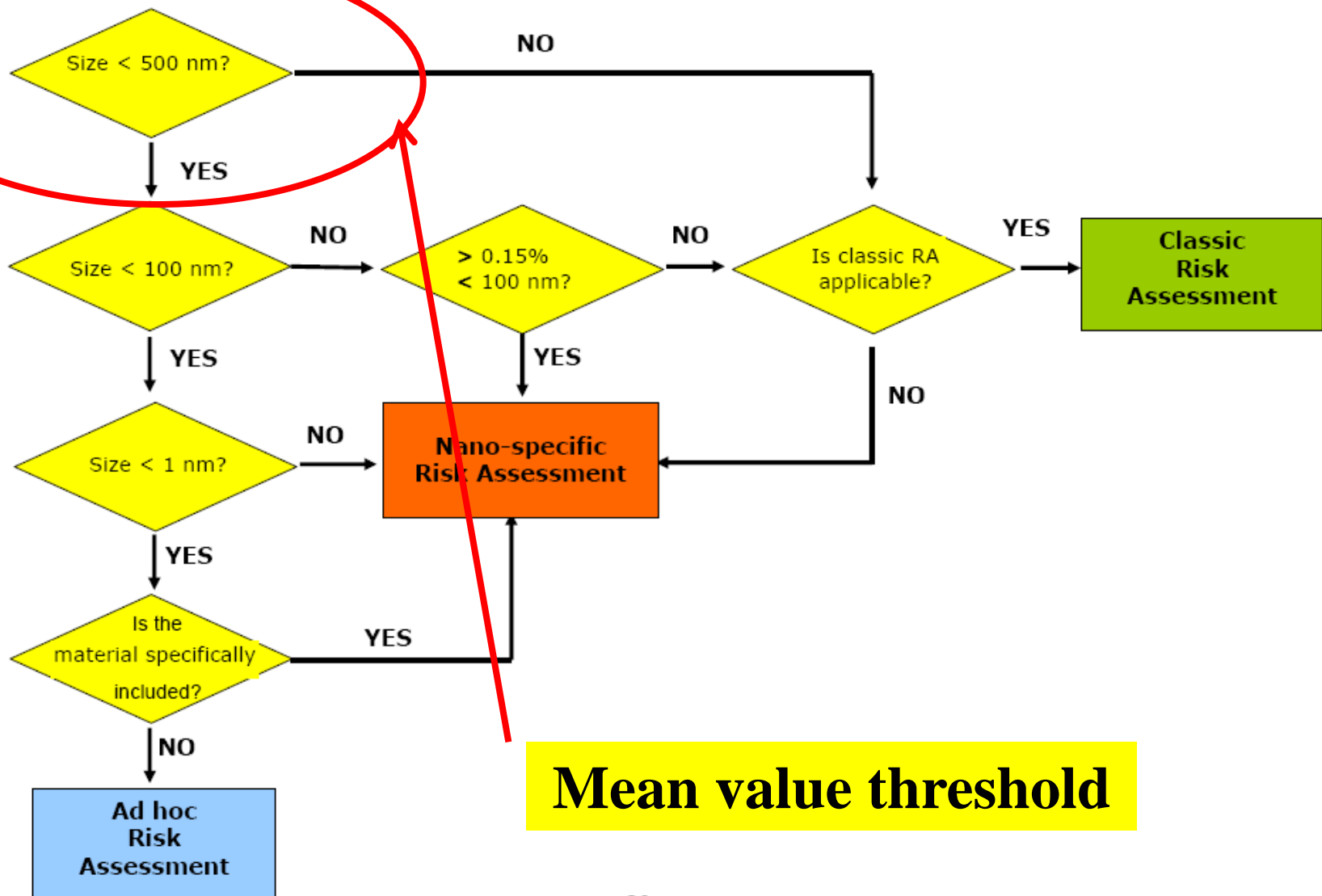


Typical size distribution of particles



Typical size distribution of particles. Please note that the axis is logarithmic. PM_{2.5} and PM₁₀ are the mass of particles sized below 2.5 and 10 micrometers, respectively. The yellow curve shows the distribution of particles measured as number, while the blue curve shows the same distribution measured as mass. As the cloud gets older, the content of condensation particles increases (from SO₂) and the largest particles (> 5 micrometers) will sediment.

Figure 1: The use of size to identify an approach for the risk assessment of nanomaterials



Scientific basis for the definition of "nanomaterial"

Data on the size distribution should be taken into account when describing a nanomaterial.

When only a part of the material has a size within the size range of the definition or description, it should be clear whether and when such a material will be considered a nanomaterial. This may be by allowing a part (a certain percentage) of the number size distribution to be below a certain threshold or by using the information on the size distribution itself.

Based on its geometric mean and geometric standard deviation, a material might be considered a nanomaterial when >0.15% of the material, as indicated by the number size distribution, has a size below the designated upper size limit.

The standard deviation of the size distribution may be used for finetuning of the definition of a nanomaterial.

For example materials might be defined as being NOT a nanomaterial as the mean size plus/minus 3 times SD (meaning 99.7% of the data set or measured nanoparticles) indicating that 99.85% of the sizes is above a certain upper size limit.

Or the other way around: any material is a nanomaterial when >0.15% of the material, based on number concentration, has a size below the upper limit,

The SCENIHR approved this opinion by written procedure on 8 December 2010

Commission Européenne : RECOMMENDATION on the definition of the term "nanomaterial" (19 Octobre 2010)

Article 1

1. This Recommendation concerns the definition of the term "nanomaterial" used in Union policies and legislation applied within the European Union and the European Economic Area.

2. Member States, the Union agencies and Industry are invited to use the definition of the term "nanomaterial" when adopting and implementing legislation and programmes concerning products of nanotechnologies.

1. Nanomaterial: means a material that meets at least one of the following criteria:

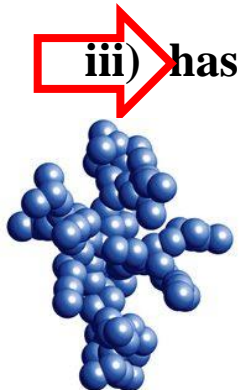
i) consists of particles, with one or more external dimensions in the nanoscale (1 nm - 100 nm) for more than 1 % of the total number of particles.

ii) has internal or surface structure in the nanoscale (1 nm - 100 nm) for more than 1 % of the total surface area.

iii) has a specific surface area greater than $60 \text{ m}^2/\text{cm}^3$, excluding materials with particles with a size lower than 1 nm.

**No mean value threshold :
All Manufactured granular materials
are under the scope of such a definition**

particle: means a minute piece of matter with defined physical boundaries
(ISO 146446:2007)

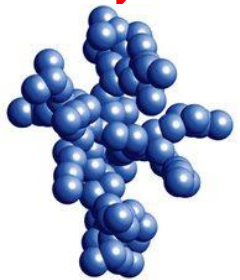


Commission Européenne : RECOMMENDATION
on the definition of the term "nanomaterial"
(19 Octobre 2010)

Article 1

1. This Recommendation concerns the definition of the term "nanomaterial" used in Union policies and measures within the European Union and the European Economic Area. The Union agencies and Industry are invited to use the definition of the term when adopting and implementing legislation and programmes concerning products of nanotechnologies.

- EC / SCENIHR: nombre %**
- Number Size Distribution 1% !! in number**
1. Nanomaterial: means a material that meets at least one of the following criteria:
- i) consists of particles with one or more external dimensions in the size range 1 nm - 100 nm, more than 1 % of their number size distribution;
 - ii) is a solid or surface structures in one or more dimensions in the size range 1 nm – 100 nm;
 - iii) has a specific surface area by volume greater than $60 \text{ m}^2/\text{cm}^3$, excluding materials consisting of particles with a size lower than 1 nm.



Introduction of the Surface !!

article: means a minute piece of material with defined physical and chemical properties (ISO 146446:2007)

Definition of a nanomaterial / European Commission

On 18 October 2011 the Commission adopted the Recommendation on the definition of a nanomaterial. According to this Recommendation a "Nanomaterial" means:

A natural, incidental or manufactured material containing particles, in an unbound state or as an aggregate or as an agglomerate and where, **for 50 % or more of the particles in the number size distribution, one or more external dimensions is in the size range 1 nm - 100 nm.**

In specific cases and where justified by concerns for the environment, health, safety or competitiveness the number size distribution threshold of 50 % may be replaced by a weight size distribution threshold between 1 and 50 %.

By derogation from the above, graphene flakes and single wall carbon nanotubes with one or more external dimensions below 1 nm should be considered as nanomaterials.

The definition is primarily to identify materials for which special provisions might apply (e.g. for risk assessment or for specific legislation). Those special provisions are not part of the definition but of specific legislation in which the definition will be used.

Nanomaterials are not intrinsically hazardous per se but there may be a need to take into account specific considerations in their risk assessment. Therefore one purpose of the definition is to provide clear and unambiguous criteria to identify materials for which such considerations apply. It is only the results of the risk assessment that will determine whether the material is hazardous and whether or not further action is justified.

Today there are several pieces of EU legislation, and technical guidance supporting implementation of legislation, with specific references to nanomaterials. To ensure conformity across legislative areas, where often the same materials are used in different contexts, the purpose of the Recommendation is to enable a coherent cross-cutting reference. Therefore another basic purpose is to ensure that a material which is a nanomaterial in one sector will also be treated as such when it is used in

Draft Guidance for Industry Assessing the Effects of Significant Manufacturing Process Changes, Including Emerging Technologies, on the Safety & Performance of Food Ingredients & Food Contact Substances, Including Food Additives that are Color Additives

FDA (USA) – up to one micrometer (April 2012)

At this time, we have not established a formal definition of “nanotechnology,” “nanoscale” or related terms. As discussed in the Task Force Report, we believe it is appropriate to take into account the potential importance of nanotechnology and the evolving state of the science. However, while one definition for “nanotechnology,” “nanoscale material,” or a related term or concept may offer meaningful guidance in one context, that definition may be too narrow or broad to be of use in another.

As we learn more about the interaction of nanoscale materials with biological systems and generalize concepts that can inform our judgment, it may be productive to develop formal, fixed definitions, appropriately tailored to the regulation of nanoscale materials in products we regulate.

In the absence of a formal definition, when considering whether a FDA-regulated product contains nanomaterials or otherwise involves the application of nanotechnology,

FDA will ask:

- (1) whether an engineered material or end product has at least one dimension in the nanoscale range (approximately 1 nm to 100 nm);
- or (2) whether an engineered material or end product exhibits properties or phenomena, including physical or chemical properties or biological effects, that are attributable to its dimension(s), even if these dimensions fall outside the nanoscale range,

up to one micrometer

Avril 2012

<http://www.fda.gov/downloads/Cosmetics/GuidanceComplianceRegulatoryInformation/GuidanceDocuments/UCM300927.pdf>

EC Submits Proposed Nano Food Labeling Regulation to WTO – Sept 2013

On September 11, 2013, the European Commission (EC) submitted to the World Trade Organization (WTO) a proposed regulation amending Regulation 1169/2011 concerning the provision of food information to consumers as regards the definition of engineered nanomaterials (ENM). The proposed regulation states that since the regulation refers to ENMs and not nanomaterials in general, natural and incidental nanomaterials should not be included in the definition. The proposed regulation states further that “it is appropriate to link the definition of ‘engineered nanomaterials’ to intentionally manufactured material, which should be explicitly defined.”

The proposed regulation includes the following statements:

- (11) Certain food additives included in the Union lists as established by Commission Regulations (EU) No 1129/2011 and (EU) No 1130/2011 could be in the form of ‘engineered nanomaterial’ in the final food. **However, indicating such food additives in the list of ingredients preceded by the word ‘nano’ may confuse the consumers as it may suggest that those additives are new while in reality they have been used in foods in that form for decades.**
- (12) Taking into account the potential risk of confusing consumers, food additives included in the Union lists by Regulations (EU) no 1129/2011 and (EU) No 1130/2011 should not be mandatorily qualified as ‘nano’ in the list of ingredients and should therefore not be covered by the definition of engineered nanomaterials. The need for specific nano-related labelling requirements relating to those additives should be addressed in the context of the re-evaluation programme, by amending, if necessary, the conditions of use in Annex II to Regulation (EC) No 1333/2008 and the specifications of those food additives, set out in Commission Regulation (EU) No 231/2012. That exception should not apply to food additives inserted in those lists at a later date, including new entries pursuant to Article 12 of Regulation (EC) No 1333/2008.
- (13) **The number based size distribution threshold of 50% should be replaced by a threshold between 1% and 50%** in the future in light of technological developments concerning detection and quantification methods and where warranted by concerns for health and safety.

**Décret n° 2012-232 du 17 février 2012 relatif à la
déclaration annuelle des substances à l'état
nanoparticulaire pris en application de l'article L.
523-4 du code de l'environnement**

**II.-La proportion minimale, mentionnée à l'article R. 523-12 du code de l'environnement, des
particules présentant une ou plusieurs dimensions externes se situant entre 1 nm et 100 nm est
fixée à 50 % de la distribution des tailles en nombre.**

**1D, 2D ou 3D, entre 1 et 100 nm
Distribution des tailles en nombre
Seuil à 50% (en nombre)**

II – Identité de la substance à l'état nanoparticulaire. Elle est décrite au moyen de l'ensemble des éléments suivants :

- a) Identification chimique de la substance : la substance est identifiée au moyen de son nom, sa formule chimique, son numéro CAS et, le cas échéant, son numéro CE (EINECS ou ELINCS). Si la substance a fait l'objet d'un enregistrement par le déclarant dans le cadre du règlement (CE) n° 1907/2006, « REACH », le n° REACH est également transmis.
- b) Présence éventuelle d'impuretés : nature et quantité, avec indication de la méthode de détermination utilisée.
- c) Taille des particules: taille moyenne des particules, associée à un écart-type, avec indication de la méthode de détermination utilisée.
- d) Distribution de tailles des particules: une courbe de distribution de tailles est fournie, avec indication de la méthode de détermination utilisée.
- e) Etat d'agrégation : taille moyenne des agrégats, avec indication de la méthode de détermination utilisée.
- f) Etat d'agglomération : si la substance est vendue sous forme agglomérée, le déclarant précise la taille des agglomérats, associée à un écart-type s'il est disponible, avec indication de la méthode de détermination utilisée.
- g) Forme : nombre de dimensions inférieures à 100 nm et caractérisation qualitative, avec indication de la méthode de détermination utilisée.
- h) Surface spécifique : surface spécifique moyenne, associée à un écart-type, avec indication de la méthode de détermination utilisée. Lorsque cette caractérisation n'est pas disponible, le déclarant le justifie ?
- i) Etat cristallin : nature des phases cristallographiques et, dans le cas d'un mélange de phases, proportion de chacune des phases.
- j) Chimie de surface : le cas échéant, indication qualitative sur le revêtement éventuel (*coating*).
- k) Charge de surface : potentiel zêta, si cette information est disponible.
- l) Le cas échéant, matrice dans laquelle la substance à l'état nanoparticulaire est contenue ou stabilisée.
- m) Nom commercial du mélange ou du matériau, le cas échéant.

RÉPUBLIQUE FRANÇAISE
Ministère de l'écologie, du
développement durable, des transports
et du logement

Version 30 nov. 2011
3/4

Arrêté du []
relatif au contenu et aux conditions de présentation de la déclaration annuelle des
substances à l'état nanoparticulaire, pris en application des articles R. 523-12 et R. 523-13
du code de l'environnement

NOR : [...]

La ministre de l'écologie, du développement durable, des transports et du logement, le ministre de l'économie, des finances et de l'industrie, le ministre de l'emploi, de la santé et le ministre de l'agriculture, de l'alimentation, de la pêche, de la ruralité et de l'aménagement du territoire,

France

- 8 Parameters (OCDE)**
 - i) Agglomeration State/Aggregation**
 - ii) Composition**
 - iii) Particle Size/Distribution**
 - iv) Shape (including length to diameter ratio for nanofibers and nanotubes)**
 - v) Solubility /Dispersibility**
 - vi) Surface Area**
 - vii) Surface Chemistry**
 - viii) Surface Charge Density**

Industrial application of nanomaterials - chances and risks

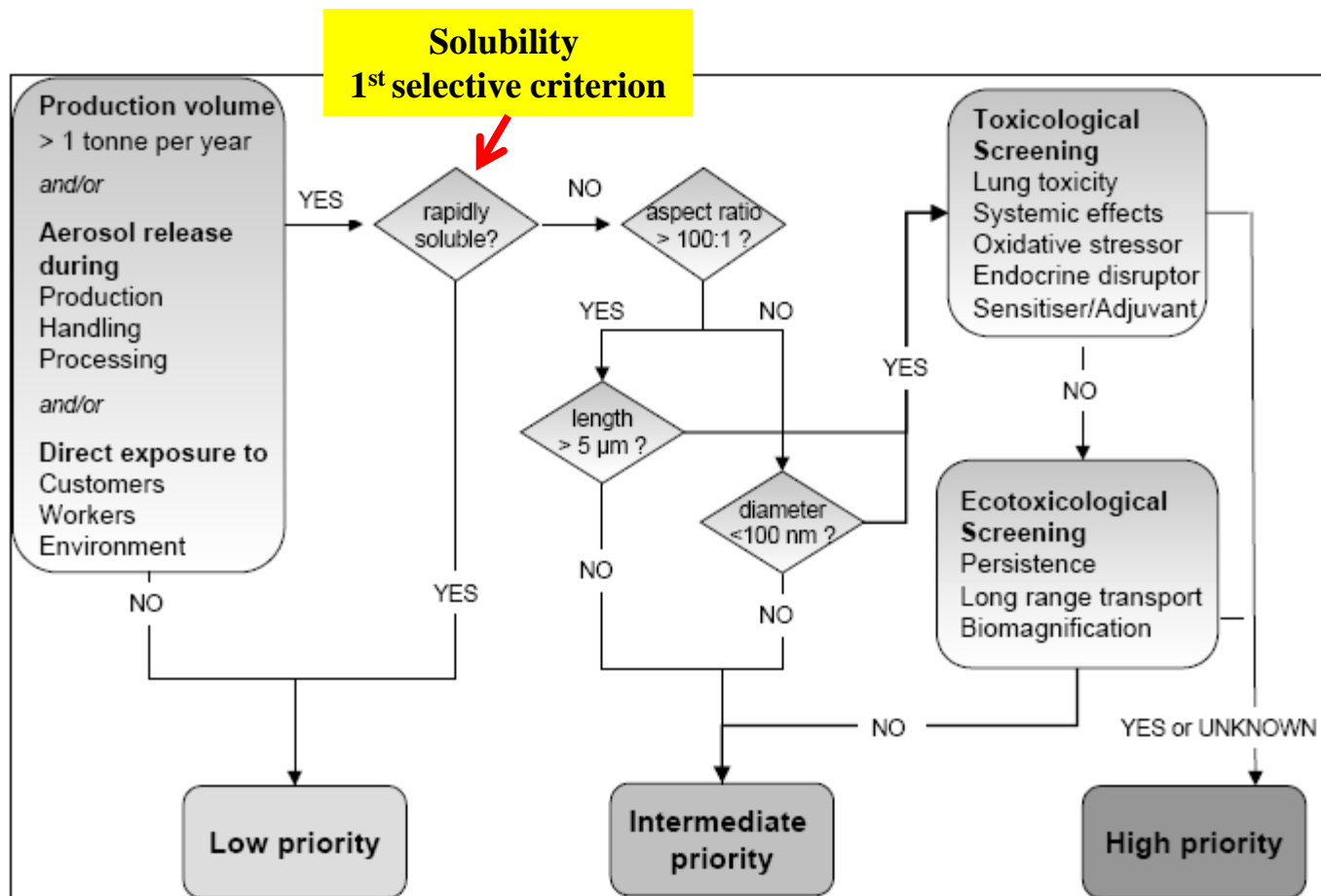


Figure 37: Scheme for a preliminary risk assessment of nanoparticulate materials (source: VDI-TZ, modified form Howard and de Jong 2004)

II – Identité de la substance à l'état nanoparticulaire. Elle est décrite au moyen de l'ensemble des éléments suivants :

- a) Identification chimique de la substance : la substance est identifiée au moyen de son nom, sa formule chimique ou son numéro d'identification (CIN, INECS ou ELINCS).
- b) Présence de substances dangereuses : nature et quantité, avec indication de la méthode de détermination utilisée.
- c) Taille des particules: taille moyenne des particules, associée à un écart-type, avec indication de la méthode de détermination utilisée.
- d) Distribution de tailles des particules: une courbe de distribution de tailles est fournie, avec indication de la méthode de détermination utilisée.
- e) Etat d'aggrégation : taille moyenne des agrégats, avec indication de la méthode de détermination utilisée.
- f) Etat d'agglomération : si la substance est vendue sous forme agglomérée, le déclarant précise la taille des agglomérats, associée à un écart-type s'il est disponible, avec indication de la méthode de détermination utilisée.
- g) Forme : nombre de dimensions inférieures à 100 nm et caractérisation qualitative, avec indication de la méthode de détermination utilisée.
- h) Surface spécifique : surface spécifique moyenne, associée à un écart-type, avec indication de la méthode de détermination utilisée. Lorsque cette caractérisation n'est pas disponible, le déclarant le justifie.
- i) Etat cristallin : nature des phases cristallographiques et, dans le cas d'un mélange de phases, proportion de chacune des phases.
- j) Chimie de surface : le cas échéant, indication qualitative sur le revêtement éventuel (*coating*).
- k) Charge de surface : potentiel zêta, si cette information est disponible.
- l) Le cas échéant, matrice dans laquelle la substance à l'état nanoparticulaire est contenue ou stabilisée.
- m) Nom commercial du mélange ou du matériau, le cas échéant.

(Carte d') Identité de la nanoparticule
Origine des Paramètres ?

RÉPUBLIQUE FRANÇAISE

Ministère de l'écologie, du développement durable, des transports et du logement

Version 30 nov. 2011

3/4

Arrêté du []

relatif au contenu et aux conditions de présentation de la déclaration annuelle des substances à l'état nanoparticulaire, pris en application des articles R. 523-12 et R. 523-13 du code de l'environnement

NOR : [...]

La ministre de l'écologie, du développement durable, des transports et du logement, le ministre de l'économie, des finances et de l'industrie, le ministre de l'emploi, de la santé et le ministre de l'agriculture, de l'alimentation, de la pêche, de la ruralité et de l'aménagement du territoire,

France

- 8 Parameters (OCDE)**
- i) Agglomeration**
 - State/Aggregation**
 - ii) Composition**
 - iii) Particle Size/Distribution**
 - iv) Shape (including length to diameter ratio for nanofibers and nanotubes)**
 - v) Solubility /Dispersibility**
 - vi) Surface Area**
 - vii) Surface Chemistry**
 - viii) Surface Charge Density**

II – Identité de la substance à l'état nanoparticulaire. Elle est décrite au moyen de l'ensemble des éléments suivants :

- a) Identification chimique de la substance : la substance est identifiée au moyen de son nom, sa formule chimique, son numéro CAS, son numéro EINECS ou ELINCS). **(Carte d') Identité de la nanoparticule** dans le cadre du règlement (CE) n° 1907/2006, « REACH », le n° REACH est également transmis.
- b) Présence éventuelle d'impuretés : nature et quantité, avec indication de la méthode de détermination utilisée.
- c) Taille des particules: taille moyenne des particules, associée à un écart-type, avec indication de la méthode de détermination utilisée.
- d) Distribution de tailles des particules: une courbe de distribution de tailles est fournie, avec indication de la méthode de détermination utilisée.
- e) Etat d'agrégation : taille moyenne des agrégats, avec indication de la méthode de détermination utilisée.

f) **Paramètres = Fct (Interaction avec Environnement= Paramètres non intrinsèques !!**
g)
h)

- de la méthode de détermination utilisée. Lorsque cette caractérisation n'est pas disponible, le déclarant le justifie.
- i) Etat cristallin : nature des phases cristallographiques et, dans le cas d'un mélange de phases, proportion de chacune des phases.
 - j) Chimie de surface : le cas échéant, indication qualitative sur le revêtement éventuel (*coating*).
 - k) Charge de surface : potentiel zêta, si cette information est disponible.
 - l) Le cas échéant, matrice dans laquelle la substance à l'état nanoparticulaire est contenue ou stabilisée.
 - m) Nom commercial du mélange ou du matériau, le cas échéant.

RÉPUBLIQUE FRANÇAISE

Ministère de l'écologie, du développement durable, des transports et du logement

Arrêté du []

relatif au contenu et aux conditions de présentation de la déclaration annuelle des substances à l'état nanoparticulaire, pris en application des articles R. 523-12 et R. 523-13 du code de l'environnement

NOR : [...]

La ministre de l'écologie, du développement durable, des transports et du logement, le ministre de l'économie, des finances et de l'industrie, le ministre de l'emploi, du travail et de la santé et le ministre de l'agriculture, de l'alimentation, de la pêche, de la ruralité et de l'aménagement du territoire,

Version 30 nov. 2011

3/4

France

8 Parameters (ISO)

i) Agglomeration State/Aggregation

ii) Composition

iii) Particle Size/Distribution

iv) Shape

(including length to diameter ratio for nanofibers and naotubes)

v) Solubility /Dispersibility

vi) Surface Area

vii) Surface Chemistry

viii) Surface Charge Density

Proteins Corona !!



Eric.Gaffet@univ-lorraine.fr

NanoMatériaux & Développement Responsable
Concilier Recherche, Innovation, Sécurité Sanitaire

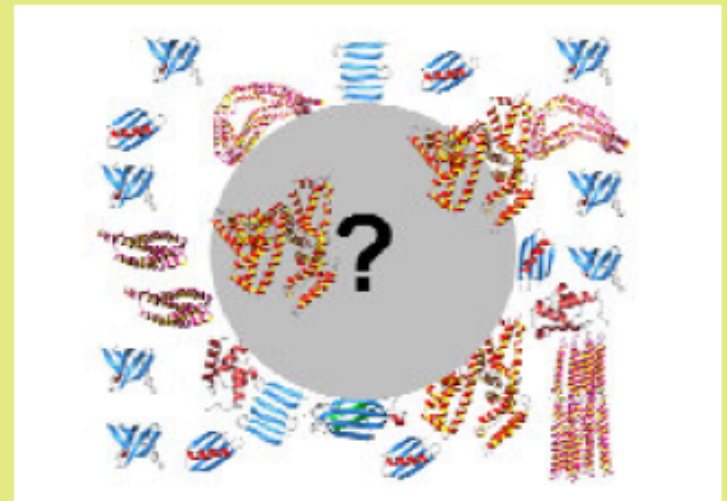
Nanoparticles do not exist as single particle entity, they adsorb things, e.g. proteins

What do we know

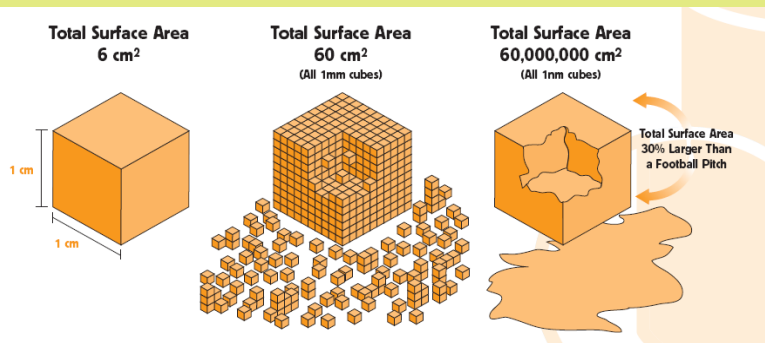
- Protein corona is important for biological interactions and cellular recognition
- Corona is not static, proteins get on and off

What do we not know

- Dependence on nanomaterial?
- Dependence on size?
- Dependence on ...?



Implications for interpretation of testing



EU FP6 project NanoInteract,

courtesy of Prof Kenneth Dawson, UCD, Dublin, Ireland

How is a nanoparticle/nanomaterial defined?

What do we mean by size?

Particle type	Nominal	TEM*	AFM*	FCS^	NTA*	DLS'	FIFFF^
TiO ₂ & FA 1mg/L	5	16.1 +/-6.4	3.7 +/-2.1	6.5 +/-2.8	164 +/-32 (30mg/L)	1230 +/-430 (30mg/L)	3.7 (100mg/L)
ZnO & FA 1mg/L	20	12.2 +/-4.5	25.7 +/-8.5	28.5 +/-10.5	130 +/-50 (100mg/L)	870 +/-680 (30mg/L)	228.3 (100mg/L)
QDs 1.92 ug/L	6-10	6.5 +/-1.9	5.9 +/-3.4	81.8 +/-4.9	213 +/-17	234 +/-35	41.5

*number average ^weight average 'z average

NO APPROVED UNIVERSAL CHARACTERIZATION METHODS

Domingos et al. 2009

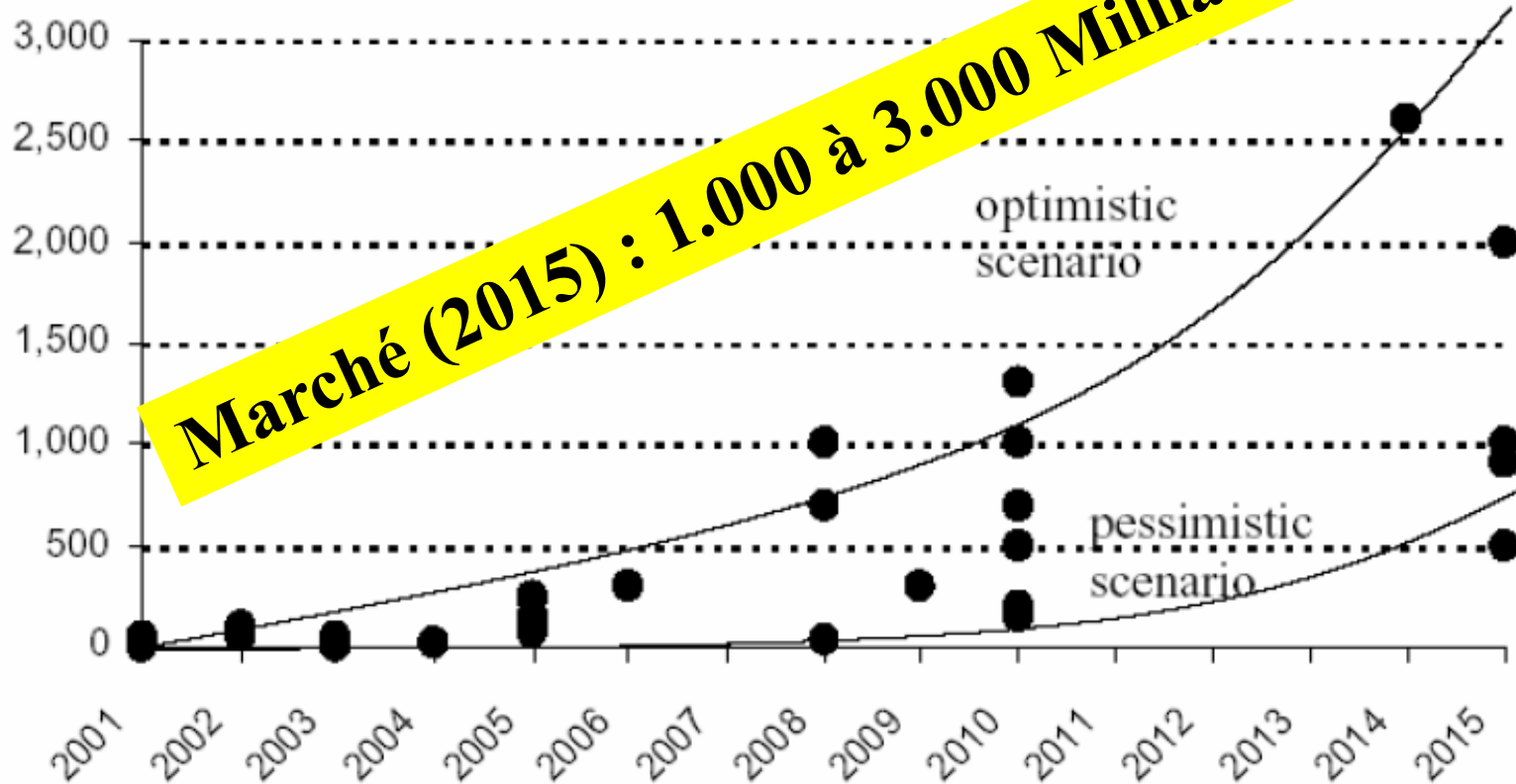
Understanding and correlation of size measurement techniques is essential

TEM, transmission electron microscopy; AFM, atomic force microscopy; DLS, dynamic light scattering; FCS, fluorescence correlation spectroscopy; NTA, nanoparticle tracking analysis; FIFFF, flow field flow fractionation



Why Nano?

Significant Growth



Compiled by Hullman (2006), based on data from German Government, Evolution Capital, NSF, Sal. Oppenheim, DG Bank, DTI, US Nanobusiness Alliance, Cientifica, In Realis, Mitsubishi Research Institute, Deutsche Bank, Nomura Research Institute, BCC, GEMZ corp., Helmut Kaiser Consultancy, and Lux Research

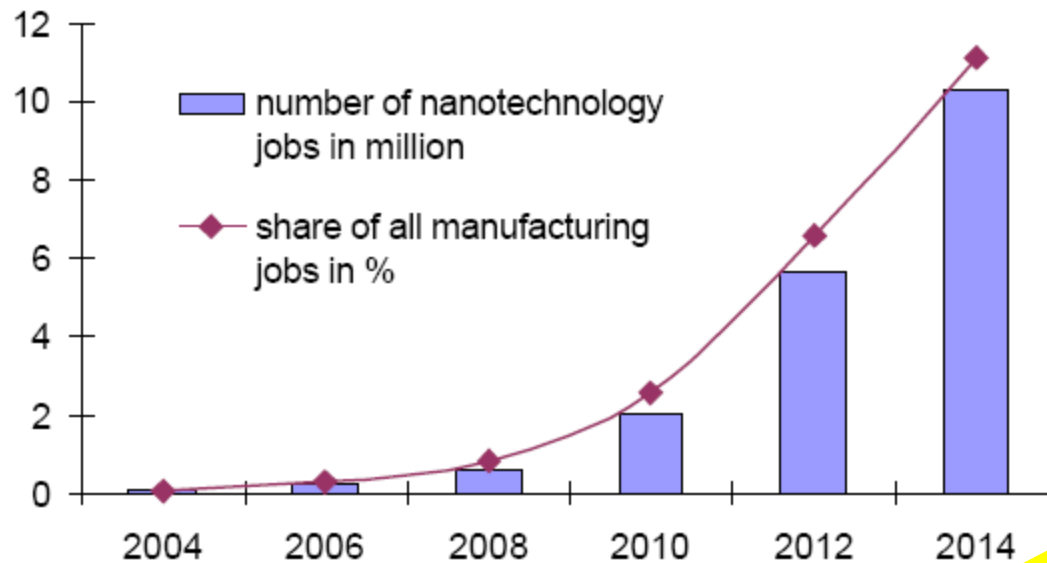


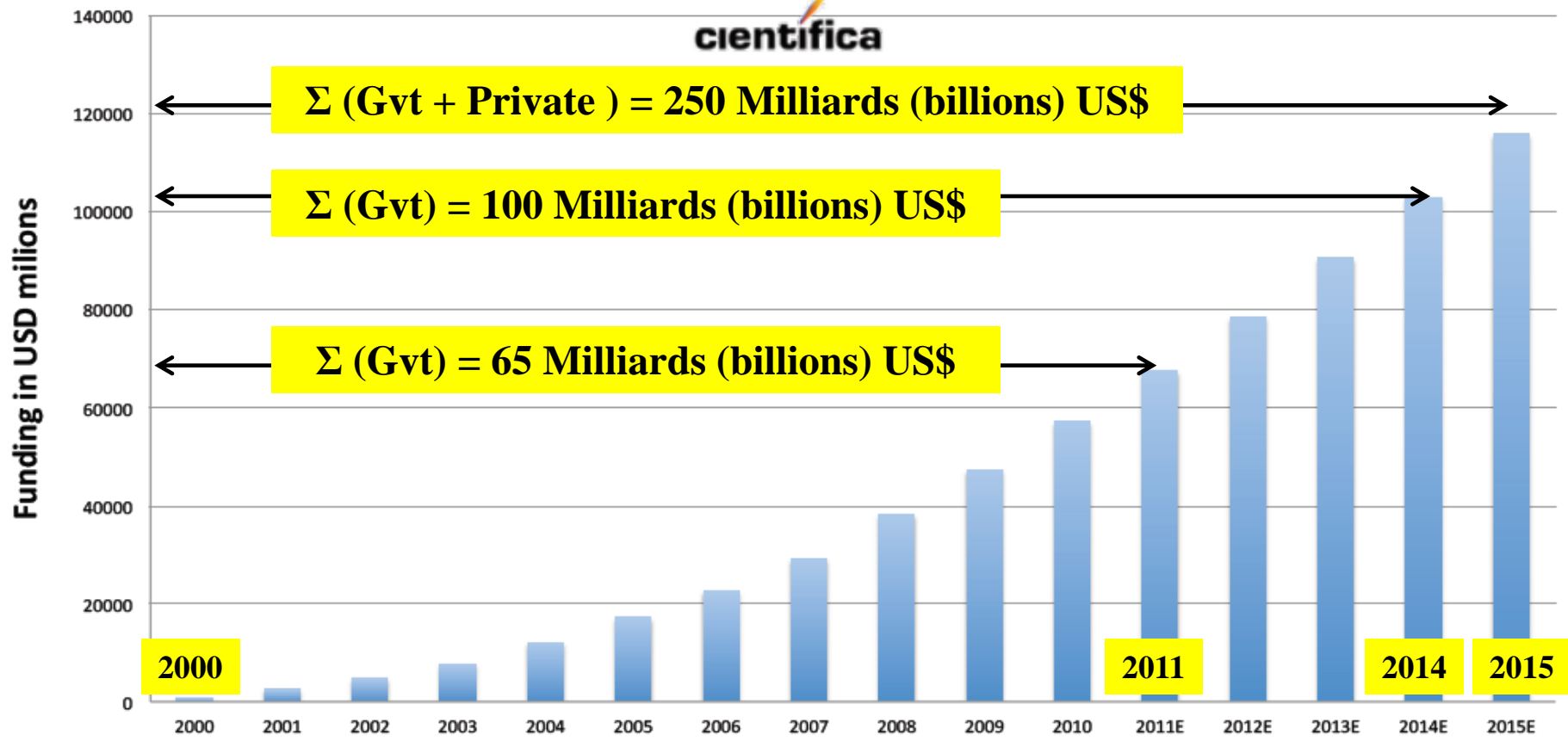
Figure 9: Number of nanotechnology jobs in million and the share of all manufacturing jobs in percent. Source: Lux Research

2015 : > 10 % Main d'œuvre Secteurs Industriels

Many of these jobs will be created in SMEs, but not only in the past few years, many already well established companies expanded their technology portfolio to nanotechnology in order to maintain their competitiveness. It remains why companies were identified as being nanotech oriented that sometimes they existed 100 years ago or even longer. Typical examples are big companies in the chemical and pharmaceutical industry, optics and electronics (Bayer, BASF, Agfa-Gevaert, General Electrics, Philips, all created before 1900), though established companies form a minority in the list of all existing nanotech companies.

Total Global Nanotechnology Funding

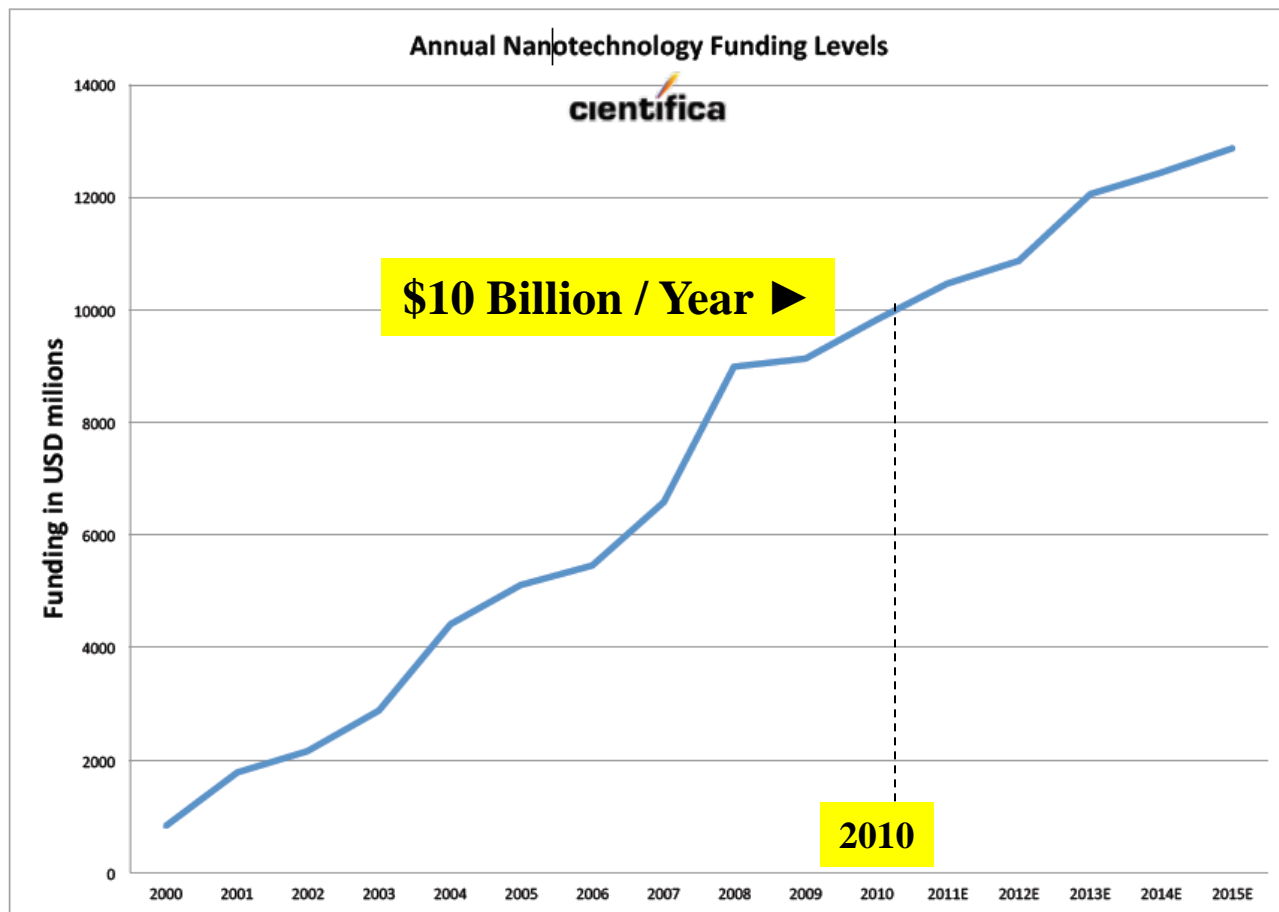
cientifica



By the end of 2011 the total government funding for nanotechnology research worldwide will be \$65 billion, rising to \$100 billion by 2014. When figures for corporate research and various other forms of private funding are taken into account, which were thought to have surpassed government funding figures as far back as 2004, we estimate that nearly

a quarter of a trillion dollars will have been invested into nanotechnology by 2015.

Annual Global Nanotechnology Research Funding Is Running at \$10 Billion / Year



Since the US National Nanotechnology Initiative was announced in 2000 almost every developed and developing economy has initiated national nanotechnology programs. **The world's governments currently spend \$10 billion per year on nanotechnology research and development, with that figure set to grow by 20% over the next three years**

i) Définitions, Markets, **Properties**, Applications

Définitions, Prospectives, Propriétés, Applications



ii) Real Risks, Perceptual Risks, Regulations

Risques réels, perçus, réglementation

iii) NP Hazard (Eco/Toxicity)

Nanotoxicité

iv) Benefits / Risks analyses

EU SCCP

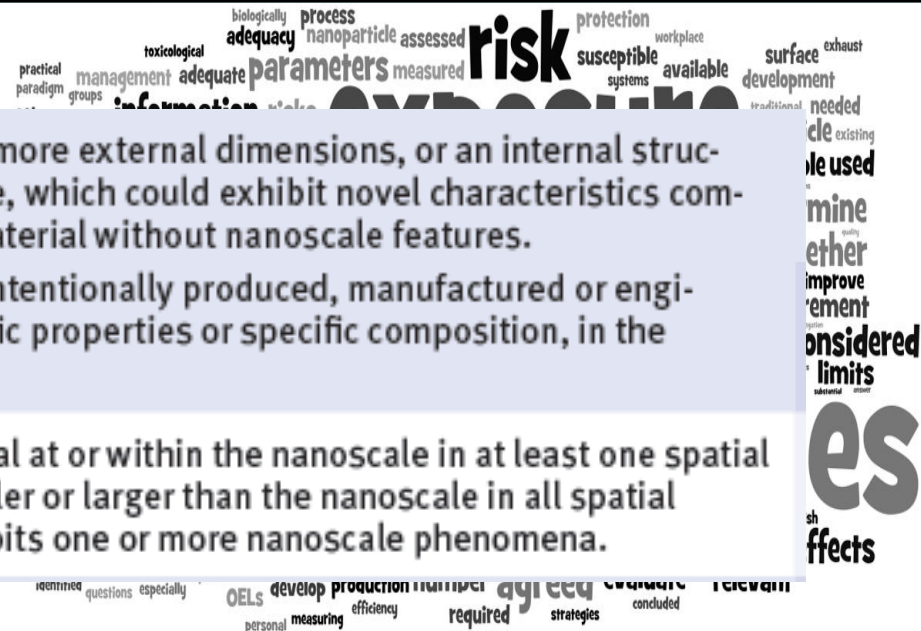
Material with one or more external dimensions, or an internal structure, in the nanoscale, which could exhibit novel characteristics compared to the same material without nanoscale features.

Australia (NICNAS)

Industrial materials intentionally produced, manufactured or engineered to have specific properties or specific composition, in the nanoscale.

Canada

Manufactured material at or within the nanoscale in at least one spatial dimension, or is smaller or larger than the nanoscale in all spatial dimensions and exhibits one or more nanoscale phenomena.

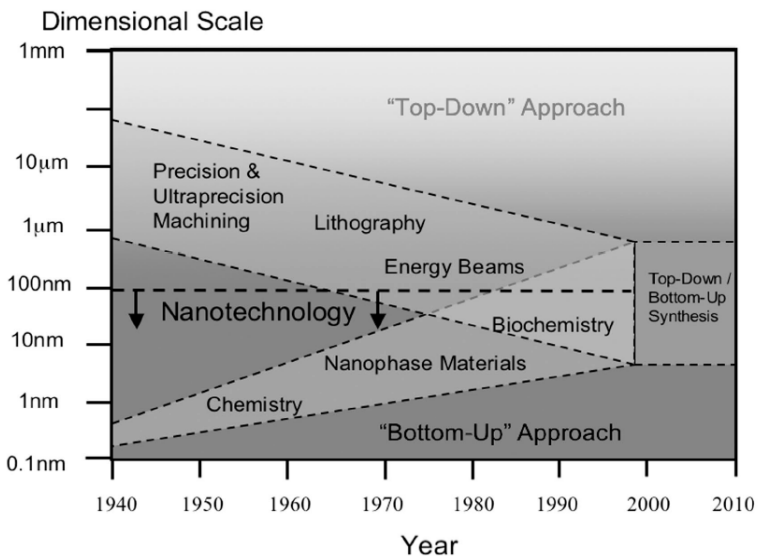
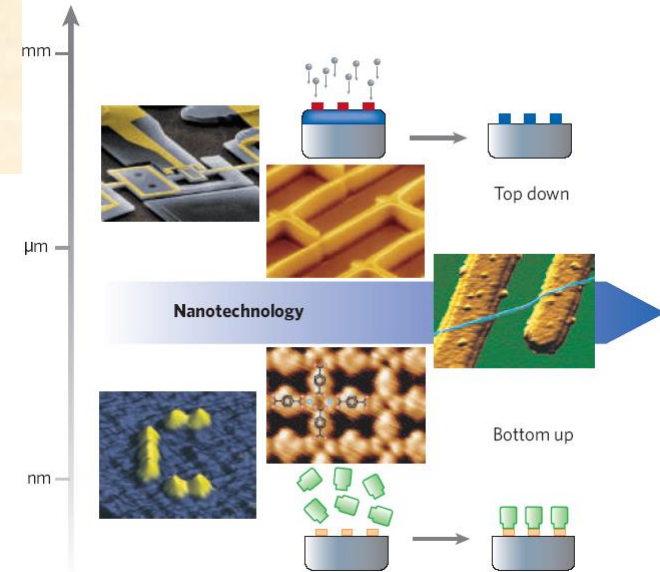
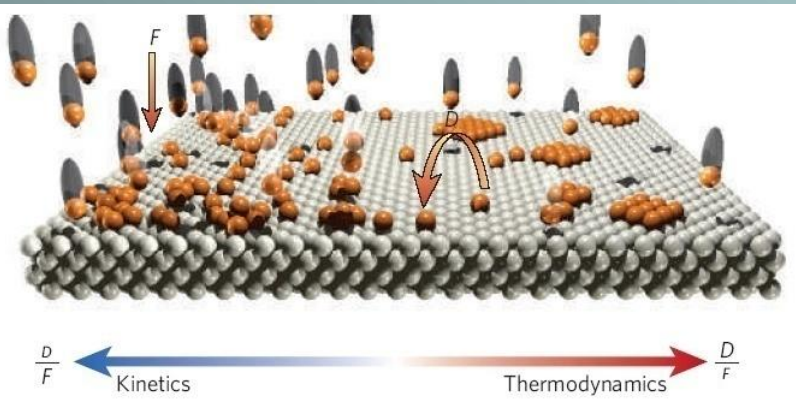


NanoParticules Manufacturées

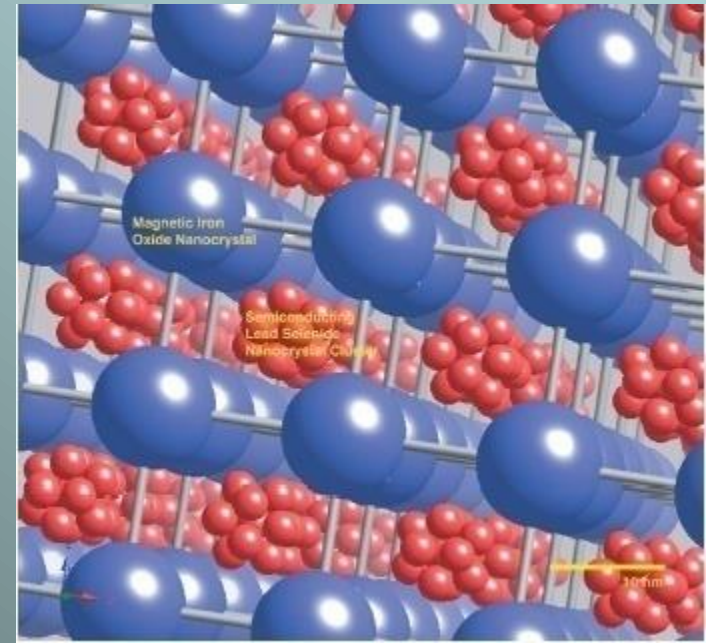
Manufactured NanoMaterials

2 Méthodes : Descendante / Ascendante

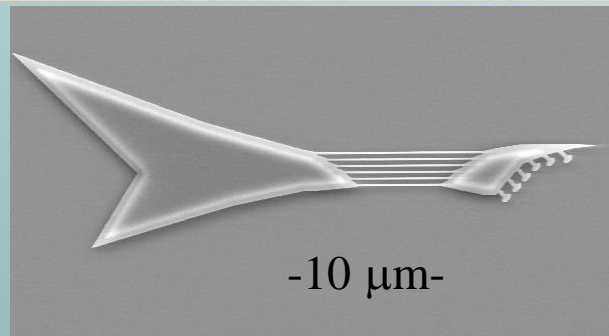
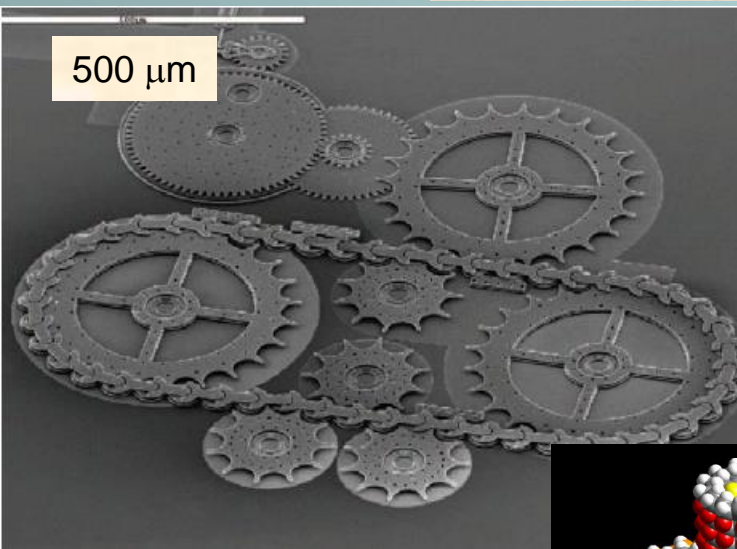
2 Main Approaches : Top Down / Bottom Up



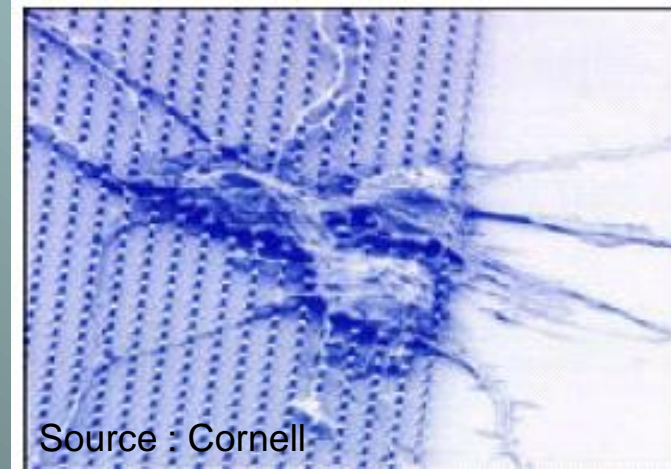
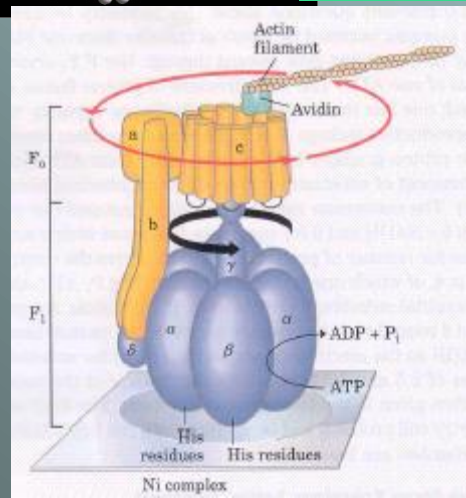
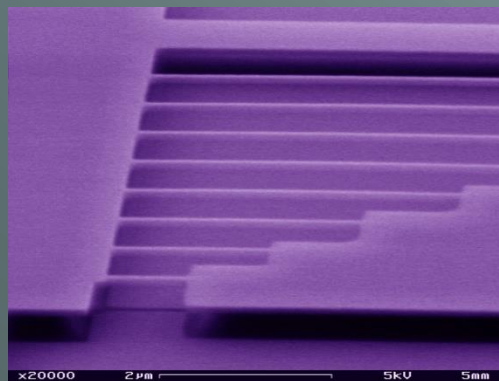
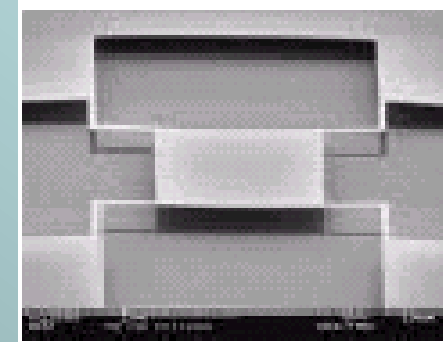
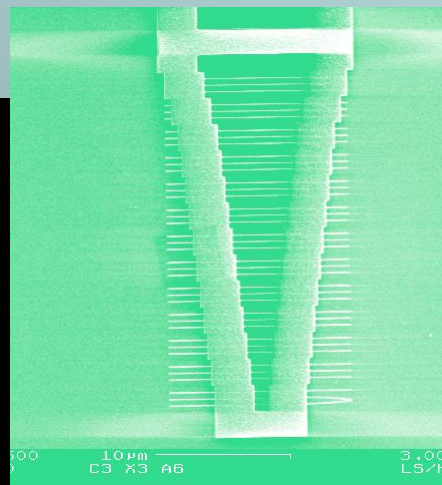
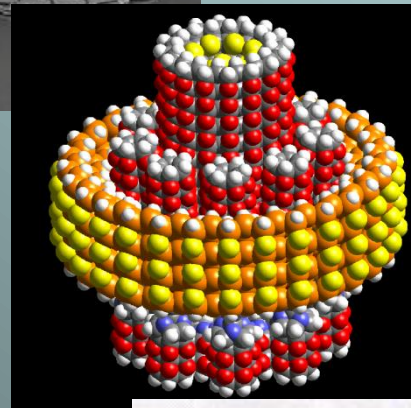
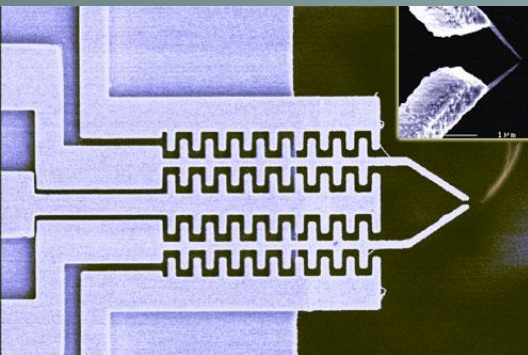
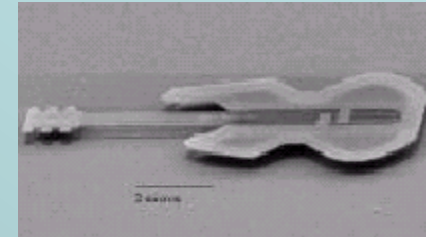
Métasynthèse



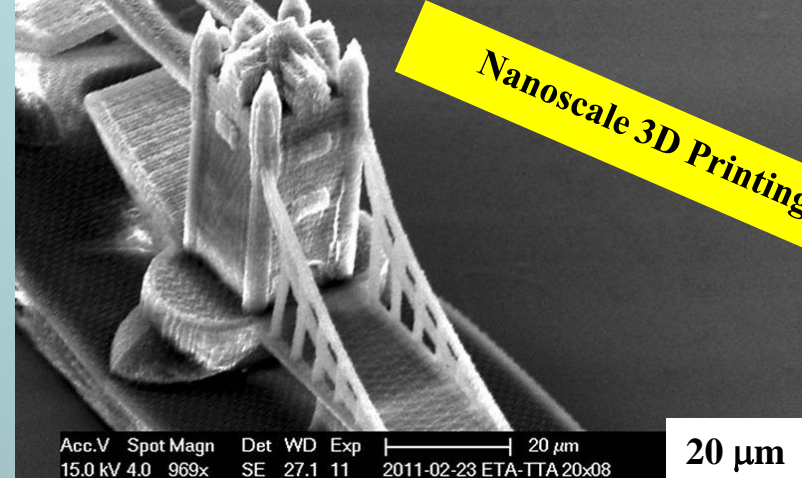
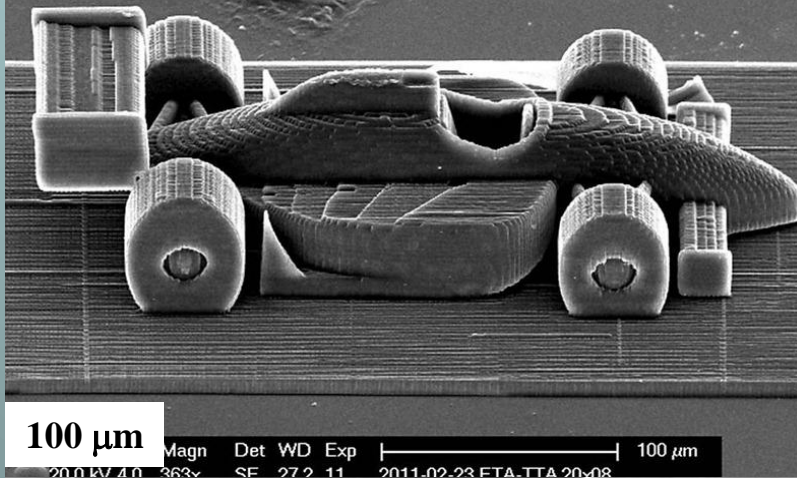
NanoDevices - NanoMachines



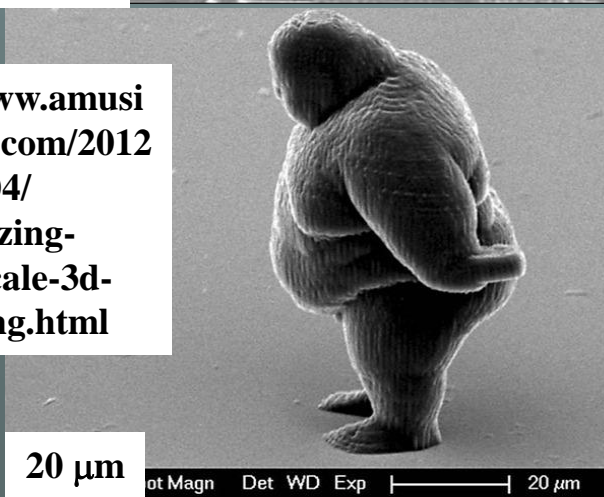
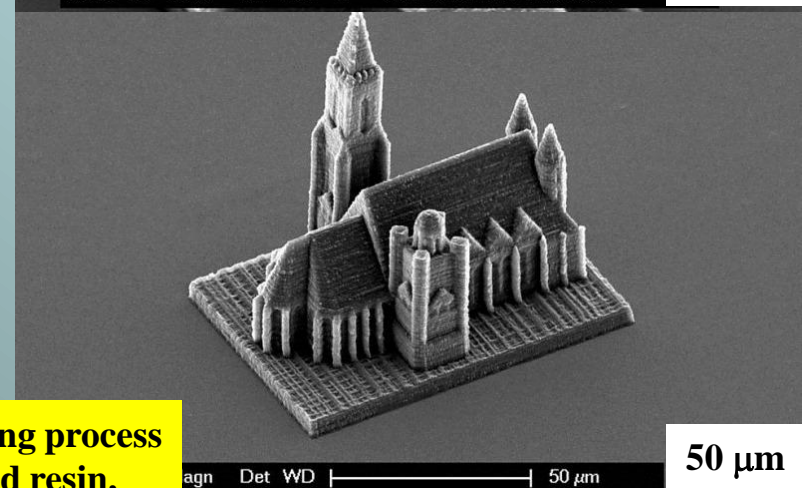
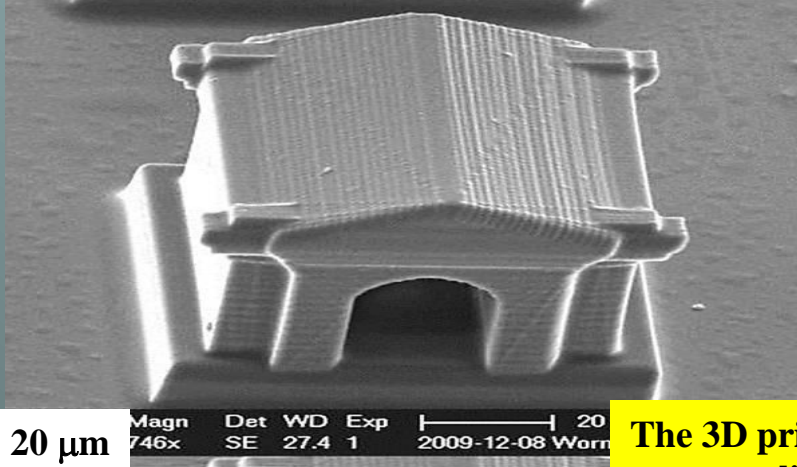
8 octaves / LASER
> seuil audition humaine



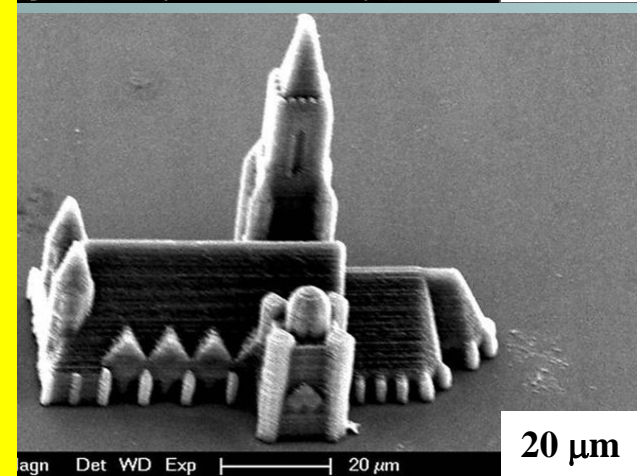
Source : Cornell



Nanoscale 3D Printing



The 3D printing process uses a liquid resin, which is hardened at precisely the correct spots by a focused laser beam. 4 minutes it can print 100 layers consisting of 200 lines per layer. That translates into five meters of polymer printed in one second



<http://www.amusingplanet.com/2012/04/amazing-nanoscale-3d-printing.html>

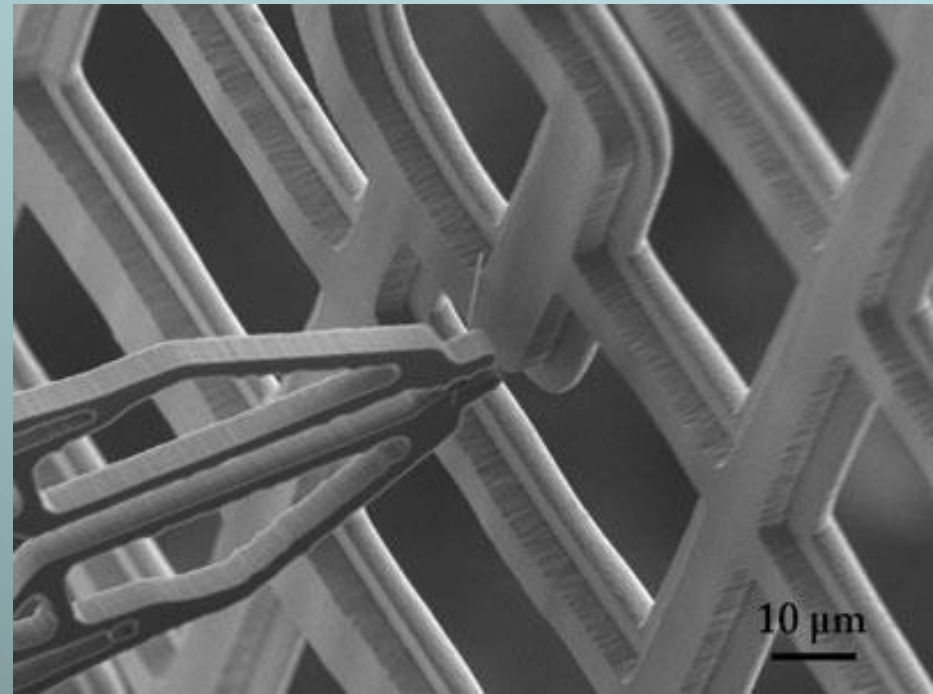
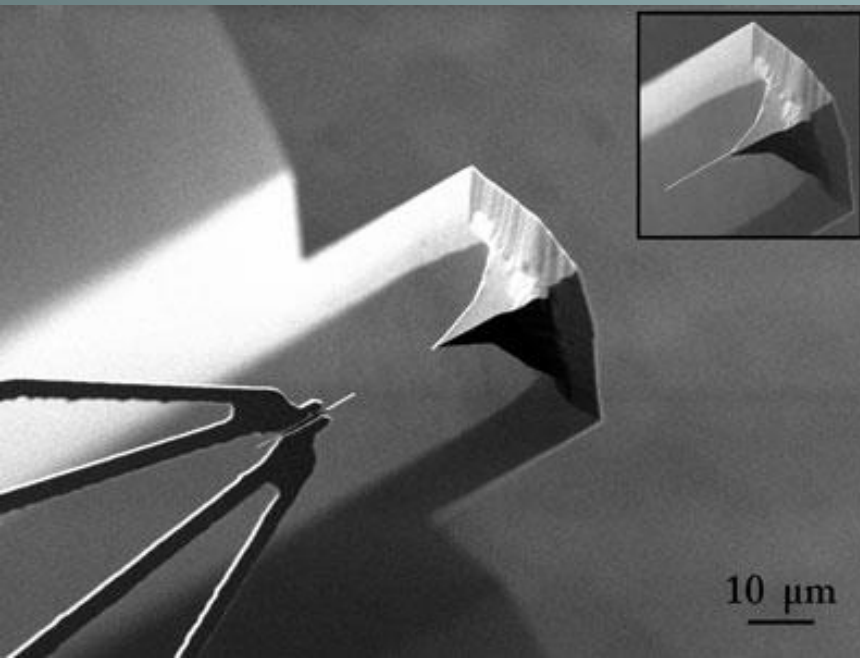
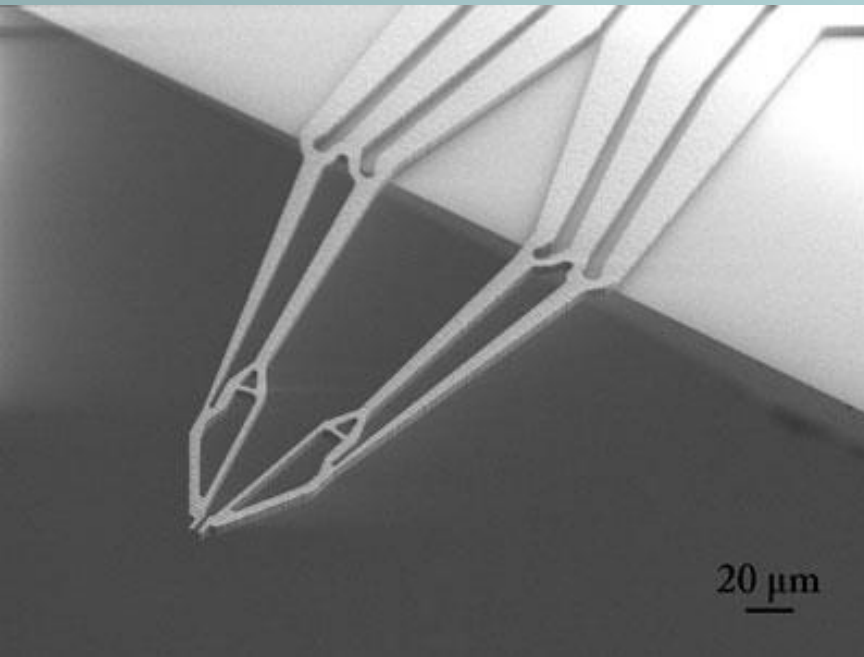


L'entreprise hi-teck Micreon, basée à Hanovre en Allemagne, a réalisé ces nanolunettes taillées au laser avec une précision d'un millième de millimètre

<http://blog.mendes-france.com/2006/04/05/nano-art-national-geographic-photographie-la-mouche-la-plus-classe-du-monde/>

NanoHand

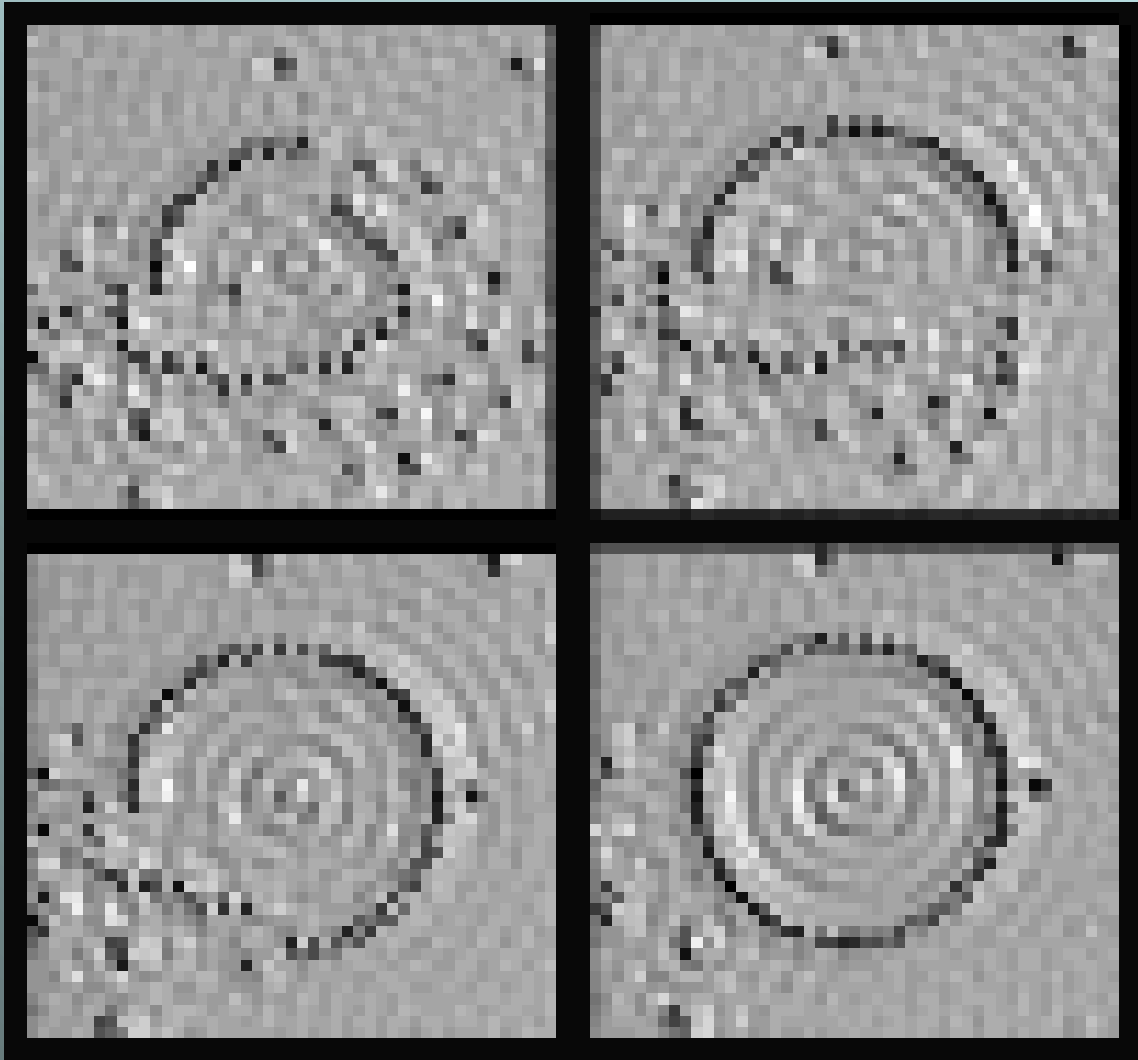
These 'nanogrippers' are not quite down to the level of atomic precision yet, but they're getting a lot closer.

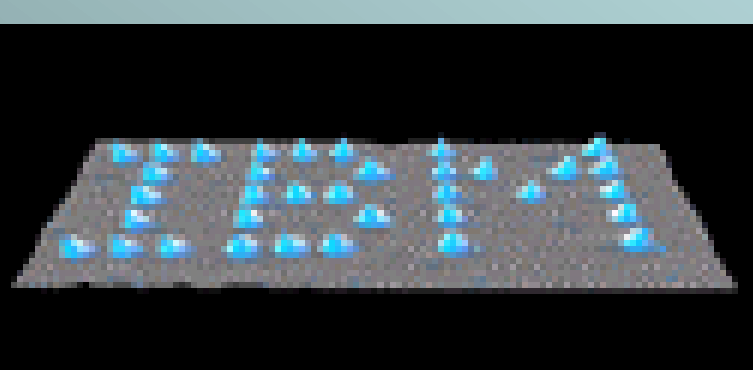


<http://crnano.typepad.com/crnblog/atom.xml> (Nov 2008)

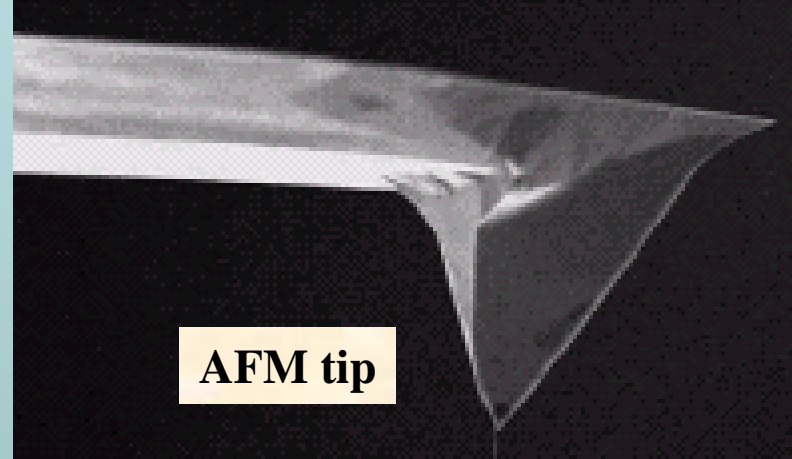
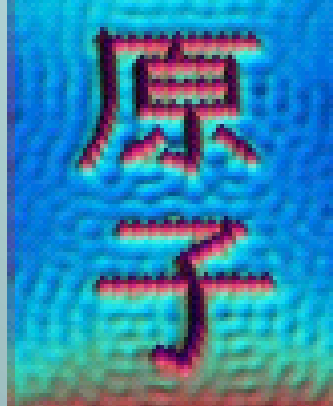
Reproducible assembly of CNT-enhanced AFM super-tips using topology-optimized microgrippers. (Image: Özlem Sardan, DTU)

<http://www.nanowerk.com/spotlight/spotid=8390.php>

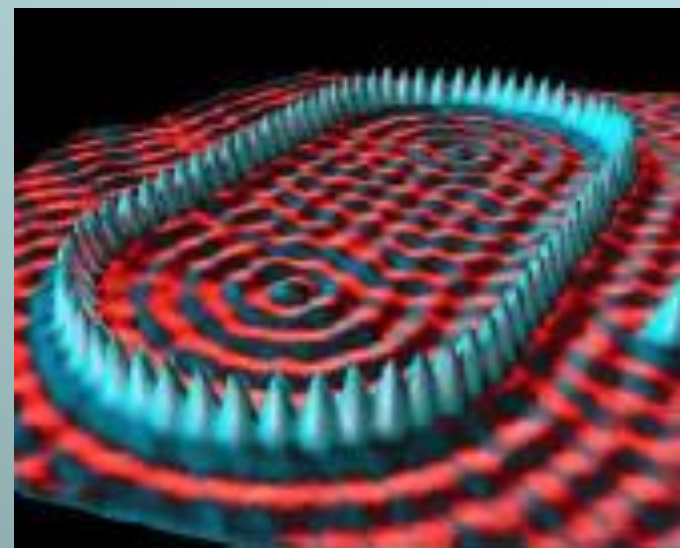
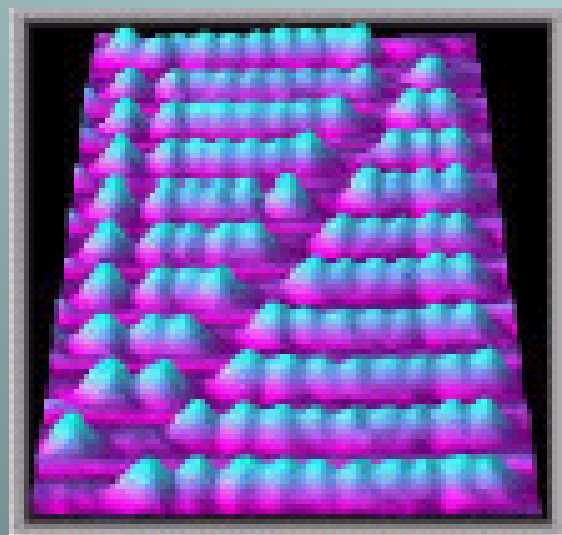
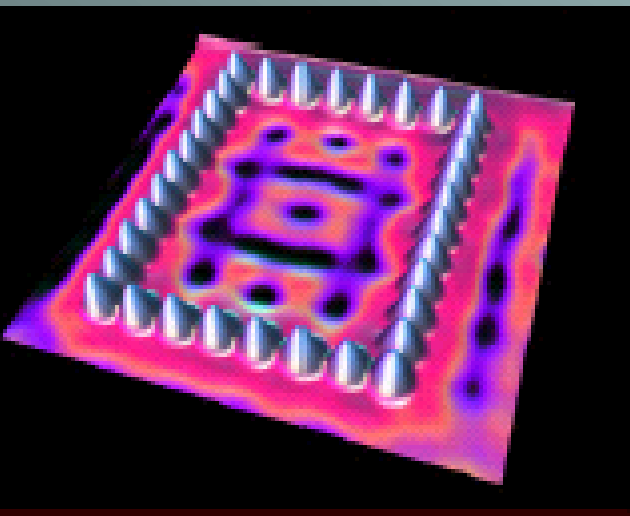




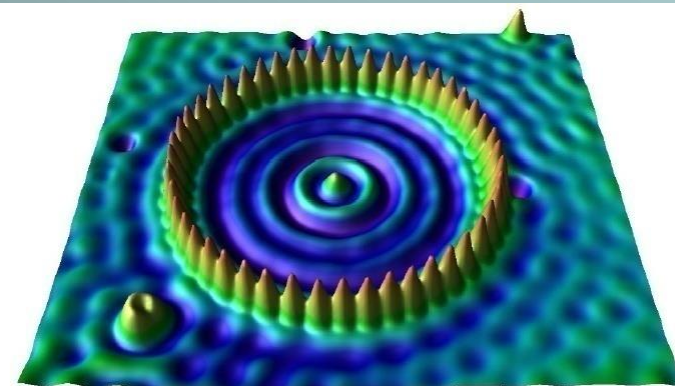
IBM logo spelled out with 35 atoms
of xenon (1989)



AFM tip



STM of a square Fe atom corral on a Cu substrate.
(Eigler & al. <http://www.almaden.ibm.com/vis/stm/corral.html>)



Grey Goo – Gelée Grise (E. Drexler – Engine of Creation 1986)
Assembleurs Moléculaires

Manipulation d'atomes individuels :

10^{-14} g de matière par an,

0.1 mg depuis la création de l'univers

A la conquête du NanoMonde – D. Luzeaux, T. Puig

Editions du Félin - 2007

Individual Atoms Handling

Monde vivant :

Taux d'erreur séquences de protéines : 1 pour mille

Suffisant pour la synthèse organique

Mais 6 à 9 ordres de grandeurs supérieurs pour des composants numériques

(dans une logique binaire !!)

A la conquête du NanoMonde – D. Luzeaux, T. Puig – Editions du Félin - 2007

Why the future doesn't need us – Bill Joy

4 Avril 2000 repris dans Nanoethics : The Ethical and Social Implications of Nanotechnology

Ed. John Wiley & Sons, Inc. – 2007

Genetics – Nanotechnology – Robotics

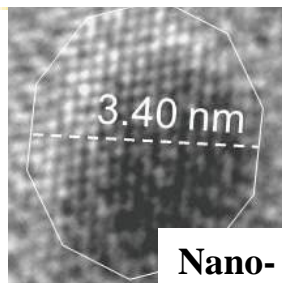
Self Replication : Even Peptides do it

A 32 amino – acid peptide can autocatalyze its own synthesis...

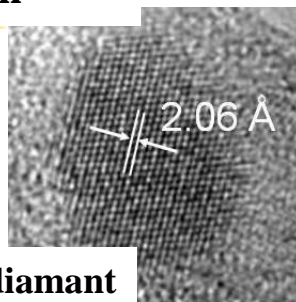
Stuart Kauffman, Nature (1996)

Mechanical Processing

**Mechanical Alloying
Consolidation
Sintering
Severe Plastic Deformation**



Nano- diamant



Physical Processing

**Pyrolyse laser
Laser Pyrolysis
Evaporation / Condensation
Thermal Plasma
Sol – Gel Techniques
Chemical Vapour**

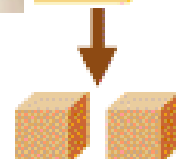
Chemical Processing

Approche « descendante » (top-down)



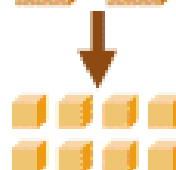
Matériau massif

(cm)



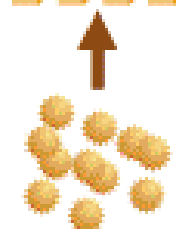
Poudre

(μm)

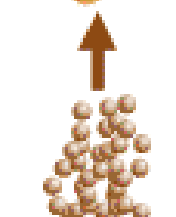


Nanoparticules

(nm)



Agrégats/amas



Atomes

(0.1 nm)

Approche « ascendante » (bottom-up)

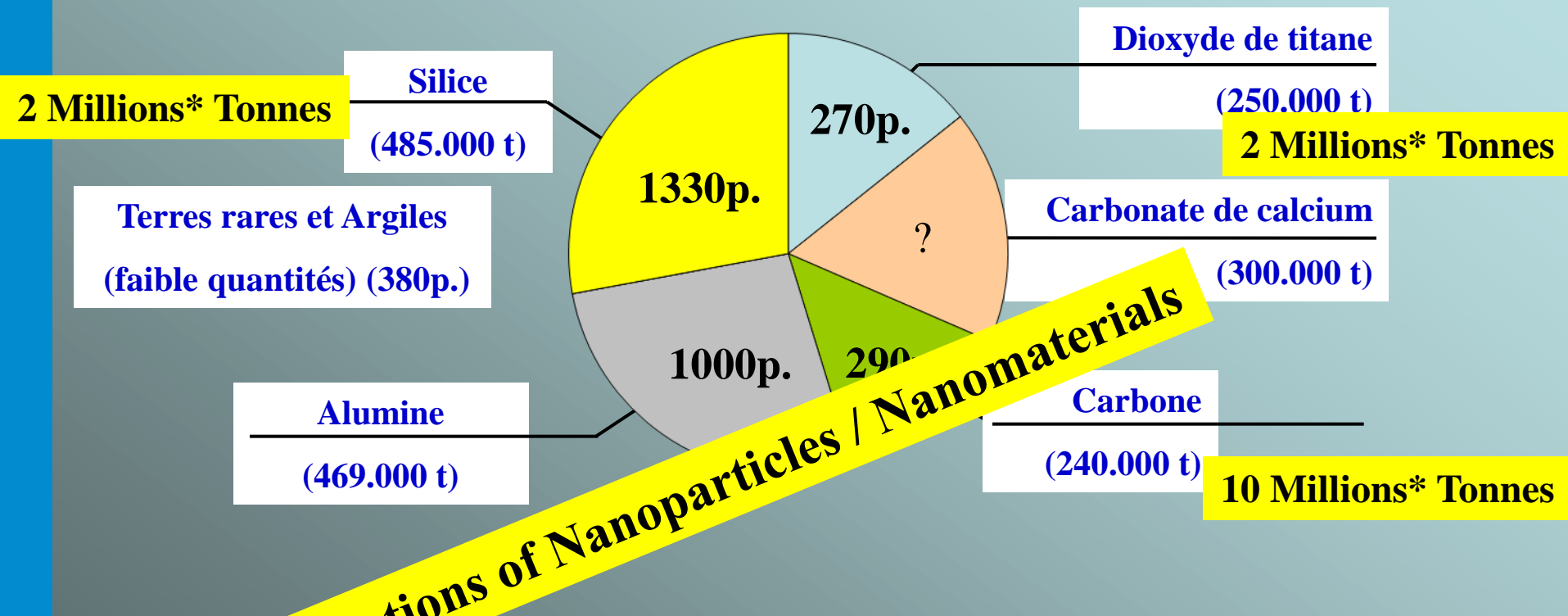
© CNRS / INRS

Nanomatériaux: Industries et Laboratoires en France

Rapport « Nanomatériaux et sécurité au travail » Afsset - 2008

afsset 

agence française de sécurité sanitaire de l'environnement et du travail



• Estimation du nombre de personnel potentiellement exposé dans les entreprises: 3.300
 Estimation du personnel potentiellement exposé dans les laboratoires: 7.000

* Worldwide Production

5.000 à 10.000 nanoparticules / cm³

Nanoparticles are abundant in the atmosphere, as they are produced in many natural processes, including photochemical reactions, volcanic eruptions, forest fires, and simple erosion, and by plants and animals, e.g. shed skin and hair. The public usually associate air pollution with human activities – cars, industry, and charcoal burning, but natural processes such as dust storms, volcanic eruptions and forest fires can produce such vast quantities of nanoparticulate matter that they profoundly affect air quality worldwide. The aerosols produced by human activities are estimated to be only about 10% of the total, the remaining 90% having a natural origin.

It has been estimated that the most significant components of total global atmospheric aerosols are, in decreasing mass abundance:

- i) mineral aerosols primarily from soil deflation (wind erosion) with a minor component (<1%) from volcanoes (**16.8 millions Tonnes**)
- ii) sea salt (**3.6 Millions Tonnes**),
- iii) natural and anthropogenic sulfates (**3.3 Millions Tonnes**),
- iv) products of biomass burning excluding soot (**1.8 Millions Tonnes**),
- v) industrial sources including soot (**1.4 Millions Tonnes**),
- vi) natural and anthropogenic nonmethane hydrocarbons (**1.3 Millions Tonnes**),
- vii) natural and anthropogenic nitrates (**0.6 Million Tonnes**),
- viii) biological debris (**0.5 Million Tonnes**)

Silice Précipitée

Product Information SIPERNAT® 500 LS

Characteristic physico-chemical data*)

Properties and Test Methods	Units	Value
-----------------------------	-------	-------

Properties and Test Methods	Units	Value
Specific surface area (N ₂) Areometer following ISO 5794-1, Annex D	m ² /g	450
Mean particle size Multisizer, 100 µm capillary following ASTM C 690-1992	µm	4.5 µm
Particle size, d50 Laser diffraction following ISO 13320-1	µm	

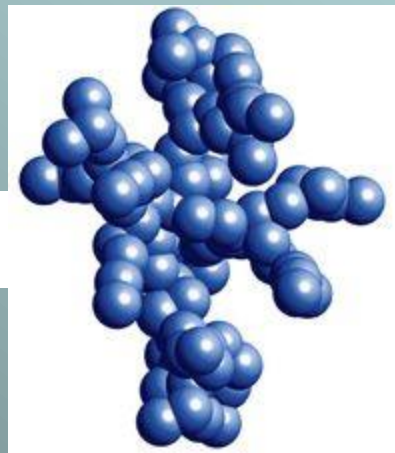
????

$\Phi < 4 \text{ nm}$

Yet Well characterized Primary & Aggregate Size at industrial level (at least for major productions)

4 nm

5 µm



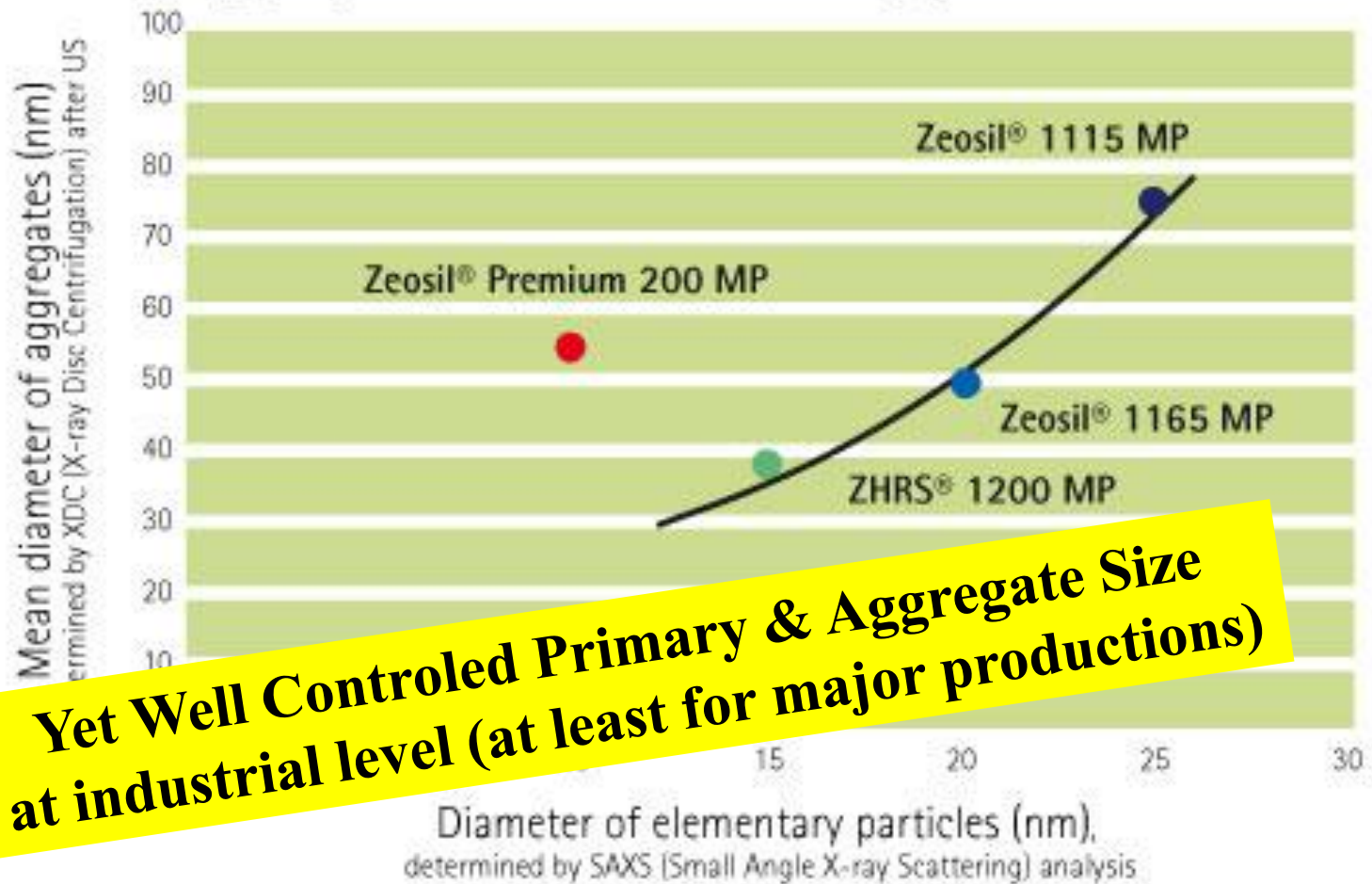
The computer model of an AEROSIL® aggregate clearly shows the remarkable structure of the fumed silicon dioxide particles

SIPERNAT® 500 LS

1) based on original substance
2) based on dry substance
3) based on ignited substance
*) The given data are typical values.

PICCS (Philippines)
DSL (Canada)
IECS (China)

Aggregate size vs. elementary particle diameter



**Yet Well Controlled Primary & Aggregate Size
at industrial level (at least for major productions)**

Cutting edge silica technology with unique performance

Zeosil® Premium is the first generation of high surface silicas which combines easy dispersibility, excellent reinforcement and low hysteretic properties.

Zeosil® Premium offers unique performance, resulting from a new compromise between silica aggregate and elementary particle size (Specific Surface Area).

iv) Benefits / Risks analyses



NanoMaterials

« Historics »

The first Nanotechnologists

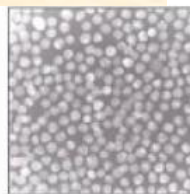
Ancient stained-glass makers knew that by putting varying, tiny amounts of gold and silver in the glass, they could produce the red and yellow found in stained-glass windows. Similarly, today's scientists and engineers have found that it takes only small amounts of a nanoparticle, precisely placed, to change a material's physical properties.

Gold in glass

25 nm
Sphere

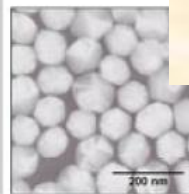


100 nanometers =
0.0001 millimeter



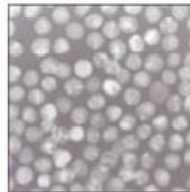
Silver in glass

100 nm
Sphere

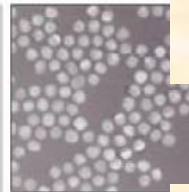


Had medieval artists been able to control the size and shape of the nanoparticles, they would have been able to use the two metals to produce other colors. Examples:

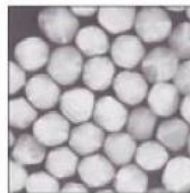
50 nm
Sphere



40 nm
Sphere



100 nm
Sphere



100 nm
Prism



Source: Dr. Chad A. Mirkin, Institute of Nanotechnology, Northwestern University

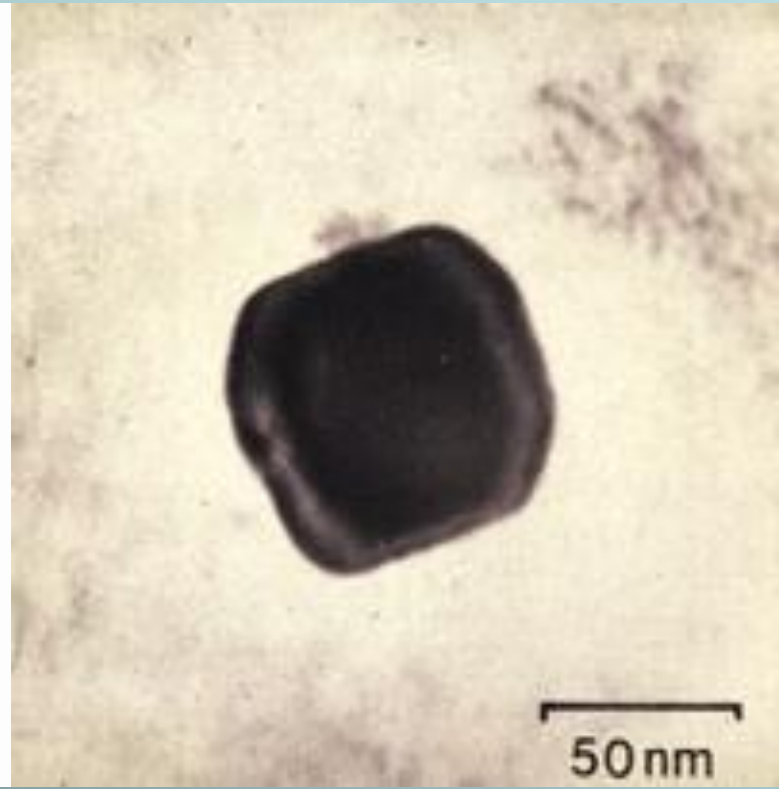
*Approximate

Source : D.H. Marcero
AF&PA Committee week
May 2006



Lycurgus Cup

Example of Ancient Gold Nanoparticles



“Nano before Nano was cool!”

Particle size between 4 and 20 millimicron

- Manufacturer of a Variety of High Surface Area Materials:
 - Silica, alumina, titania, zirconia, ceria, and “hydrophobic” grades
 - Used in rubber, paint, and reinforcement
- The Oxford English Dictionary entry for “Nano” is 1947 after commercialization of AEROSIL®

nano – Silice
Depuis Avril 1949 par Degussa (Evonik en 2008)



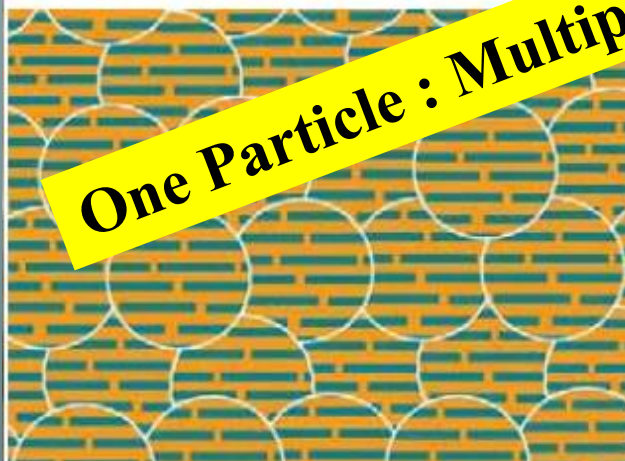
“Farbe & Lacke” April 1949

The SNWG provided the SAP meeting with a detailed historical and technical analysis that demonstrated that these materials have a long established commercial history as engineered particles of nanoscale size.¹ Despite changes in terminology, the underlying material being described is in fact the same that has been used for decades. i.e. nanoscale silver.

A careful examination of the EPA public registration database for silver over a period of 6 decades reveals:

- **The very first registered silver product was a colloidal nanosilver algacide product that has been safely used by millions of consumers for over 50 years (registered since 1954).**
- Every EPA silver registration between 1970 and 1990 was either a colloidal nanosilver or nanosilver-composite product.
- The very first **NON-nanosilver product registered by EPA was not registered until 1994.**
- An overall analysis reveals that today **over 50% of all EPA registered silver products** are in fact based on **nanoscale silver.**

Figure 1. Schéma d'un film de Laponite



One Particle : Multiple uses on market

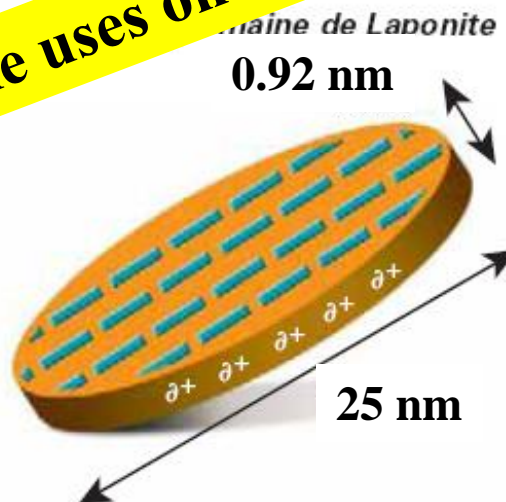


Figure 1. Diagramme de production

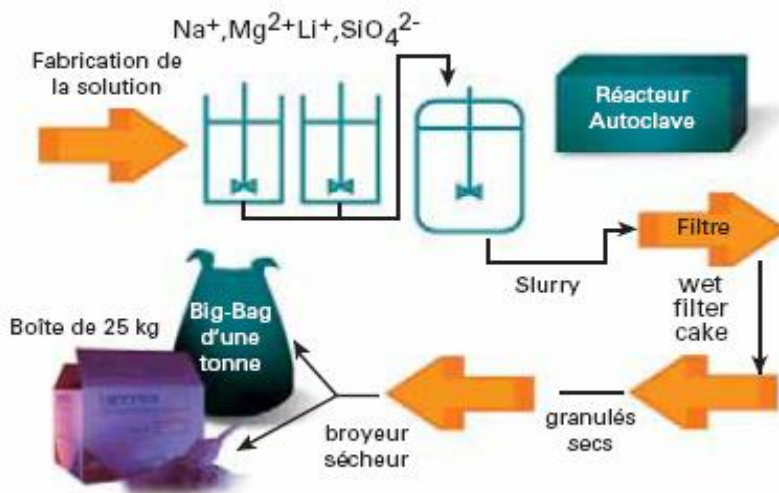
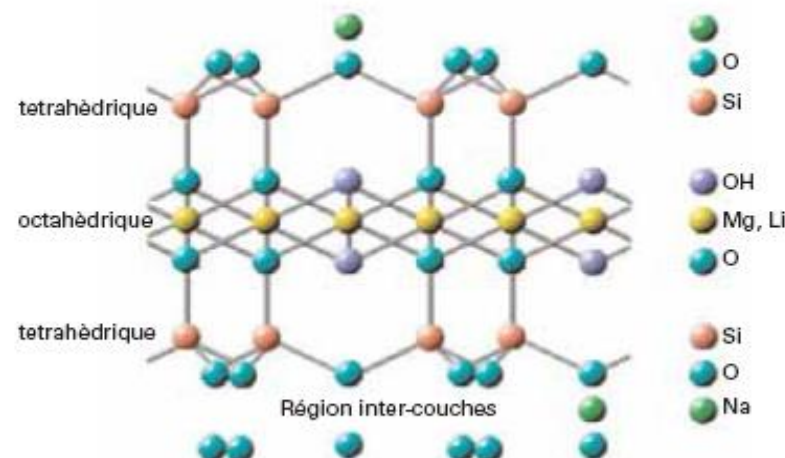


Figure 2. Structure



Applications de Laponite (source : Rockwood)



**One Particle :
Multiple uses on market**

HealthCare

**Surface
Coatings**

**House
Products**

**Papiers
Films Polymers**

Building

Agriculture

**General
Industry**

Produits de soins personnels

- produits de beauté
- systèmes d'émulsion
- émulsifiants
- pâte dentifrice
- produits pour le visage

Produits de surface

- produits pour la décoration et l'architecture
- revêtements à effets de structure
- peintures multicolores "à l'eau"
- peintures industrielles et finition
- revêtements de sols et vernis
- revêtements industriels et de protection
- revêtement stabilisateur de rouille
- alkydes réductibles dans l'eau
- teintures pour bois
- vernis pour bois
- encres d'imprimerie
- peintures pour enfants et artistes
- Suspensions de pigments

Produits ménagers

- nettoyants pour fours et dégraissants
- produits d'entretien à l'eau de Javel gélifiés
- nettoyants applicables par pulvérisation
- détergents en tablettes
- shampoings pour moquettes
- produits de nettoyage à base d'acides et alcalins
- produits d'entretien des surfaces dures
- désodorisants
- détergents pour lave-vaisselle
- produits antisalissures
- agents anti-réposition

Papier et films polymère

- revêtements antistatiques
- papier et film d'impression électrographique
- films barrières
- revêtements
- enduits
- encre
- imprimés
- apprêts
- papier pour l'industrie
- microparticule pour systèmes de rétention et drainage

Produits pour bâtiment

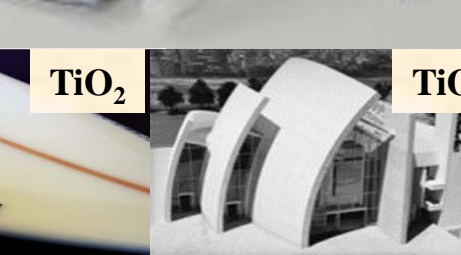
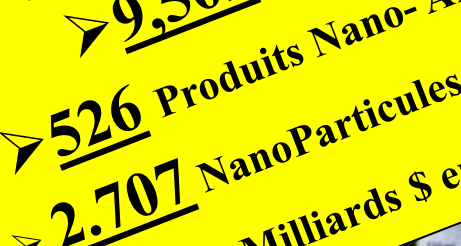
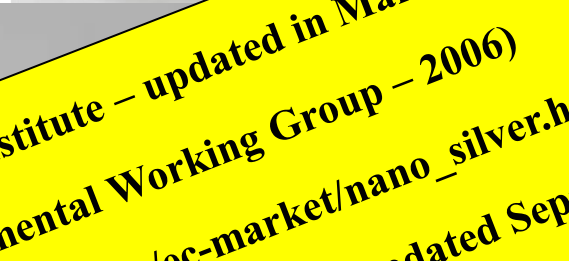
- plâtres et pâtes de ciment
- retardateurs de prise
- suspensions de bois
- colles à bois
- colles à carrelage

Agriculture

- gels pour la germination de graines
- gels pour enracinement de plantes
- concentrés fluidifiables agrochimiques - herbicides, pesticides
- suspensions d'oligo-éléments

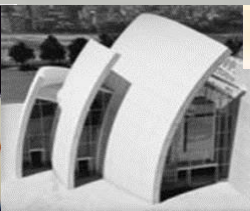
Rockwood met à disposition des formulations types pouvant servir d'exemples pour une large gamme de produits.





Yet on the Market

- 1.317 NanoProducts (Woodrow Wilson Institute – updated in March 2011)
- 9.509 products (Cosmetic (Environmental Working Group – 2006)
- 526 Produits Nano- Argent (http://www.ec21.com/ec-market/nano_silver.html)
- 2.707 NanoParticules / 169 Suppliers (w3.nanowerk.com – updated Sept. 2011)
- 150 Milliards \$ en 2007 (Emballages alimentaires 4 Milliards \$ en 2008)



Europe / Octobre 2010 - ANEC – BEUC Inventory

Categories	Number of products investigated	Percentage
APPLIANCES	27	5,68
AUTOMOTIVE	72	15,16
CROSS CUTTING	66	13,89
ELECTRONIC & COMPUTERS	6	1,26
FOOD & DRINK	27	5,67
PRODUCTS FOR CHILDREN	18	3,78
HEALTH & FITNESS	199	41,89
HOME & GARDEN	60	12,63
TOTAL	475	

Results

From this updated inventory, we can see the following trends:

- While the number of products claiming to contain nanomaterials that we found increased considerably (475 in 2010 / 151 in 2009), the proportion of products per category stayed basically the same, with health and fitness products topping the chart.

- Most of the products available in 2009 are still available in 2010 as only 4% of products we investigated are not available anymore.

- Some of the nano-claims relating to a specific product can be found on an online shop, while they are absent from the website of the brand itself.

These trends are not necessarily a general rule and apply only to the products that we found.

Categories/Sub categories	Number of products investigated	Percentage
APPLIANCES	27	5,68
1. Kitchen appliances	25	5,25
2. Others	2	0,42
AUTOMOTIVE	72	15,13
Maintenance & Accessories	72	15,13
CROSS CUTTING	66	13,87
1. Coatings	39	8,19
2. Others	27	5,67
ELECTRONIC & COMPUTERS	6	1,26
FOOD & DRINK	27	5,67
1. Supplements	25	5,25
2. Others	2	0,42
PRODUCTS FOR CHILDREN	18	3,78
HEALTH & FITNESS	199	41,81
1. Clothing	36	7,56
2. Personal care	136	28,57
3. Sporting goods	27	5,67
HOME & GARDEN	60	12,61
1. Cleaning	28	5,88
2. Construction materials	11	2,31
3. Others	22	4,62
TOTAL	475	

NGO's Inventory - ONLY !!
(No State Agency Inventory)

<http://www.euractiv.com/en/food/nanotech-presence-consumer-goods-growing-news-499152>

<http://pr.euractiv.com/press-release/anecbeuc-inventory-exposes-game-roulette-16047>

http://www.anec.org/attachments/ANEC%20BEUC%20leaflet%20on%20nano%20inventory_How%20much%20nano%20do%20we%20buy.pdf

Belgique - containing NM
2.000 – 5.000 unique substances
80.000 – 160.000 unique preparation
800.000 – 1.300.000 unique articles

In Figure 2, the number of unique NM-containing products per company using NMs (categorized as substances, preparations, and articles) are broken down according to sector. The companies in the sectors coatings & inks, textiles, and paper products have the highest number of unique NM-containing products per company since pigments and some filler materials (e.g. SAS, PCC) are considered NMs. The sectors electronics (e.g. computers, radios, electrical parts, etc.) and complex objects (e.g. cars, refrigerators, furniture, etc.) also have many products containing NMs, especially due to coatings (e.g. on machinery) and also filler materials in rubber and plastic components.

In general, for the entire supply chain, the number of unique products is as follows: there are around 2000-5000 unique substances, 80,000-160,000 unique preparations, and 800,000-1,300,000 unique articles containing NMs³⁰.

Ranges in Figure 2 are aggregated values for the entire sector and does not represent the minimum and maximum range of each NACE code constituting each sectors: meaning, within each sector, subgroups can have declarations per company values higher or lower than in Figure 2. It is also important to note that due to the interconnected nature of the present world economy, a majority of products are imported from outside of Belgium, therefore leading to non-linear, fragmented supply chain.

Belgique
35.000 – 45.000 entreprises (NanoProduits)
15 – 20% du nombre total d'entreprises



The range of companies putting products with NMs on the market was estimated by multiplying the (i) total number of companies per sector by (ii) the lower and upper fraction of companies using NMs per sector obtained by the aforementioned integration of the three different sources; the total number of companies for each sector was obtained using the Belgian public authorities databases and categorized according to economic activities (NACE) as previously described.

For all sectors evaluated, the number of companies placing a NM-containing product on the market was estimated to be between 35,000-45,000 enterprises. This represents approximately 15-20% of all the enterprises in Belgium according to 2011 data from the Belgian National Social Security Office²⁹.

AGENCE NATION. SECUR. SANITAIRE ALIMENTATION ENVIR. TRAVAIL [FR] https://www.r-nano.fr



R-Nano.fr
Déclaration des substances à l'état nanoparticulaire



français | english
anses
agence nationale de sécurité sanitaire
alimentation, environnement, travail



Aide

[Accueil](#)

Bienvenue

Bienvenue sur l'application de déclaration des substances à l'état nanoparticulaire « R-Nano ».

Au 30 juin 2013, date limite pour déclarer les substances fabriquées, distribuées ou importées en 2012, plus de 930 déclarants, dont plus de 90 fournisseurs étrangers, ont réalisé plus de 3400 déclarations.

Un rapport public, qui sera mis en ligne en novembre 2013 recensera les substances déclarées et leurs usages.

Zone de documentation réglementaire

Code de l'environnement (partie législative) articles L. 500-1 à L. 500-5

Publications

Mise à disposition du public des extraits des déclarations

La mise à disposition du public prévue aux articles

Aide

Tutoriel - Document d'aide aux utilisateurs déclarants



Accès professionnel



Au 30 juin 2013, date limite pour déclarer les substances fabriquées, distribuées ou importées en 2012, plus de 930 déclarants, dont plus de 90 fournisseurs étrangers, ont réalisé plus de 3400 déclarations.

Un rapport public, qui sera mis en ligne en novembre 2013 recensera les substances déclarées et leurs usages.

Éléments issus des déclarations des substances à l'état nanoparticulaire

Nov. 2013

Tableau 10 : Catégories de substances produites et/ou importées en plus grande quantités (plus de 100 tonnes)


MASSE PRODUITE ET/OU IMPORTÉE EN KG	NOM CHIMIQUE
274 837 135	NOIR DE CARBONE
155 071 912	DIOXYDE DE SILICIUM / SILICE AMORPHE
34 501 525	CARBONATE DE CALCIUM
14 321 436	DIOXYDE DE TITANE
2 193 565	OXYDE D'ALUMINIUM
1 568 000	COPOLYMERE DE CHLORURE DE VINYLIDENE (NOM DECLARE)

500.000 Tonnes en France

« Les quantités **produites et importées** issues des données déclarées en 2013, toutes substances confondues, sont respectivement de **279 439 tonnes et 142 676 tonnes**. L'analyse a permis de dégager un nombre total de catégories de substances à l'état nanoparticulaire déclarées compris entre 243 et 422. Un second rapport sera publié avant janvier 2014 qui permettra d'affiner ces chiffres en regroupant les déclarations par numéro CAS et celles par nom chimique. »

141 232	2-[(2-METHOXY-4-NITROPHENYL)AZO]-N-(2-METHOXYPHENYL)-3-OXOBUTYRAMIDE
138 100	2-PROPENOIC ACID, 2-METHYL-METHYL ESTER, POLYMER WITH 1,3-BUTADIENE, BUTYL 2-PROPENOATE AND ETHENYLBENZENE (NOM DECLARE)
138 000	PYRROLO[3,4-C]PYRROLE-1,4-DIONE, 3,6-BIS([1,1'-BIPHENYL]-4-YL)-2,5-DIHYDRO- (NOM DECLARE)
136 500	HYDROXYDE D'ALUMINIUM
134 740	4,4'-DIAMINO[1,1'-BIANTHRACÈNE]-9,9',10,10'-TÉTRAONE
107 796	DIOXYDE DE CERIUM

Domaines d'Applications des Nanomatériaux et Nanotechnologies

Technology Sector	Nanoparticles	Nanofilms	Composites	Tools	Devices
Information and Communication	Nanowires, transistors, quantum computing, displays	Magnetic films for data storage, lens coatings, semiconductor s	Plastic electronics, flat panel displays	STM, lithography, MBE, AFM, molecular assemblers	MEMS switches, carbon nanotube devices, sensors
Healthcare and Life Sciences	Drug delivery, image contrast agents, medical dressings	Coated particles, scalpel blades	Medical implants		Lab-on-a-chip, drug discovery, micro-fluidics, microarrays
Energy and Environment	Fuel additives, catalysts, hydrogen storage	Battery technology, advanced solar cells	Batteries, supercapacitors, fuel cells		Thermoelectric
Automotive, Aerospace and Industrial	Catalysts, electrodes, lubricants	Advanced coatings (e.g. scratch- and corrosion resistant, antimicrobial)	Exterior and Interior parts, engine/powertrain components, fuel-delivery, tires		MEMS sensors, LEDs, optical switches, microcontrollers, displays, actuators
Other	Cosmetics, personal care products, cosmeceuticals, clothes	Specialist coatings (e.g. for textiles and clothes)	Packaging (food and beverages)		

Source: 3i (Based on a diagram from Evolution Capital)



Daewoo refrigerator containing nano silver



Victor Castano anti-graffiti paint containing silica nanoparticles



Dockers stain-resistant trousers (NanoTex technology)

Sharper Image athletic socks containing silver nanoparticles



Sharper Image plastic storage bags containing silver nanoparticles



GMR disk drive heads



Intel Pentium 4 processor using 90 nm process technology



Lion Corp. antimicrobial sprays containing ionized nano-silver particle attached to the surface of alumina-silica just 15 nanometers in diameter



Easton CNT bicycle components



Samsung OLED displays using nanostructured polymer films



Zelens fullerene-containing cosmetic creams



Boots Soltan sunscreens containing titanium dioxide nanoparticles



Altair's NanoSafe rechargeable nano titanate battery module

World's first nano-enhanced carbon fiber downhill bike rim

Première jante de vélo descente nano-renforcée de fibre de carbone au monde

2 mai 2012 : Zyvex Technologies (the world's first molecular nanotechnology company) and ENVE Composites have announced an exclusive partnership to provide a bicycle rim specifically for downhill mountain biking that uses the latest advanced materials: nano-enhanced carbon fiber



Greg Minnaar riding the new nano-enhanced DH rim at the 2012 World Cup Opener in South Africa

Most notable is an unprecedented increase in durability, strength, and stiffness over traditional alloy offerings on the market. Often, top level teams will need to change rims more than 180 times during a season. World Cup downhill racing champion Steve Peat raced on one pair of the ENVE DH wheels during the entire 2011 season. Traditional aluminum rims historically lasted him a mere one to three runs.

Today Life Applications

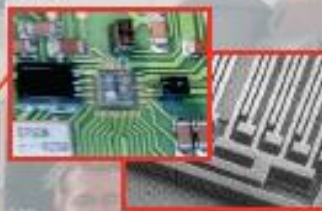


Today Life Applications

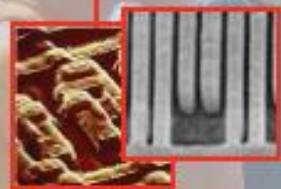
Pace Maker
Li-Batteries
New Materials



Air Bag
Acceleration Sensors
MEMS



Cosmetics
TiO₂ Nanoparticles



Mobile Phone
SAW Structures



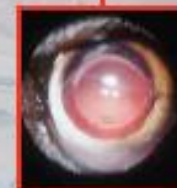
Artificial Hips
Biocompatible
Materials



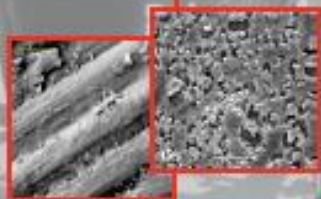
Glasses and Coatings
Optical Materials
UV Filter



Digital Camera
CCD Chip



Artificial Lens
Biocompatible
Polymers



Bike Frame
Carbon Fibres
Composite Materials



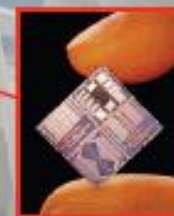
GMR Read Head
Magnetic
Multilayers



LED Display
Photonic Materials



Intelligent Credit Card
Integrated Circuits



Exact Time via Satellite
Semiconducting devices
Micro-Batteries

Tailored materials at work

Air France Headquarters Roissy-Charles de Gaulle International Airport

Architects: Denis Vallode and Jean Pistre
Owner: Air France
Year: 2006
Cement: white TX Arca®
Precasting firm: MSA
Supplier of TX Active®: Ciments Calcia*

The new building, accommodated inside the Roissy-Charles de Gaulle International Airport, is the prestigious headquarters of the French flag carrier, Air France.



Hotel de Police Bordeaux – France

Architect: Claude Marty (Lacroux Massicault SA Architects)
Owner: The French Department of Interior
Year: 2003
Cement: white TX Arca®
Precasting firm: CIR in Tonneins
Supplier of TX Active®: Ciments Calcia*

Located downtown, the building is a modern structure with a white facade.



Surface Auto-Nettoyante / nTiO2

**Economie de Matière
Substitution / Changement de Procédés
Impacts Positifs sur les Coûts**

Commodore Ostend, Belgium

The building is a modern structure with a white facade.

ment in
stigious
nd and
support

xposed
ted by
In this
e final
ived.

menti
ers in
in the
nt at
crete



Ciments du Maroc's Headquarters Casablanca, Morocco

Architect: Rachid Andaloussi
Owner: Ciments du Maroc*
Year: 2005

The building houses the headquarters of Ciments du Maroc, the Moroccan subsidiary of Italcementi Group.

The building, whose circular structure recalls the Group's spiral logo, was made with traditional concrete covered with a white mineral coating exerting the TX Active® photocatalytic effect.

Sun, and even the more so at these latitudes, is the staunch ally in the fight against organic pollution.



* Ciments du Maroc is the second largest cement manufacturer in Morocco. It boasts more than 1000 employees and operates 3 cement plants, 1 grinding center and 1 bagging facility. Through the subsidiary Betomar, which operates 4 aggregate quarries and 15 concrete batching plants, Ciments du Maroc is the leader in the ready mix concrete and aggregates industry.







Eglise du Jubilé - Rome



Nanotechnologies in automobiles

Existing applications

Possible future applications

Application	Functionalities	Car body shell exterior	Car body	Interior	Chassis and tyres	Electrics and electronics	Engine and drive train
Effect							
Mechanical functionalities	Hardness, friction, tribological properties, breaking resistance	Nano varnish			Carbon black in tyres		Low-friction aggregate components
		Polymer glazing	Nanosteel		Nanosteel		
Geometric effects	Large surface-to-volume ratio, Poresize			Nano filter		Super caps	
			Gecko effect	Gecko effect		Fuel cell	
Electronic/magnetic functionalities	Size dependent electric and magnetic properties		Gluing on command			GMR sensors	Piezo injectors
					Switchable materials (rheology)	Solar cells	
Optical functionalities	Colour, fluorescence, transparency	Ultra-thin layers		Anti-glare coatings			
		Electro chromatic layers					
Chemical functionalities	Reactivity, selectivity, surface properties	Care and sealing systems	Forming of high strength steel	Dirt protection			Catalysts
			Corrosion protection	Fragrance in the cabin			Fuel additives

Nanotechnology in automotive tyres

Other cases of nanomaterials used in tyres:

- **Nanobase**: a nano-molecular structure at the bottom of the strong cap of the tyre, improving grip and steering properties, while also reducing heat emission and therefore rolling resistance; used in the **Nokian WR A3 tyre**;
- **NanoPro-Tech** (Nanostructure-Oriented Properties Control Technology), a nano coating for the tyre tread, which reduces heat generation; used in the new **Ecopia tyre range of Bridgestone**;
- **Tyres enhanced with CNT** (carbon nanotubes) appear to have improved mechanical properties, such as tensile strength, tear strength and hardness of the composites, by almost 600%, 250% and 70% respectively, comparing with those of the pure SBR composites (styrene-butadiene rubber)3;
- **A nanoclay containing BIMSM** (brominated isobutylene- co-para-methylstyrene elastomer), developed and commercialised by **ExxonMobil**, shows increased air retention properties that exceed those of halobutyl rubbers by about 50%;
- Lamellar nanomaterial organoclays e.g. **Montmorillonite Clay (MMT)** developed by **Pirelli** give the tyre an isotropic behaviour (equal performance in longitudinal and lateral directions) and a better trade-off between handling and comfort while also exhibiting higher stiffness, better thermoplastic stability and reduced decay;
- Polyhedral Oligomeric Silsesquioxanes (**POSS**) ;
- **Nano Oxides** (Silica, Alumina) ;
- **Carbon Nano Fibres** (CNF) ;
- **Graphene** (delaminated Graphite) ;
- Poly(alkylbenzene)-Poly(diene) (PAB-PDM) nanoparticles (polymer nano-strings)

Zyvex Technologies Launches ZyMER(R) Innovative Advanced Rubber Technology Zyvex Molecularly Engineered Rubber Revolutionizes Commercial Applications

ZyMER is a distinct nano-engineered rubber technology using chemistry that allows carbon nanotubes to be inserted inside a rubber compound for added strength and improved conductive properties of elastomers. After six years of researching, developing, and refining manufacturing processes with companies such as APV Engineered Coatings®, and also one of the largest providers of products and services to the energy industry, results demonstrate ZyMER to be highly effective in manufacturing environments for industrial applications, such as gaskets and belts. Other customer collaboration efforts are focused on additional rubber products, **such as improved efficiency for tires in the automotive market.**

Surface resistivity
of $10(6) - 10(7)$ ohms/cm

-Tear strength improvements
of 30-40%

-Tensile modulus (stiffness) improvements
of 50-60%

ZyMER



Caption:

ZyMER, advanced rubber technology, improves the efficiency of tires in the automotive market. Zyvex is the first company to commercialize nanomaterial additives for rubber products. (source: Zyvex Technologies)

Title: ZyMER
Format: JPEG
Dimensions: 1280 (w) x 659 (h)
File Size: 199.88 KB
Source: Zyvex Technologies
[Download Hi Res]

Comfort

Atmospheric pressure sensor
(transmission control, motronic)

Manifold absolute pressure sensor
(Electronic diesel control, motronic)

Knock sensor
(Motronic)

Mass air flow sensor
(Motronic – air intake)

Angular position sensor
(Motronic – cam and crankshaft position)

Piezo actuator
(Fuel injection)

Rotational speed sensor
(Electronic transmission control, motronic)

Oil quality sensor
(Transmission and engine)

Soot sensor
(Motronic – exhaust)

High pressure sensor
(Fuel injection system, common rail)

Oxygen sensor
(Motronic - lambda)

Pedal position sensor
(Electronic accelerator, electro-hydraulic brake)

Powertrain

Humidity/temperature sensor
(Air condition)

Air quality sensor
(Air condition)

Angular rate sensor
(Navigation, tilt, chassis)

Light sensor
(Automatic light, air conditioning)

Rain sensor
(Wash/wipe control)

Microphones/displays
(Communication)

Inertial/pressure sensor
(Central locking, theft protection)

Tank/tire pressure sensor
(On board diagnostics)

Tilt sensor
(headlamp aiming, security)

Radar 77 GHz
(lateral control, obstacle detection)

Infrared
(Night vision system)

Radar 24 GHz
(Pre-crash, parking aid)

Steering wheel angle sensor
(Vehicle dynamics)

Rotational speed sensor
(Antilock braking system)

Pressure sensor
(Vehicle dynamics, crash detection)

Yaw rate sensor
(Electronic stability program)

Angular rate sensor
(Roll over)

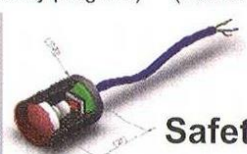
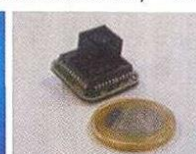
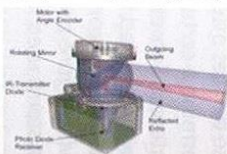
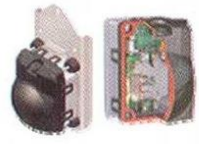
CMOS camera
(parking aid)

Inertial sensors
(airbag and stability control)

Out of position sensor
(Airbag)

Seat occupancy sensor
(Airbag)

Safety





Eolys: an essential component in the diesel post-treatment system

Diesel fuel tank

- Eolys is compatible with diesel and diesel additives
- Completely miscible with diesel
- Eolys/diesel mixtures are highly stable

Eolys reservoir with on-board dosing system

- Minimal packaging constraints (highly concentrated active ingredient)
- Temperature stability

Exhaust gas

- No secondary gaseous emissions
- No mineral particulate emissions
- Particulate matter emissions reduced far below 2004/5 limit values

Fuel lines

- Eolys is compatible with the majority of plastics and elastomers

Particulate filter

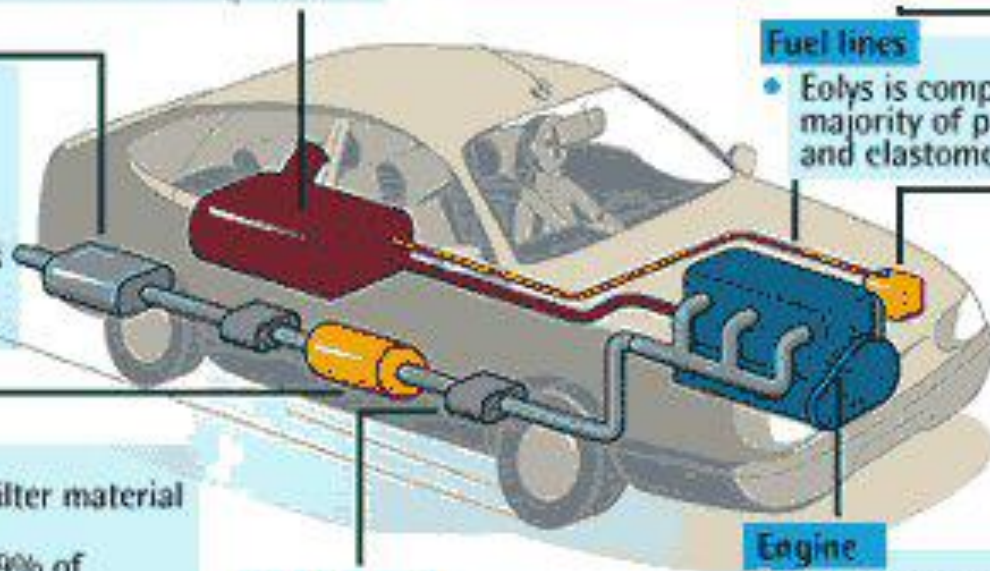
- No adverse Eolys / filter material interaction
- Traps in excess of 99% of particulates
- Eolys-enabled regeneration

Catalyst

- No negative impact on performance

Engine

- No increase in wear
- No fouling
- No drop in performance
- No impact on oil consumption



Pour un plein de 60 litres, le système injectera 37,5 ml de solution contenant 1,9 g de c  rine.
Le r  servoir d'additif, d'une capacit   de 5 litres, assure une autonomie de 80 000 km.

Google's Autonomous Robotic Car

The Google autonomous car is no mere lab prototype; this self-driving robotic car has logged more than 140,000 miles on regular roads, with only occasional human intervention



Autonomous Driving

Google's modified Toyota Prius uses an array of sensors to navigate public roads without a human driver. Other components, not shown, include a GPS receiver and an inertial motion sensor.

LIDAR

A rotating sensor on the roof scans more than 200 feet in all directions to generate a precise three-dimensional map of the car's surroundings.

VIDEO CAMERA

A camera mounted near the rear-view mirror detects traffic lights and helps the car's onboard computers recognize moving obstacles like pedestrians and bicyclists.

POSITION ESTIMATOR

A sensor mounted on the left rear wheel measures small movements made by the car and helps to accurately locate its position on the map.



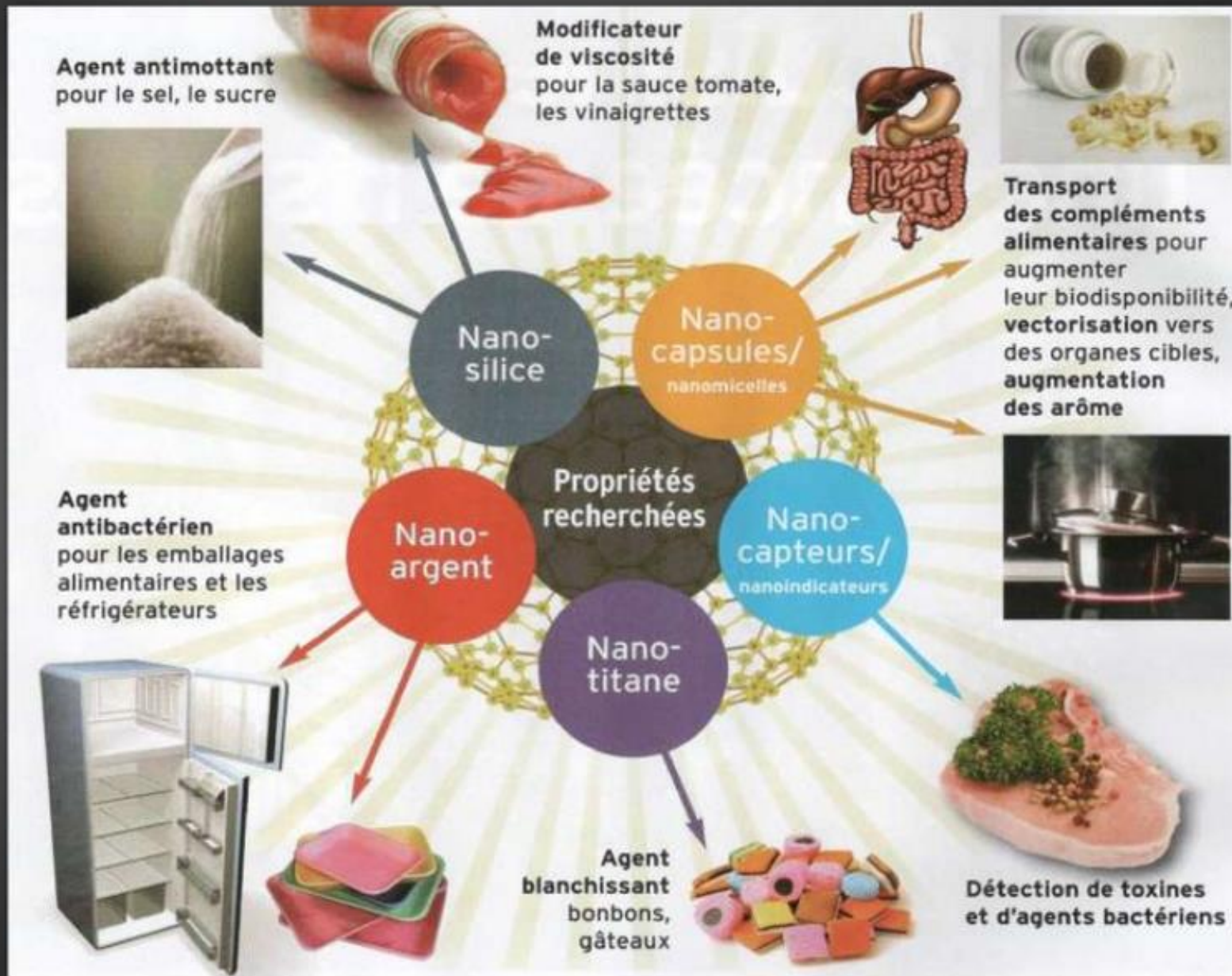
RADAR

Four standard automotive radar sensors, three in front and one in the rear, detect the presence of distant objects.



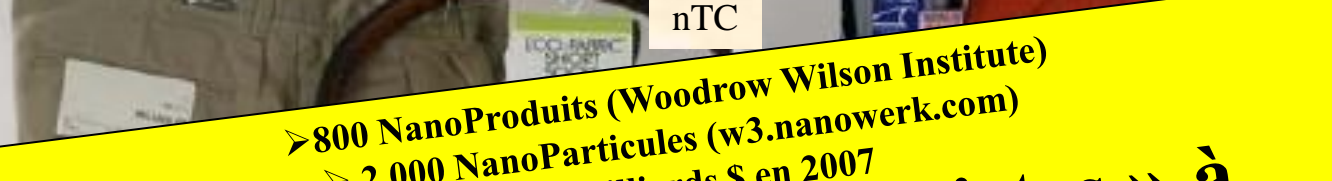
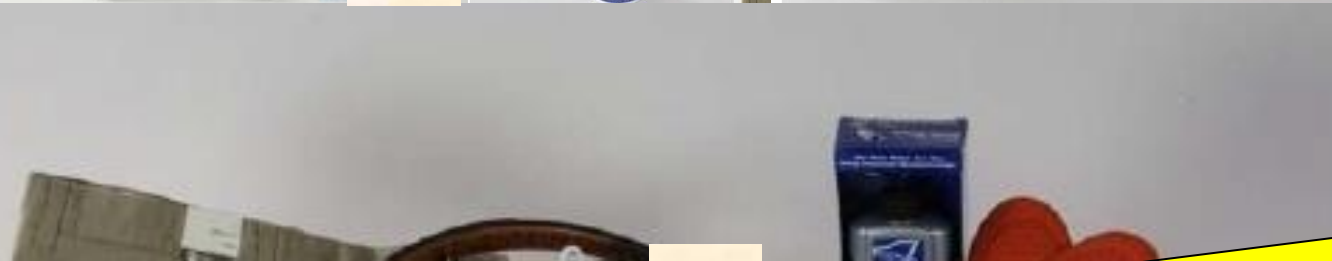
"Autonomous cars are years from mass production, but technologists who have long dreamed of them believe that they can transform society as profoundly as the Internet has. Now the NY Times reports that Google has been working in secret on vehicles that can drive themselves, using artificial-intelligence software that can sense anything near the car and mimic the decisions made by a human driver. With someone behind the wheel to take control if something went awry and a technician in the passenger seat to monitor the navigation system, **seven test cars have driven 1,000 miles without human intervention** and more than 140,000 miles with only occasional human control. One even drove itself down Lombard Street in San Francisco, one of the steepest and curviest streets in the nation. The only accident, engineers said, was when one Google car was rear-ended while stopped at a traffic light. ("(<http://tech.slashdot.org/story/10/10/09/2140245/Google-Secretly-Tests-Autonomous-Cars-In-Traffic>)

Les applications alimentaires



*Supplément
Panorama
du médecin*

N° 5204



➤ 800 NanoProduits (Woodrow Wilson Institute)
➤ 2.000 NanoParticules (w3.nanowerk.com)
➤ 150 Millions \$ en 2007
➤ Applications « Futuristes » à
5 (?) – 10 ans – 30 (!!) ans

Franz Ziener Jacket

TiO₂

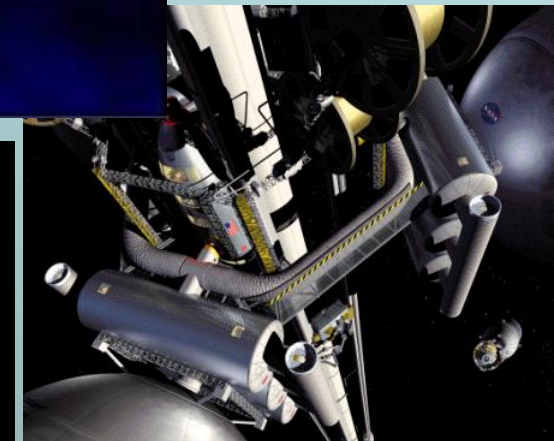
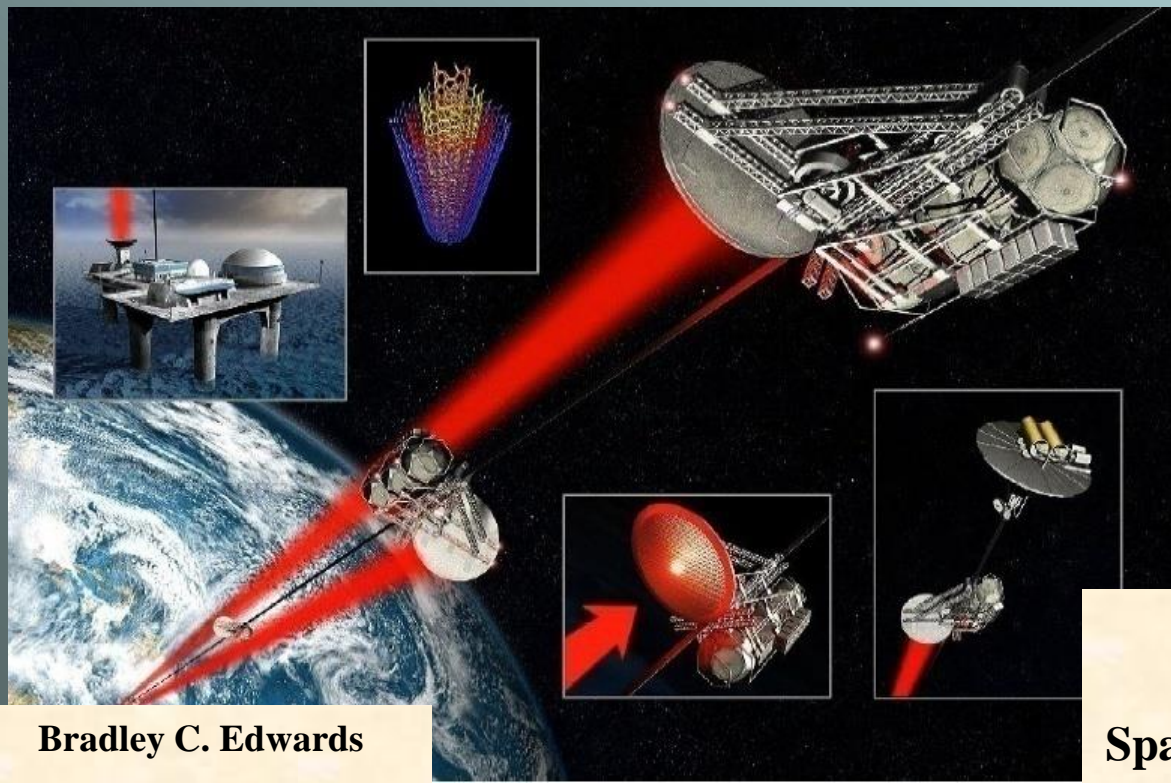
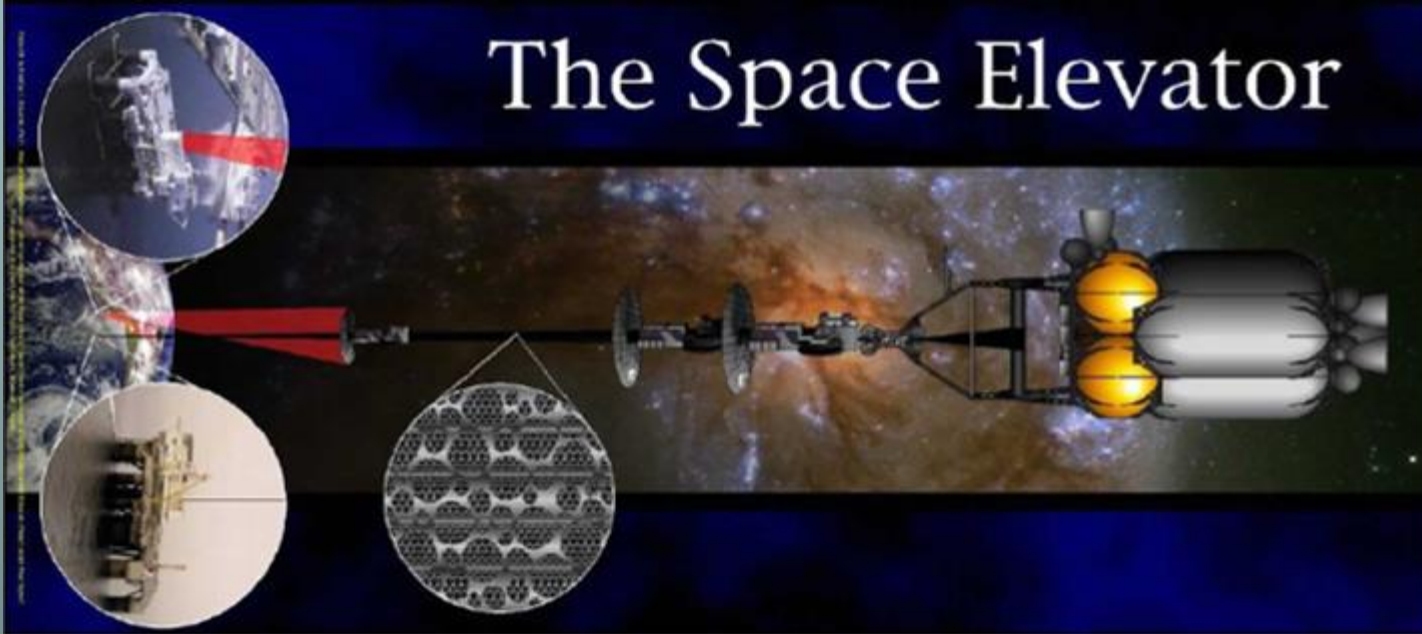
TiO₂

nTC

Ag

nTC

The Space Elevator



Young Modulus : 1 T Pa
Tensile Strength : 200 G Pa
C, Al₂O₃, SiO₂ fiber : 20 GPa
Necessary : 62 GPa

Investment – 10 billions \$
Space Elevator – 100 \$ / kg
Space Shuttle – 10.000 – 40.000 \$ / kg

Space-elevator tether climbs a mile high (Feb. 2006)

A slim cable for a space elevator has been built stretching a mile into the sky, enabling robots to scrabble some way up and down the line.

LiftPort Group, a private US company on a quest to build a space elevator by April 2018, stretched the strong carbon ribbon **1 mile (1.6 km)** into the sky from the Arizona desert outside Phoenix in January tests, it announced Monday.

The company's lofty objective will sound familiar to followers of the Centennial Challenges programme. The desired outcome is a 300-mile (99,779 km) tether that robotic lifters – powered by laser beams – can climb, ferrying cargo, satellites and eventually people into space. The recent test followed a September 2005 demonstration in which robots climbed 300 metres of ribbon tethered to the Earth and pulled up a large balloon. This time around, the company tested an improved version aloft by three balloons.

Rock solid To make the cable, researchers sandwiched three carbon composite strings between four sheets of fibreglass tape, creating a cable about 5 centimetres wide and no thicker than about six sheets of paper. "For this one, the real critical test was making a string strong enough to hold the balloons at a mile high for 6 hours...it was rock solid," said Michael Laine, president of LiftPort. "We made a cable that was strong enough to hold the balloons at a mile high for 6 hours...it was rock solid." A platform linking the balloons and the tether was successfully held in place during the test. LiftPort calls the platform HALE,

Long Endurance, and plans to market it for aerial observation and communication purposes. But the test was not completely without problems. The company's battery-operated robotic lifters were designed to climb up and down the entire length of the ribbon but only made it about 400 feet from the ground. Laine told New Scientist that the robots had worked properly in preparatory tests and his team is still analysing the problems.



Strong, light blades a boost for wind energy? (Août 2011)



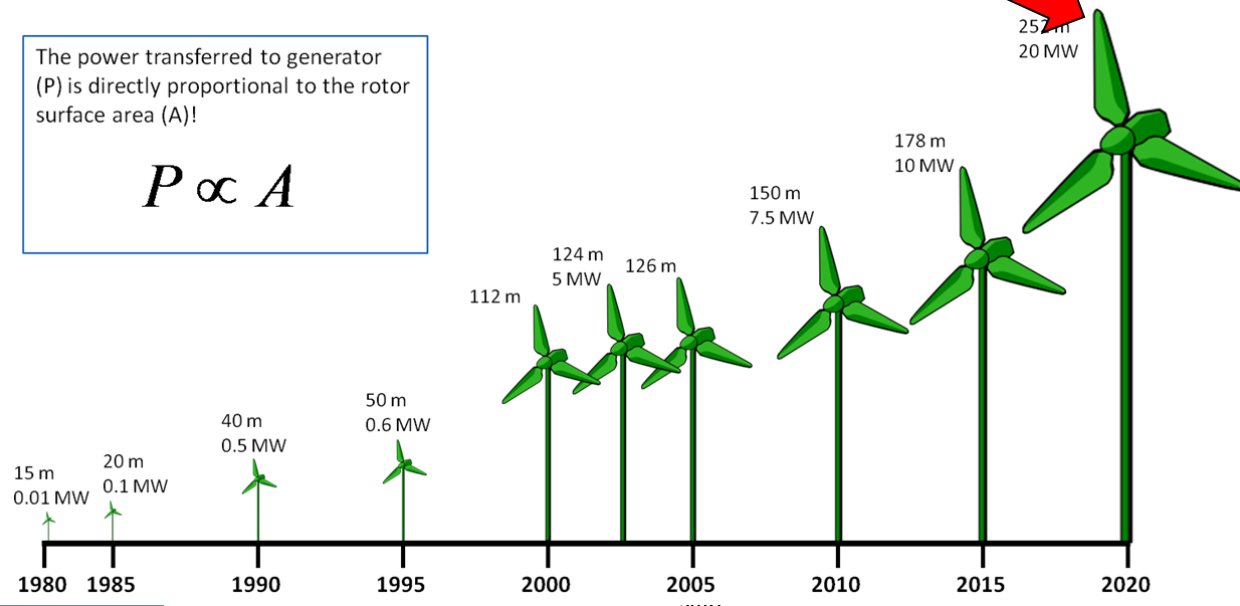
The world's first carbon nanotube reinforced polyurethane wind blades were installed on a 400W 12V wind turbine generator.

The technology could be scaled up, enabling the industry to build blades as long as 250 meters, according to researchers.

Bigger is better ... when it's also lighter and stronger. Engineers and materials scientists designing the next generation of blades are looking for ways to get more energy from the wind. Bigger blades can get more energy from the wind, but this advantage is lost if the blade is also heavier, since more wind is needed to turn the rotor. In addition, the more mass the blades have, the more they flex in the

The power transferred to generator (P) is directly proportional to the rotor surface area (A)!

$$P \propto A$$

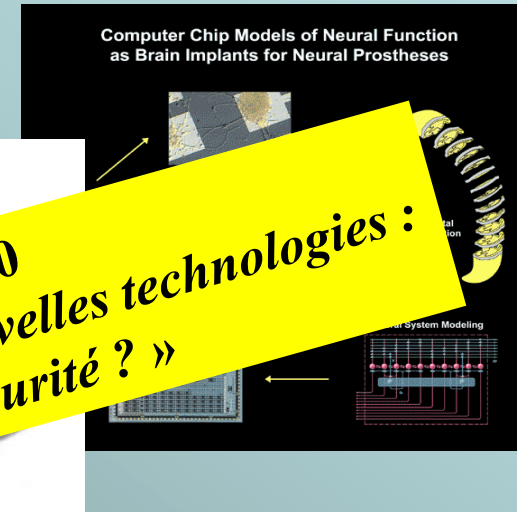
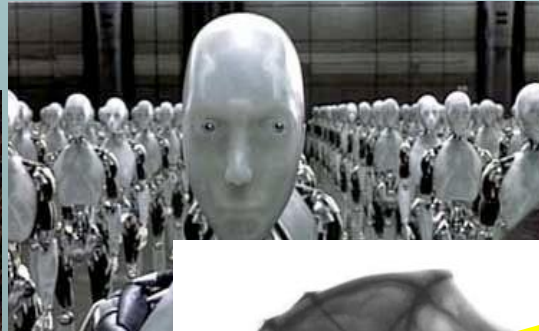


Longer blades that wring more energy from the wind, however, are likely to run up against the

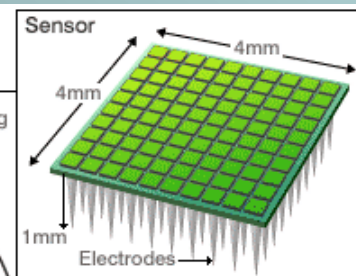
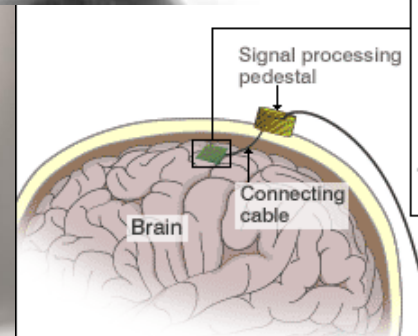
http://futureoftech.msnbc.msn.com/_news/2011/08/30/7527257-strong-light-blades-a-boost-for-wind-energy?chromedomain=cosmiclog

http://nanopatentsandinnovations.blogspot.com/2011/10/researchers-build-tougher-lighter-wind.html?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+NanoPatentsAndInnovations+%28Nano+Patents+and+Innovations%29

Steps towards « Human Version 2.0 » (brain – computer enhanced people) ou l'Homme Réparé, Transformé, Augmenté (TransHumanisme)



Hugh the Borg from Star Trek: TNG



SOURCE: Nature

Voir Rapport IRSEM / DGA – Mai 2010
**« Augmentation des performances humaines avec les nouvelles technologies :
Quelles implications pour la défense et la sécurité ? »**

Lentilles de compétition

Nike a développé des lentilles de contact colorées, anti-reflet et destinées à augmenter l'acuité visuelle des sportifs.

Initiées il y a 8 ans en partenariat avec le fabricant Baush & Lomb, ces lentilles «correctrices» du spectre visible existent en 2 modèles.

Ambrée, la paire de lentilles Maxsight vise les sports rapides, comme le foot, le basket ou le baseball, en jouant sur les contrastes. Elle atténue les bleus (le ciel, etc.) et «surligne» les rouges. Couleur de la balle ou des coutures oblige.

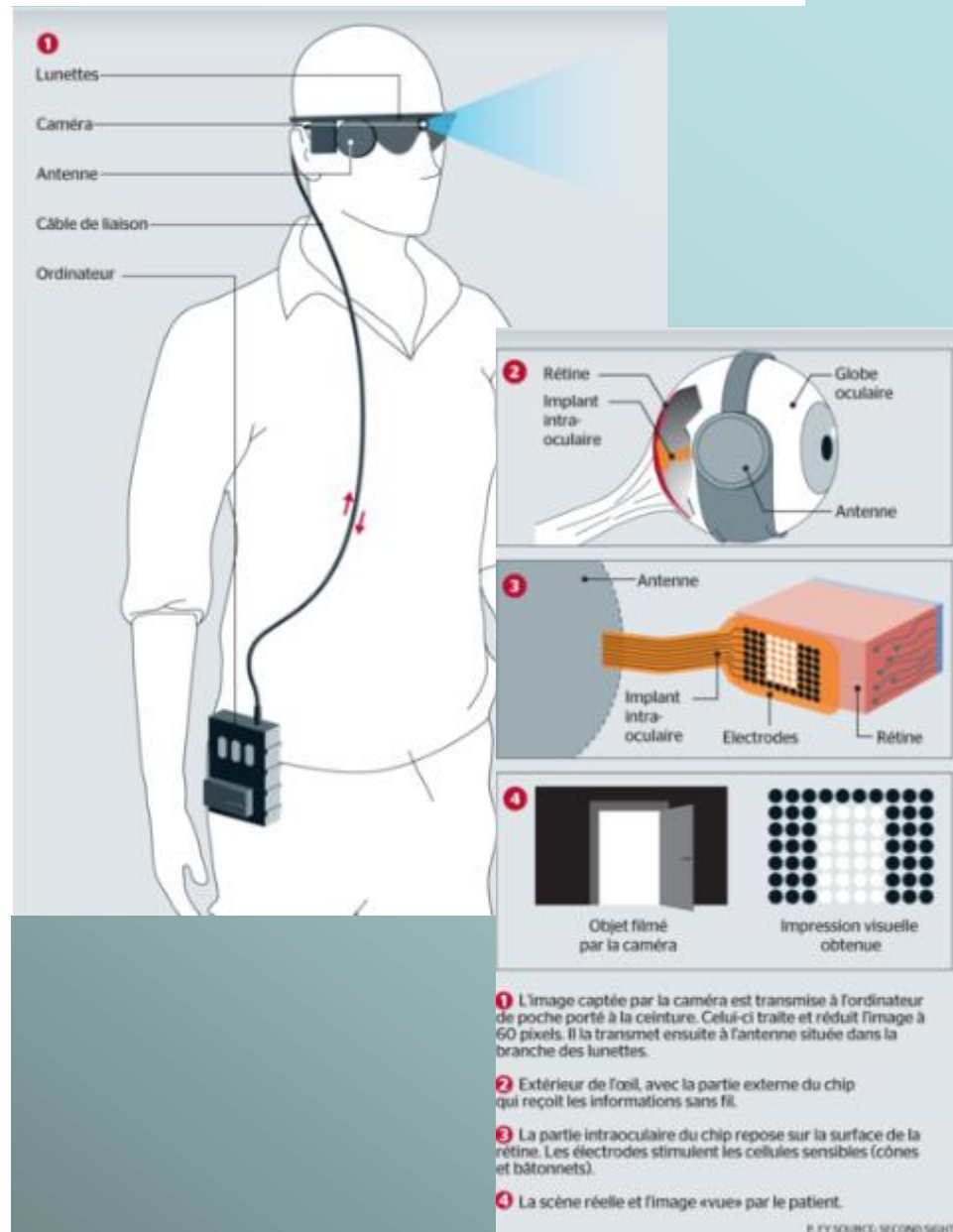


La version gris-vert, adaptée au golf ou au rugby, permet elle de mieux distinguer les brins d'herbe et privilégie le confort visuel à la vitesse.

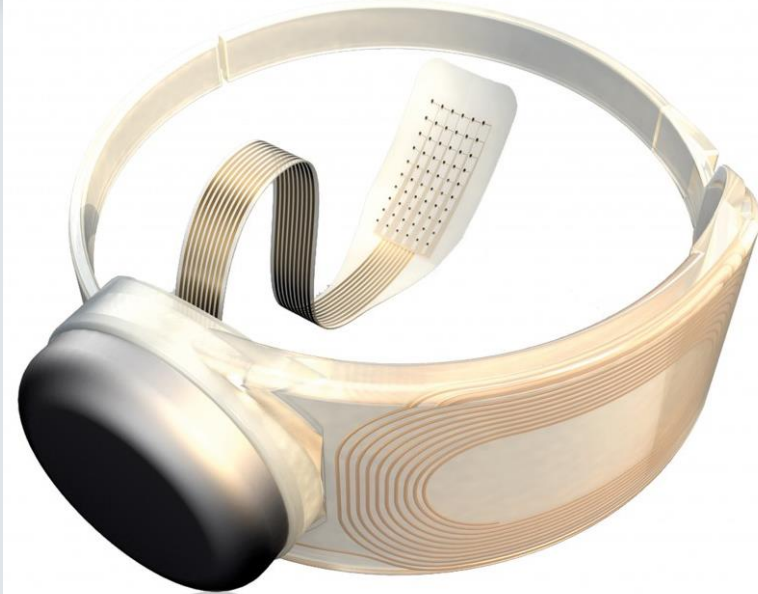
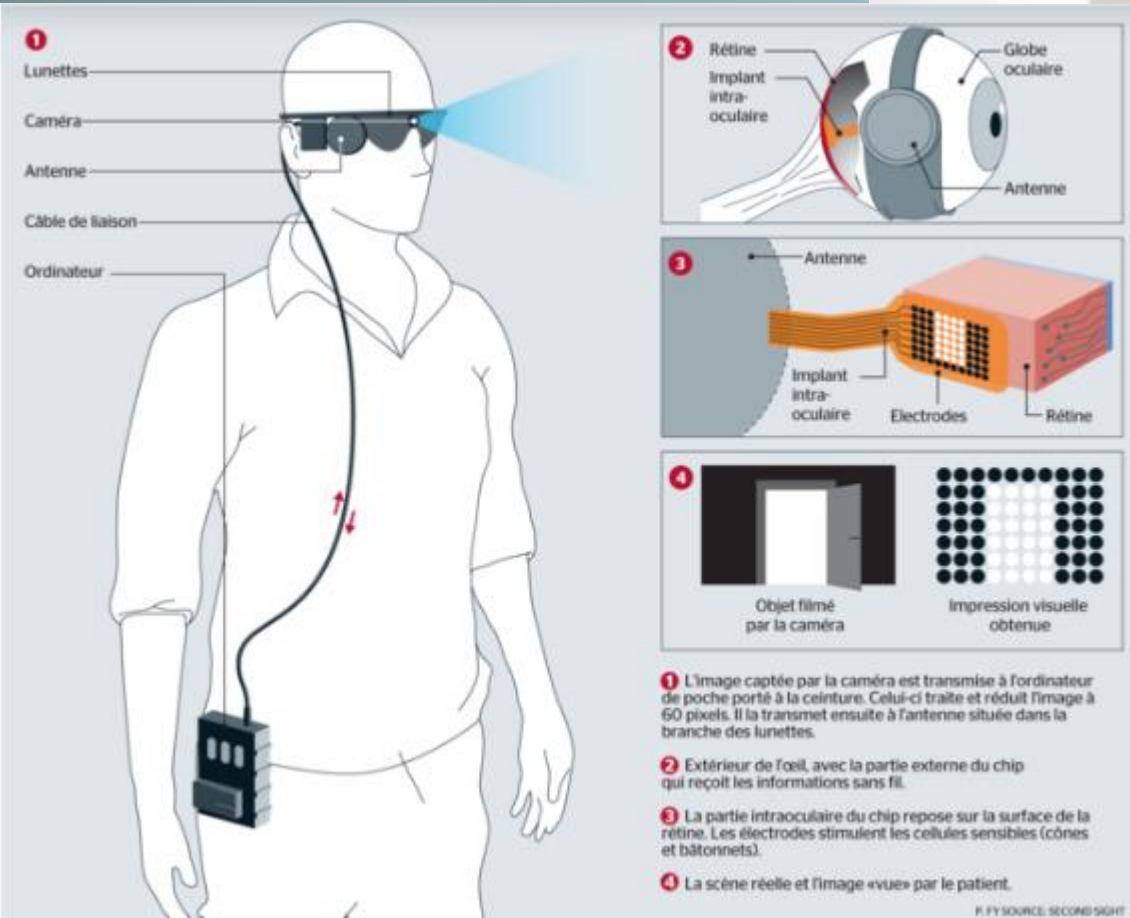
Disponible depuis la rentrée 2005 aux Etats-Unis et en Europe, Nike a notamment fait appel pour ses tests à des champions comme le tennisman Roger Federer ou le golfeur Justin Leonard

Le premier œil bionique de Suisse sera greffé à Lausanne – Avril 2013

L'Hôpital Ophtalmique de Lausanne va implanter un dispositif révolutionnaire déjà testé à l'étranger. Des électrodes placées derrière l'œil, un petit ordinateur portable et une caméra fixée sur des lunettes: ce dispositif révolutionnaire redonne à des personnes aveugles non pas la vue mais la capacité de visualiser des zones et des formes. Une soixantaine de patients dans le monde – et bientôt à Lausanne – vivent avec l'implant rétinien Argus II. Ce dernier, appelé aussi œil bionique, approuvé en Europe (et en Suisse) depuis deux ans, vient d'obtenir le feu vert de la FDA américaine. Le parc scientifique de l'EPFL abrite le siège européen de Second Sight Medical Products, la start-up californienne qui a mis au point cet implant novateur. Patron de la chirurgie vitréo-rétinienne à l'Hôpital Ophtalmique, le Professeur Thomas Wolfensberger se prépare à effectuer dans les mois qui viennent la première implantation d'Argus II homologué en Suisse. Un patient a été sélectionné, mais la recherche d'argent pour prendre en charge l'intervention, estimée à 100 000 fr., est toujours en cours. Pour l'heure, aucune assurance-maladie ne finance cette opération. «Cet implant permet pour la première fois de redonner la vue autrement que par le système de la lumière, affirme le Dr Wolfensberger. Bien sûr, nous ne parlons pas de toute la vue. Mais pour des personnes aveugles, percevoir des traits verticaux ou horizontaux, des objets foncés sur une surface claire et reconnaître des grosses lettres est énorme».



<http://www.tdg.ch/suisse/Le-premier-il-bionique-de-Suisse-sera-greffe-a-Lausanne-/story/20925800>



<http://sciencesetavenir.nouvelobs.com/sante/20130215.OBS9087/l-oeil-bionique-bientot-sur-le-sol-americain.html>

Redesigning people



URE



Équipée de "jambes bioniques", une femme paralysée termine le marathon de Londres (Mai 2012)



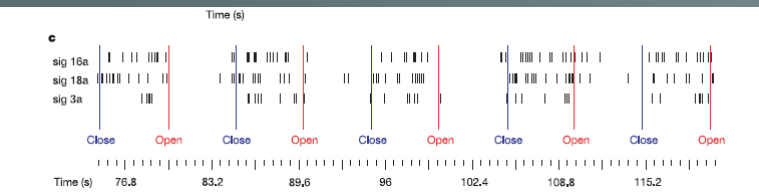
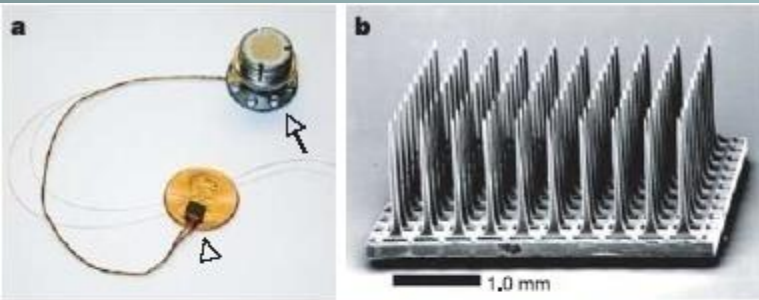
Claire Lomas à l'approche de la ligne d'arrivée du marathon de Londres, le 8 mai. | AFP/CARL COURT

Une Britannique paralysée, âgée de 32 ans, a réussi à boucler pour la première fois le marathon de Londres à l'aide de *"jambes bioniques"*, un appareillage qui lui a permis de se tenir debout et de marcher plus de quarante kilomètres en dépit de son handicap. Claire Lomas a franchi mardi en larmes, mais *"aux anges"*, la ligne d'arrivée, appuyée sur ses béquilles, seize jours après avoir entamé ce parcours de 42,2 kilomètres

http://www.lemonde.fr/sport/article/2012/05/09/equipee-de-jambes-bioniques-une-femme-paralysee-termine-le-marathon-de-londres_1698341_3242.html#xtor=RSS-3208

Neuronal ensemble control of prosthetic devices by a human with tetraplegia 2006

Leigh R. Hochberg^{1,2,4}, Mijail D. Serruya^{2,3}, Gerhard M. Friehs^{5,6}, Jon A. Mukand^{7,8}, Maryam Saleh^{9†}, Abraham H. Caplan⁹, Almut Branner¹⁰, David Chen¹¹, Richard D. Penn¹² & John P. Donoghue^{2,9}



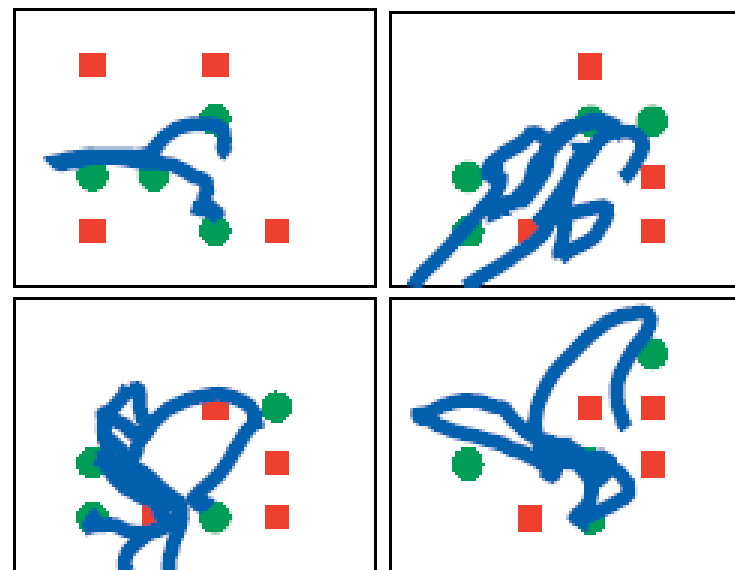
Editor's Summary, *Nature*, July 13, 2006

"The cover shows Matt Nagle, first participant in the BrainGate pilot clinical trial. He is unable to move his arms or legs following cervical spinal cord injury. Researchers at the Department of Neuroscience at Brown University, working with biotech company Cyberkinetics [OTCBB:CYKN] and 3 other institutions, demonstrate that movement-related signals can be relayed from the brain via an implanted BrainGate chip, allowing the patient to drive a computer screen cursor and activate simple robotic devices. Such neuromotor prostheses

ns to replace or restore lost is."

cover Our Technology

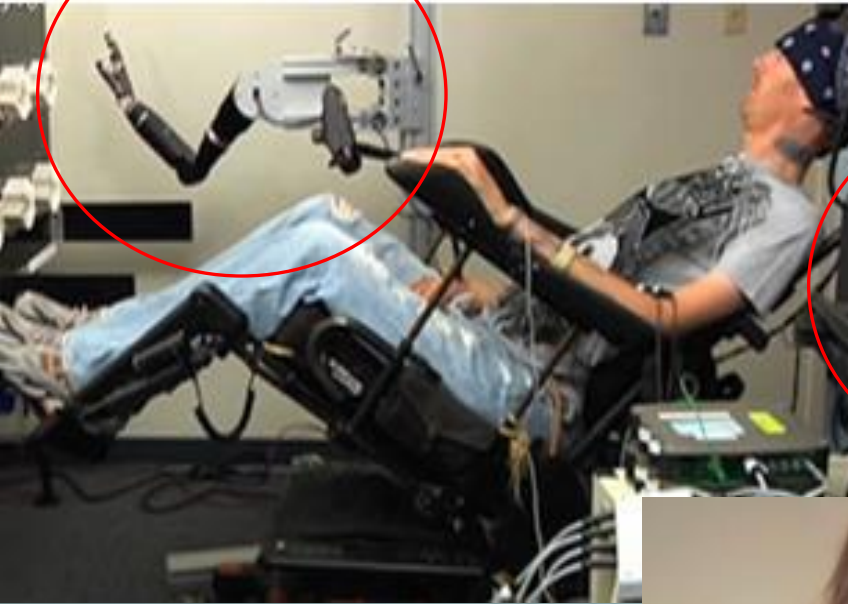
Participant 1. a, The microchip, connected by a 13-cm cable, which is secured to the scalp is connected to the microchip. Scanning electron micrographs are available for neural electrodes spaced 400 μm apart, in an axial MRI of the brain of the participant showing the location of the microchip implant site. A scaled micrograph of the microchip is outlined in red. (N). He is sitting in a wheelchair after a craniotomy. The grey box contains amplifier and amplified neural signals to



computers sitting beside the participant. He is looking at the monitor, directing the movement of the arm. A technique for controlling the arm is described in the article. **Nature – vol 442 (13 July 2006) pp 164**

Brain linked to robotic hand; success hailed (Oct 2011)

2011



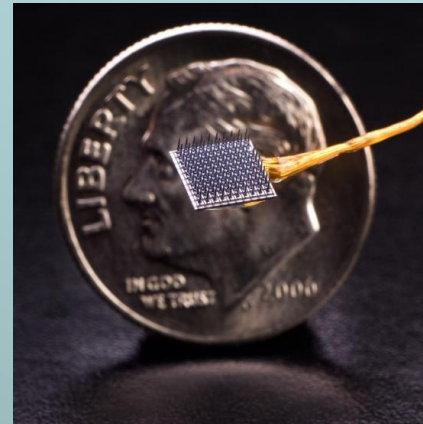
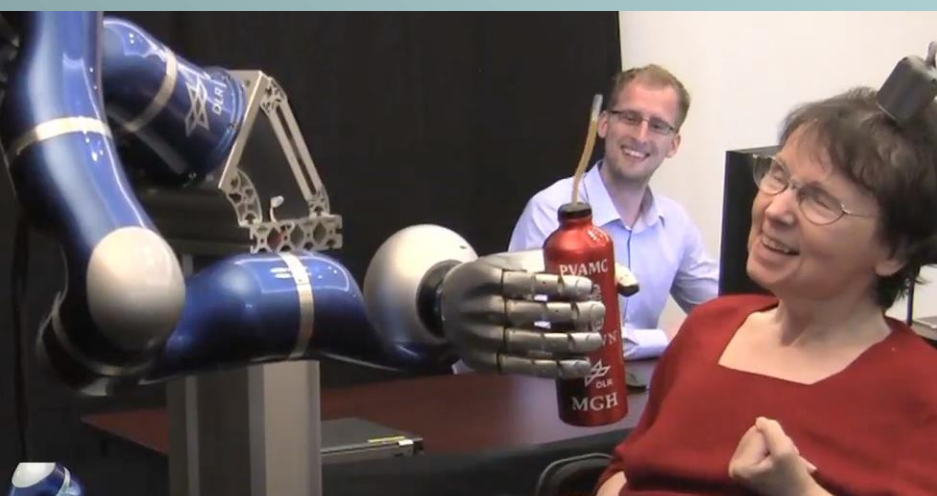
Doctors at the University of Pittsburgh Medical Center had installed an ECoG (electrocorticography) array at a precise location against the brain to control the robotic arm.



<http://www.post-gazette.com/pg/11283/1181062-53.stm>

http://www.kurzweilai.net/brain-linked-to-robotic-hand-success-hailed?utm_source=KurzweilAI+Daily+Newsletter&utm_campaign=a642357a99-UA-946742-1&utm_medium=email

People with paralysis control robotic arms using brain-computer interface



The BrainGate2 pilot clinical trial employs the investigational BrainGate system initially developed at Brown University, in which a baby aspirin-sized device with a grid of 96 tiny electrodes is implanted in the motor cortex — a part of the brain that is involved in voluntary movement.

On April 12, 2011, nearly 15 years after she became paralyzed and unable to speak, a woman controlled a robotic arm by thinking about moving her arm and hand to lift a bottle of coffee to her mouth and take a drink, using the BrainGate neural interface system.

That achievement is one of the advances in brain-computer interfaces, restorative neurotechnology, and assistive robot technology by the BrainGate2 collaboration of researchers at the Department of Veterans Affairs, Brown University, Massachusetts General Hospital, Harvard Medical School, and the German Aerospace Center (DLR).

http://www.kurzweilai.net/people-with-paralysis-control-robotic-arms-using-brain-computer-interface?utm_source=KurzweilAI+Daily+Newsletter&utm_campaign=49e7b0ca41-UA-946742-1&utm_medium=email



Rats télépathes (Fev. 2013)

[http://sciencesetavenir.nouvelobs.com/sante/20130301.](http://sciencesetavenir.nouvelobs.com/sante/20130301.OBS0557/l-incroyable-experience-des-rats-telepathes.html?xtor=RSS-24)

OBS0557/l-incroyable-experience-des-rats-telepathes.html?xtor=RSS-24

INTERFACE. « Une interface cerveau à cerveau capable de transférer en temps réel des informations ». C'est en ces termes que les chercheurs de l'institut des Neurosciences Edmond et Lily Safra au Brésil, et de l'université de Duke aux États-Unis décrivent leur expérience.

« Nous avons voulu voir si cette interface cerveau à cerveau pouvait être employée à des fins de communication entre des animaux expliquent les chercheurs dans leur publication. Une communication de qualité suffisante pour permettre de mener à bien une tâche en coopération » précisent-ils. Et le résultat est des plus impressionnants !

La "transmission de pensée" marche dans 70 % des cas !

Imaginez plutôt : isolé dans une cage, un rat fait face à deux pédales. S'il appuie sur la bonne, il obtiendra une petite ration d'eau en guise de récompense. Mais aucun indice ne lui permet de savoir laquelle choisir. Pourtant l'animal va opter pour la bonne réponse dans 70 % des cas.

En effet, à des milliers de kilomètres de là, l'un de ses congénères, dans une autre cage, est confronté au même choix que lui. Sauf que dans sa cage à lui, la bonne réponse est affichée sous la forme d'une diode qui s'allume au-dessus du levier qui délivrera la récompense.

STIMULATIONS. Préalablement, les chercheurs ont implanté des micro-électrodes dans le cerveau de chacun des deux rongeurs. Ces dernières enregistrent l'activité électrique dans les zones du cortex responsables de l'activité motrice et sensorielle des animaux. Elles peuvent également y envoyer de petites stimulations électriques.

Lorsque l'animal disposant des indications lumineuses se rue sur le bon levier, les électrodes captent l'activité de ses neurones et la transmettent à un ordinateur. La machine convertit alors ces informations en un signal numérique qui transite en quelques millisecondes via internet jusqu'au laboratoire qui héberge l'autre rat. Les informations sont alors converties en stimulations électriques transmises aux électrodes. Comme on peut le voir sur cette vidéo, le second rat utilise ces informations pour appuyer sur la même pédale que son acolyte quelques secondes plutôt.

Androides

(the Repilee Q2 in 2005)

2005



<http://fractalenlightenment.blogspot.com/2008/03/cyborg-insects-androids-and-controlled.html>



<http://androidworld.com/prod01fr.htm>

Wireless Sensor Networks

Integrated devices

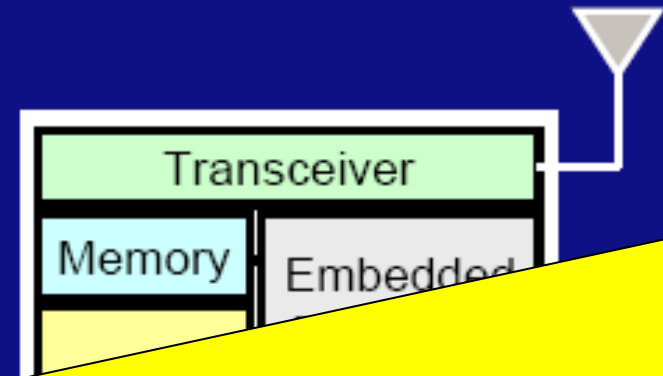
- power supply
- sensors
- embedded processor
- wireless link

Many, cheap sensors

- wireless → easy to install & maintain
- intelligent → collect & process data
- low cost

Small

- Increased range
- Low power
- MST
- MCM (A)



RFID

Coût ↓ ↓ ↓

Utilisation ↑ ↑ ↑

Nombre d'individus ↑ ↑ ↑

Autonomous sensor

TNOdes

RFID / Hitachi

Ses mensurations (0,05 x 0,05 mm²) lui ont valu le nom de « poudre »

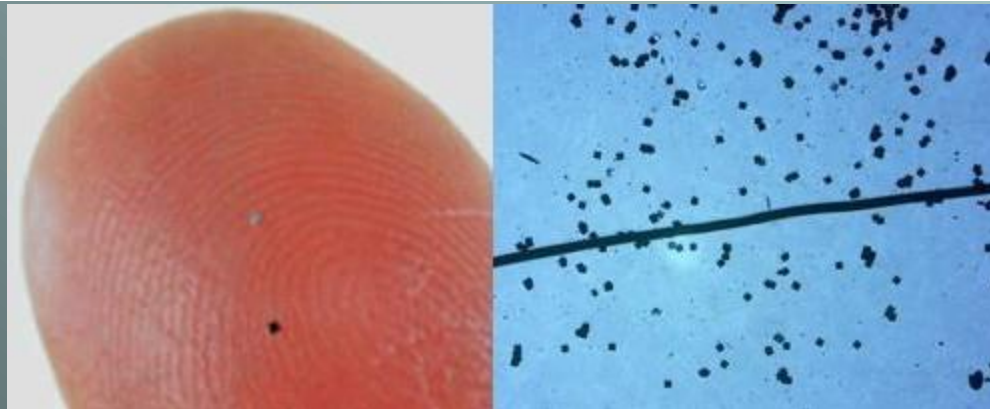
2006

Hitachi vient de présenter la plus petite puce RFID jamais réalisée.
Ses mensurations (0,05 x 0,05 mm²) lui ont valu le nom de « poudre ».

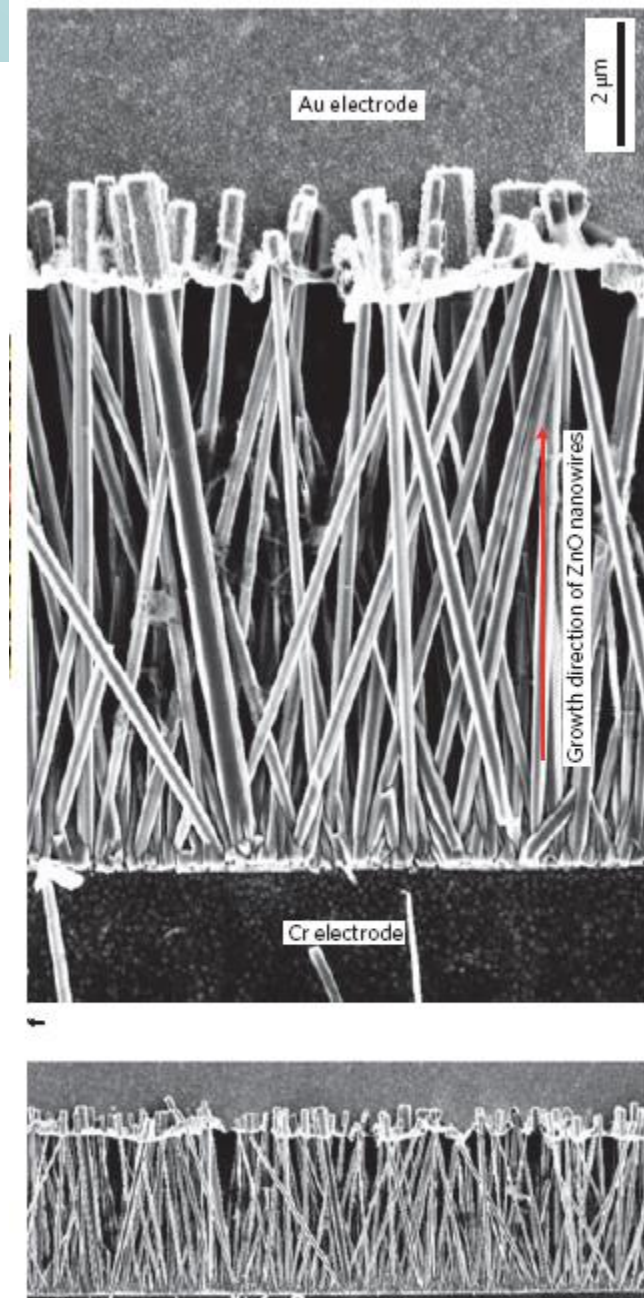
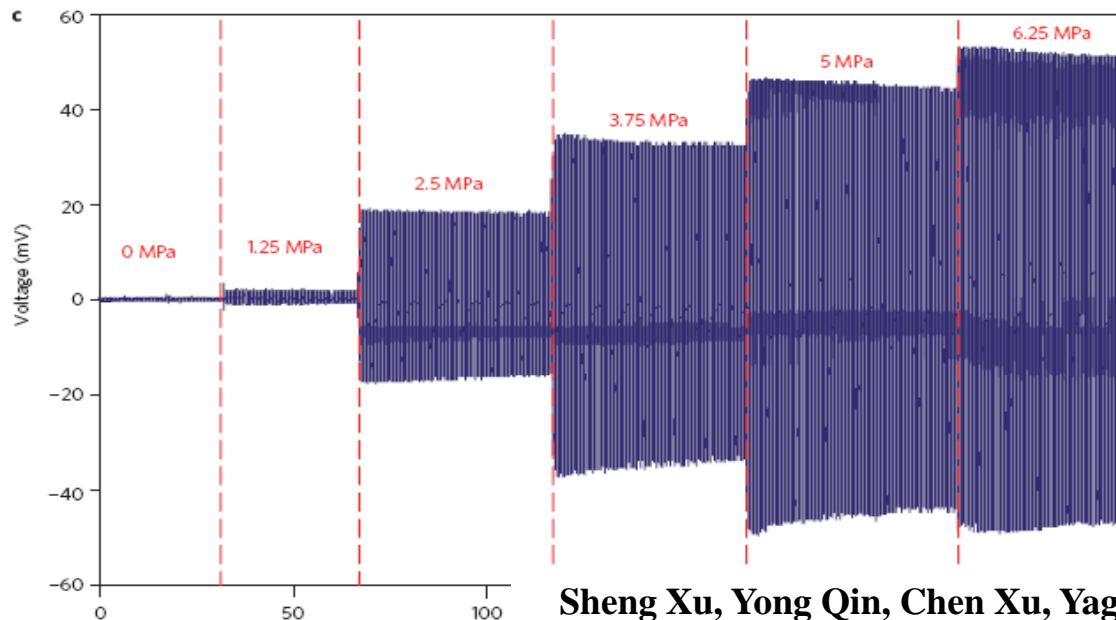
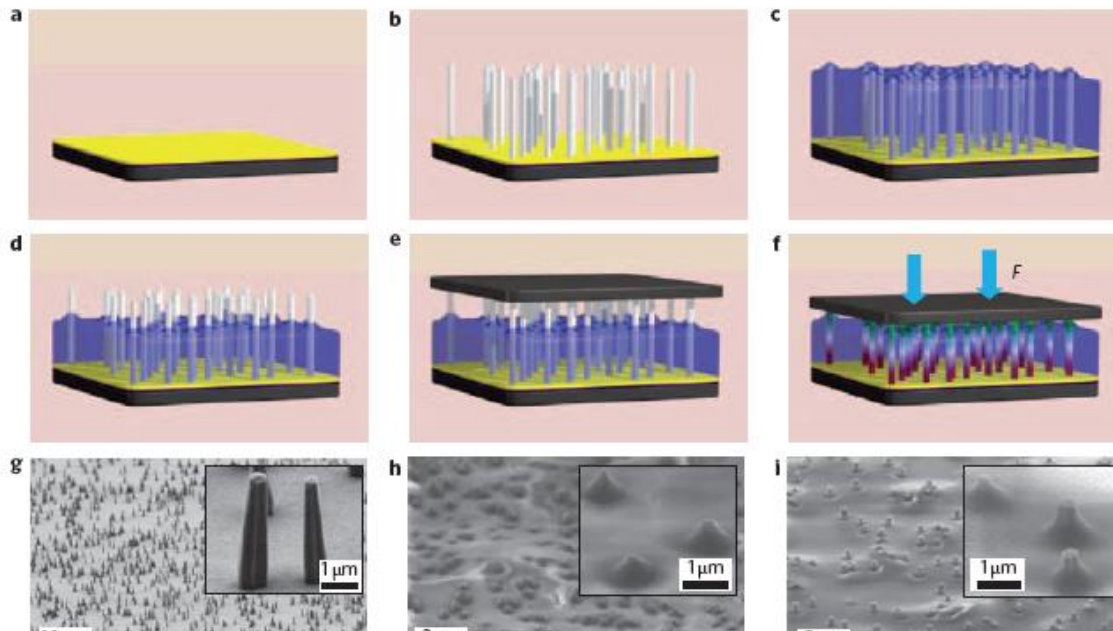
150 micromètres x 150 micromètres x 7.5 micromètres !!

Cette puce est tout de même 64 fois plus petite que la plus petite puce avant elle et 9 fois plus petite que le prototype présenté par Hitachi l'année dernière.
Elle contient une ROM de 128 bits permettant de stocker un numéro d'identité de 38 chiffres et peut être facilement intégrée dans une feuille de papier.

Pour rappel, une puce RFID (Radio Frequency Identification) permet une identification automatique du contenu qu'elle transporte. Les puces RFID peuvent contenir toute sorte d'information et se trouvent sur de mout supports comme sur un passeport aux étiquettes de produits vendus en supermarché en passant par des billets de concert. L'apparition de « poudre » de RFID permet de faciliter leur intégration sur de plus en plus de support.



Self-powered nanowire devices



Sheng Xu, Yong Qin, Chen Xu, Yaguang Wei, Rusen Yang and Zhong Lin Wang
Nature Nanotechnology – on line Mars 2010

NanoMatériaux et NanoTechnologies :

Pour un développement Responsable

(Sécurisé, Maîtrisé, Partagé)

Conclusion & Perspectives

Déjà sur le Marché!

(depuis plusieurs décennies)

Comment prendre en compte l'incertitude?

(Cas par Cas ?? 50 ans...)

► Safe by Design

(contrôle de toxicité et/ou exposition– Cycle de vie)

► Safe by Process

(contrôle de l'exposition)

► Inventaire

(Agences Sanitaires– pas seulement démarche volontaire)

► Risques / Bénéfices ?

(transparence des analyses – dialogue parties prenantes)

