Nano-Safety approach at Universidad de los Andes

Propuesta de seguridad en actividades nano en la Universidad de los Andes

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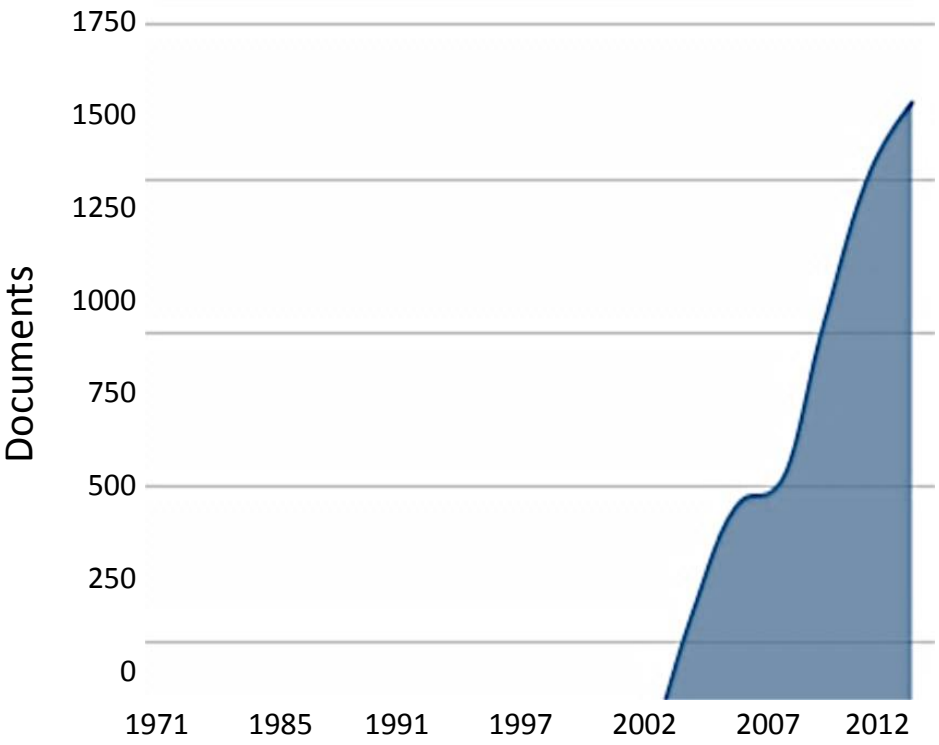
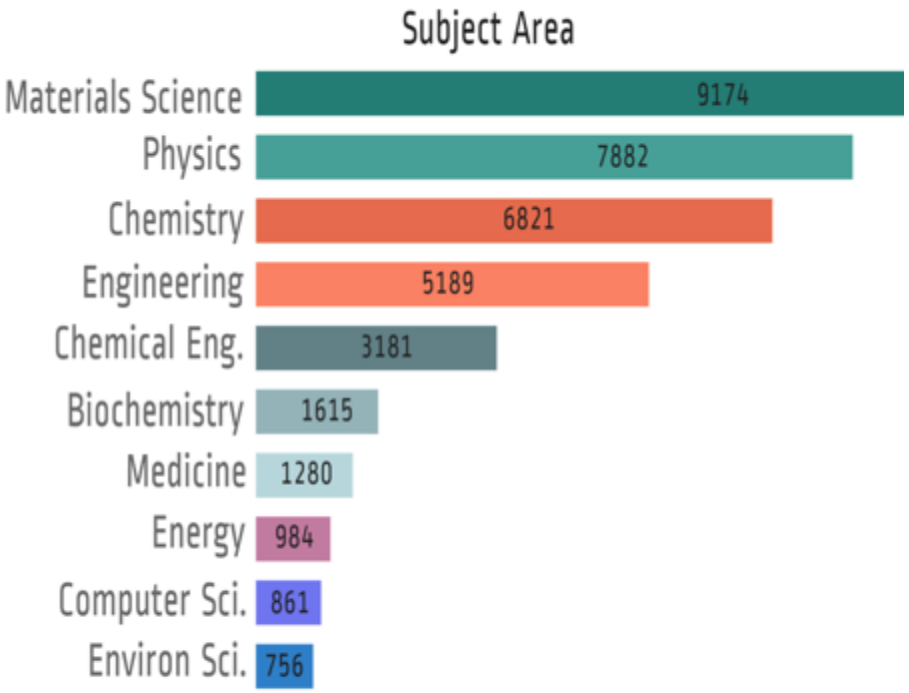
Bogota D.C

2015

Nano publications in Latin America

Publicaciones nano en Latinoamérica

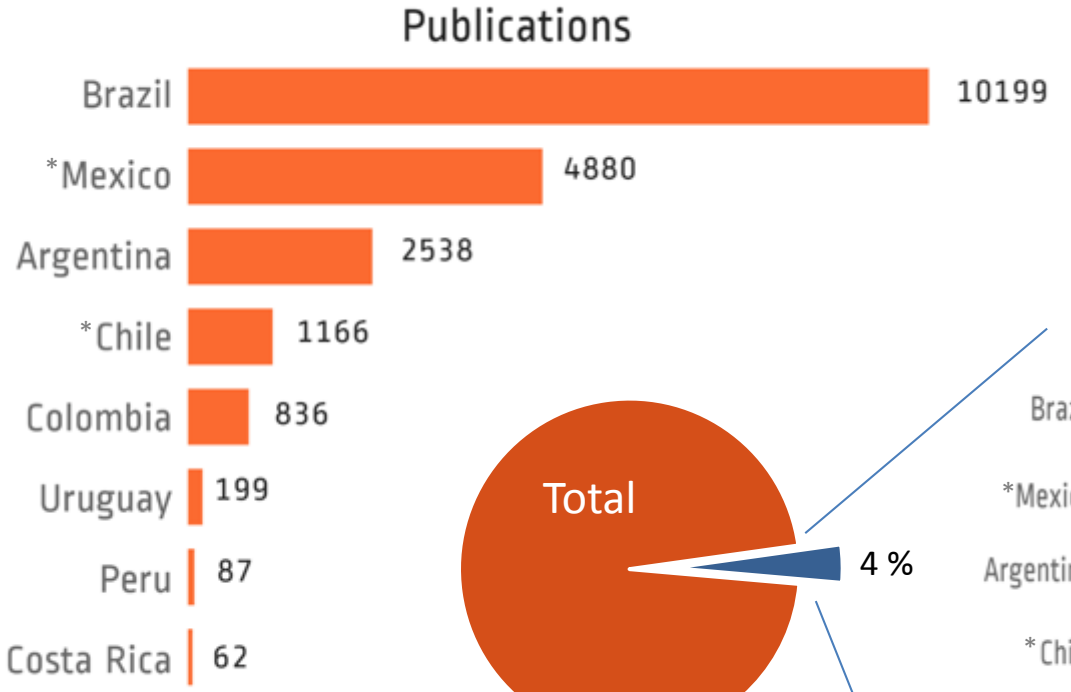




Source: Elseiver-Scopus 02 Jun 2015

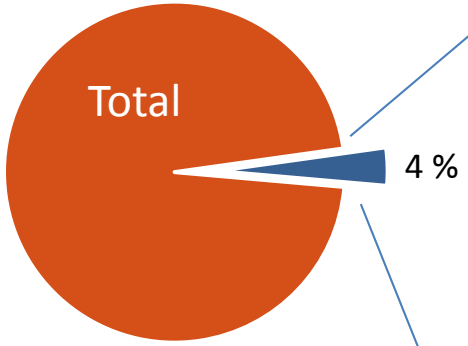
Nano safety vs nano in Latin America

Nano seguridad vs nano en Latinoamérica

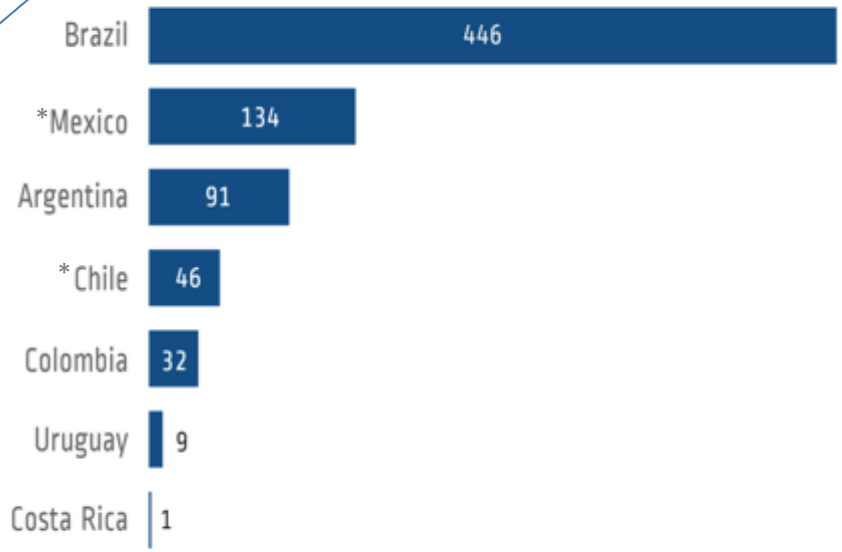


* OECD Countries

Source: Elseiver-Scopus 02 Jun 2015

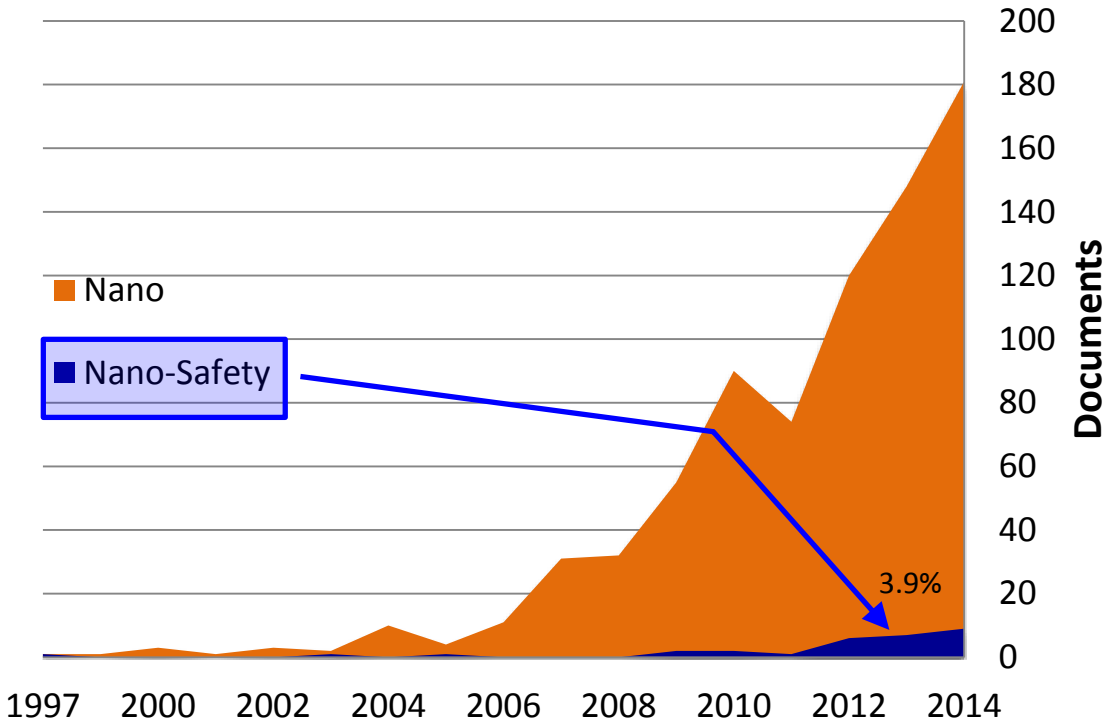


Latin America publications focus on Nano-safety



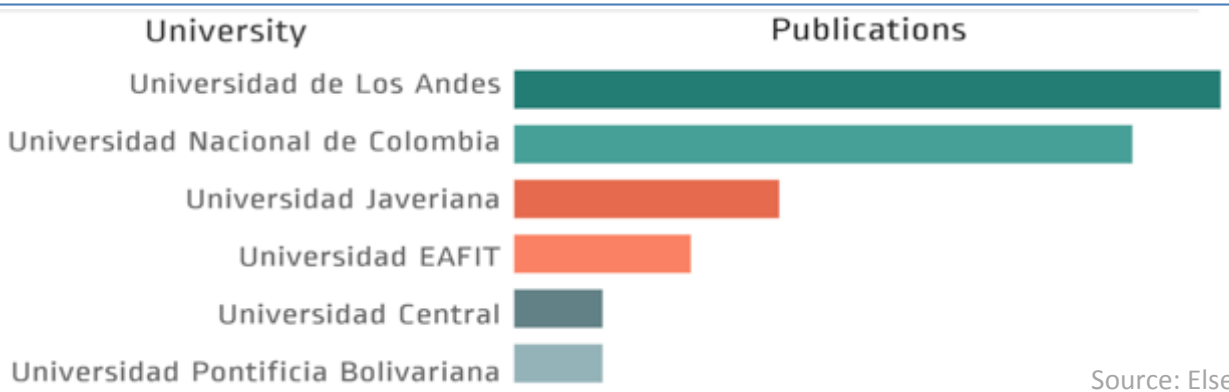
Nano publishing at Colombia

Publicaciones nano en Colombia



Modified from: Linklinejournal.com

Nano-safety by affiliation



Source: Elseiver-Scopus 02 Jun 2015

Colombian nano patents

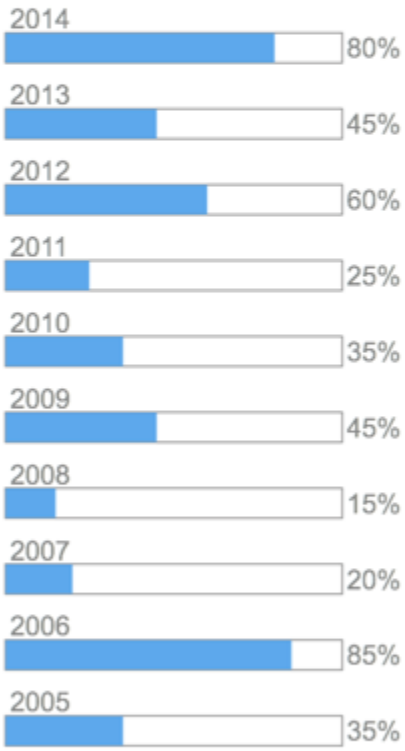
Nano patentes colombianas

Universidad de los Andes

Number of patents
Número de patentes

By Area — By Year

Chem Eng (28%) | Chem (28%) | Mat Sci (24%) | Physics (9%) | Energy (4%) | Agricul (3%) | Biology (3%) | Medicine (3%)



Source: EPO 02 Jun 2015

Database source Info

Información de búsqueda en las bases de datos

Data base: Scopus (http://www-scopus-com.ezproxy.uniandes.edu.co/)
ISI Web (http://apps.webofknowledge.com.ezproxy.uniandes.edu.co/)

Search keywords criteria:

AFFILCOUNTRY(Argentina) OR AFFILCOUNTRY(Brasil) OR AFFILCOUNTRY(Brazil) OR AFFILCOUNTRY(Bolivia) OR AFFILCOUNTRY(Colombia) OR AFFILCOUNTRY(Ecuador) OR AFFILCOUNTRY(Chile) OR AFFILCOUNTRY(Peru) OR AFFILCOUNTRY(Uruguay) OR AFFILCOUNTRY(Paraguay) OR AFFILCOUNTRY(Venezuela) OR AFFILCOUNTRY(Trinidad) OR AFFILCOUNTRY(Panama) OR AFFILCOUNTRY(Costa Rica) OR AFFILCOUNTRY(Guatemala) OR AFFILCOUNTRY(Nicaragua) OR AFFILCOUNTRY(El Salvador) OR AFFILCOUNTRY(Mexico) AND nano

Years searched: 1961 - 2015

Accessed on: Jun 02 2015

Uniandes by the numbers

Universidad de Los Andes en números

	2001	2005	2011	2014
Undergraduate Pregrado	26 *(7,902)*	28 *(10,489)*	31 *(12,497)*	32 *(13,445)*
Master Maestría	22 *(988)*	22 *(1,521)*	38 *(2,515)*	51 *(3,149)*
PhD Doctorado	7 *(4)*	7 *(63)*	14 *(276)*	15 *(420)*
Titular Professors Profesores de planta	389	476	581	629
Facilities Infraestructura (m^2)	63,458	75,955	156,694	163,981

Nano activities distribution at Uniandes

Distribución de actividades nano en Uniandes

Nano-Risk Scenario

Escenario de riesgo nano

Universidad de los Andes

School of Engineering

- 8 floors *(pisos)*
- 3 basements *(sotanos)*
- 56 research labs *(laboratorios)*
- 38,379 m^2 *(45.900 yd^2)*
- 17 H / 6 D
- 5,000 – 10,000 people
  - 5,277 undergraduate *(pregrado)*
  - 992 master *(maestria)*
  - 106 PhD *(doctorado)*

Accredited ABET Engineering Accreditation Commission

Nano-Risk Scenario

Escenario de riesgo nano

Universidad de los Andes

School of Engineering

- 1 Clean room
  (sala limpia)
- 10 labs working on nano
  (laboratorios usando nanomateriales)
- 360 people exposed
  (personas expuestas)
  - 300 Indirect
    (indirectos)
  - 60 Direct (directos)

Accredited ABET Engineering Accreditation Commission

Nano-Risk Challenge

Retos con el Riesgo-Nano

¿How to manage the safety of a laboratory where nano-materials are handled?

¿Cómo gestionar la seguridad de laboratorios que sintetizan o manipulan nano-materiales?

¿How to turn research & development processes into academic oportunities to construct safety cultutre?

¿Cómo convertir los procesos de investigación y desarrollo en oportunidades académicas para construir cultura de seguridad?

¿How to include the emerging risks related to the handling of nano-materials or nano-composites in the HSE management?

¿Cómo incluir los riesgos emergentes asociados al uso de nano-materiales o nano-compuestos en la gestión HSE?

Main objectives

Objetivos principales

Provide safe environment to develop nanotechnology activities at Universidad de Los Andes

Protect human health

Proteger la salud humana

Protect environment

Proteger en medio ambiente

Protect facilities

Proteger la infraestructura

Protect institution goodwill

Proteger la reputación de la institución

Promote sustainable research and innovation development

Promover el desarrollo sostenible de investigación e innovación

Risk Management flow

Flujo de gestión del riesgo

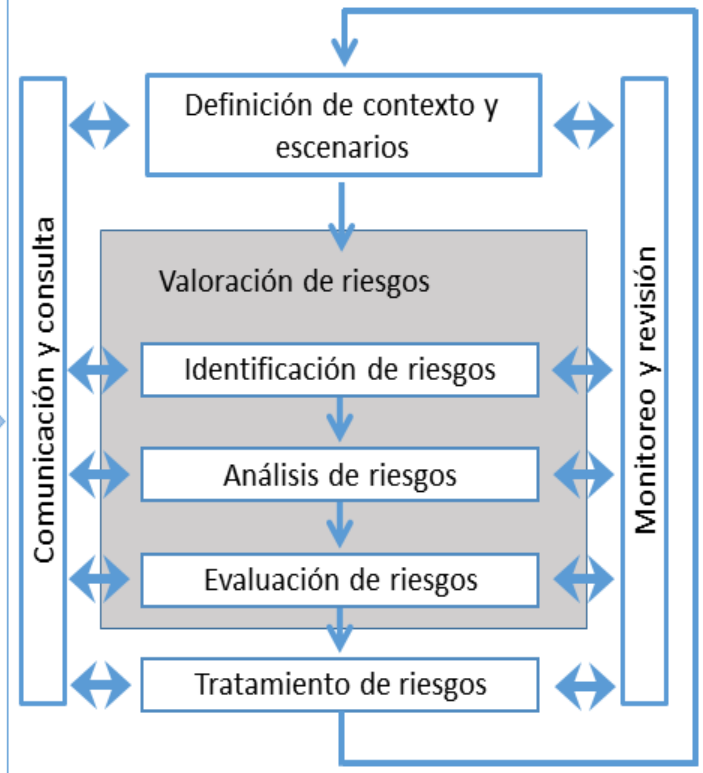
Universidad de los Andes

Principios para la G R

- Creación de Valor
- Integridad
- Soporte a la toma de decisiones
- Reducción de incertidumbre
- Sistematicidad
- Exhaustividad
- Repetitividad
- Escrutabilidad
- Mejor Info. Disponible
- Pertinencia
- Inclusión de factores humanos y culturales
- Participación
- Flexibilidad
- Aprendizaje continuo de la Organización

Marco organizacional para la G R

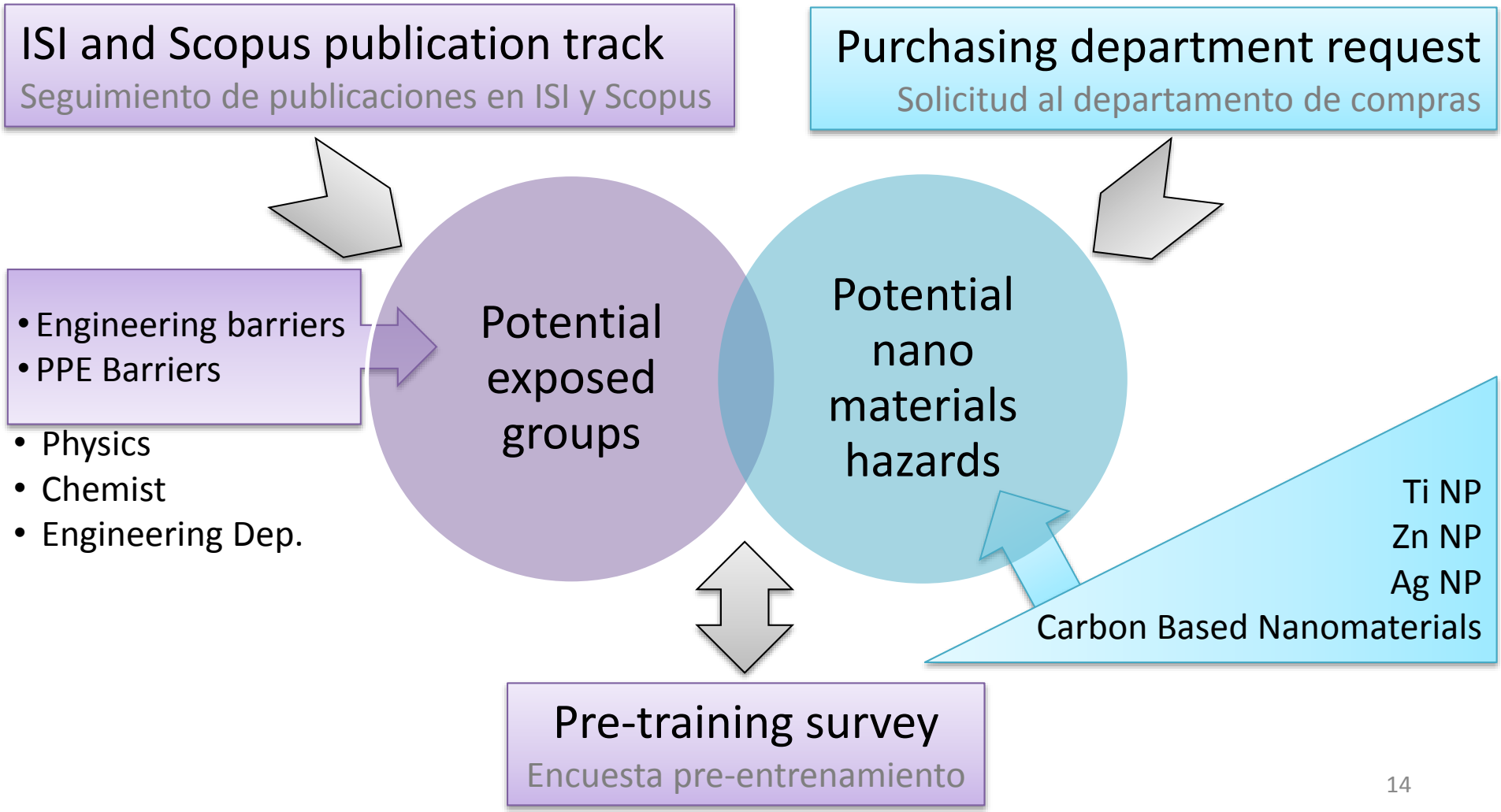
Procesos de G R



ISO 31000-2009

Scenaries and context definition

Definición de contexto y escenarios



Risks identification

Identificación de riesgos

Risk perception of nano?

¿Cual es la percepción de riesgo nano?

Are nanomaterials potentially harmful for health?

¿Son los nanomateriales potencialmente riesgosos para la salud?

Did you considered nano-risk while you were planing your experients

¿Considero el riesgo nano mientras planeaba sus experimentos?

Risks identification

Identificación de riesgos

Have you been trained on safety handling of nanomaterials?

¿Ha recibido entrenamiento en el manejo seguro de nanomateriales?

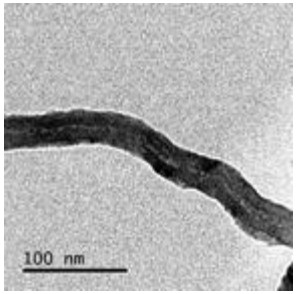
Which PPE do you use to handling nanomaterials?

¿Que EPP usa usted para manipular nanomateriales?

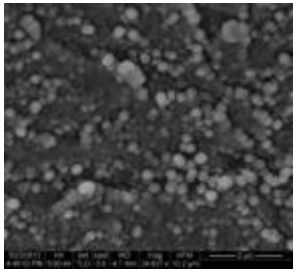
Risks identification

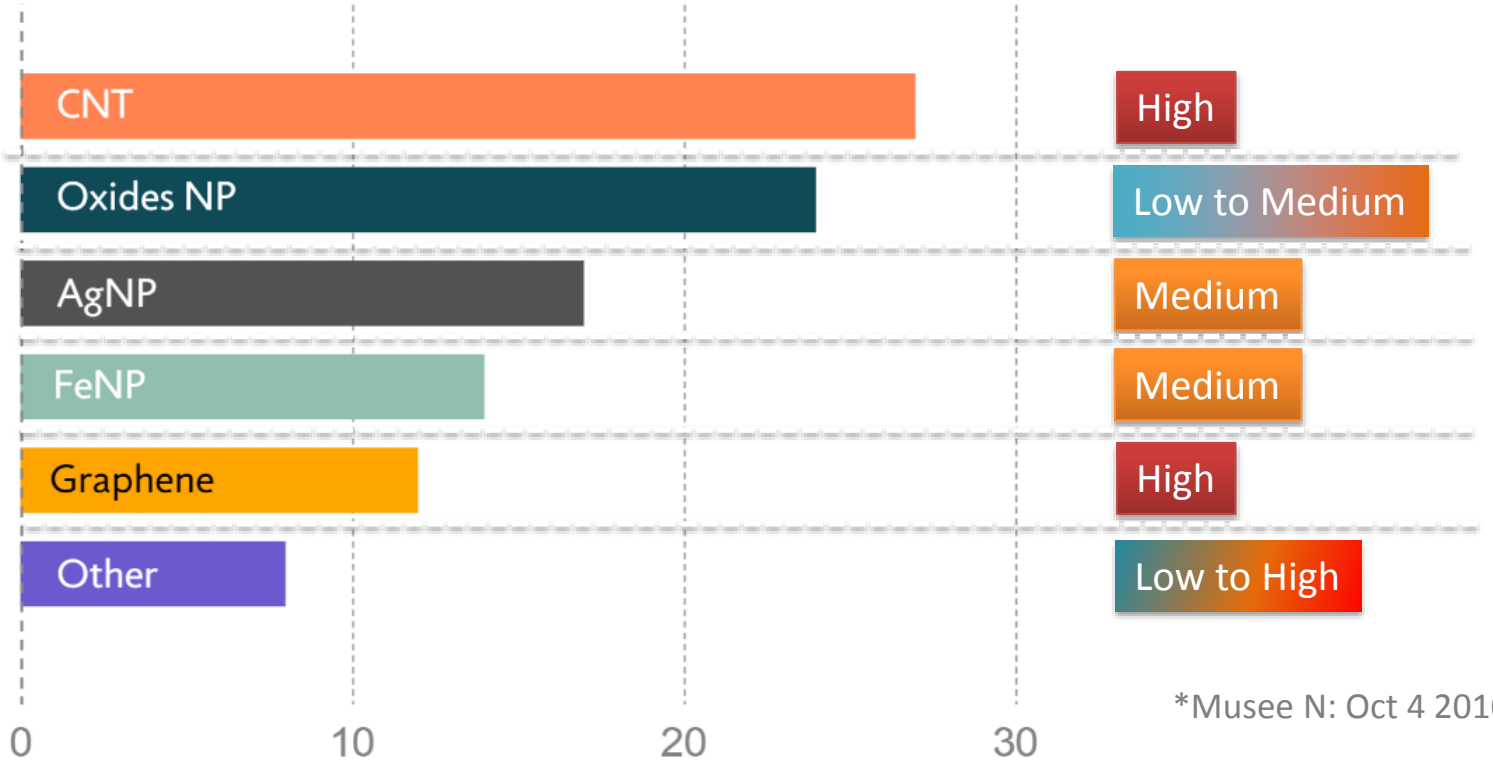
Identificación de riesgos

MWCNT



Ag Nanoparticles





*Musee N: Oct 4 2010

Universidad de los Andes

Table 1. Qualitative quantification of toxicity levels of different NMs based on the currently available ecotoxicity data

NMs type	Examples	Hazard (toxicity)[a]
Carbon based	Fullerenes	High
	Singled-walled carbon nanotubes (SWCNT)	High
	Multi-walled carbon nanotubes (MWCNT)	High
Metal oxides	Zinc oxide (ZnO)	Medium
	Titanium oxide (TiO_2)	Low
	Aluminium oxide (Al_2O_3)	Medium
	Yttrium iron oxide ($Y_3Fe_5O_{12}$)	Low
	Silicon dioxide (SiO_2)	Low
	Iron oxide (Fe_2O_3)	Medium
Metals	Silver (Ag)	Medium
	Gold (Au)	High
	Silica (Si)	Low
Quantum dots	Cadmium-selenide (CdSe)	High
	Cadmium telluride (CdTe)	High
Others	Silicon nanowires	Low
	Nanoclay particles	Low
	Dendrimers	Medium

Musee N: Oct 4 2010

Risks Assessment

Análisis de riesgos

Risk of involuntary exposure
Riesgo de exposición involuntaria

- **Nano-risk misperception** (Percepción inadecuada del riesgo nano)
- **Incomplete or lack of safety-training on handling nanomaterials** (Entrenamiento incompleto o ausente en el manejo seguro de nanonomateriales)
- **Incomplete use of PPE** (Uso incompleto de EPP)

Use of potentially hazardous nanomaterials
Uso de nanomateriales potencialmente peligrosos

- **Carbon based nanomaterials** (Nanomateriales basados en carbono)
- **Metals and oxides** (Oxídos y metales)

Risk of environmental issues
Riesgos al medio ambiente

Risks Evaluation & treatment

Evaluación y tratamiento de riesgos

Universidad de los Andes

High risk of involuntary exposure
Alto riesgo de exposición involuntaria

Training on nanomaterials and safety
Entrenamientos en nanomateriales y seguridad

Protocols for safety handling of CBN
Protocolos para el manejo seguro de NBC

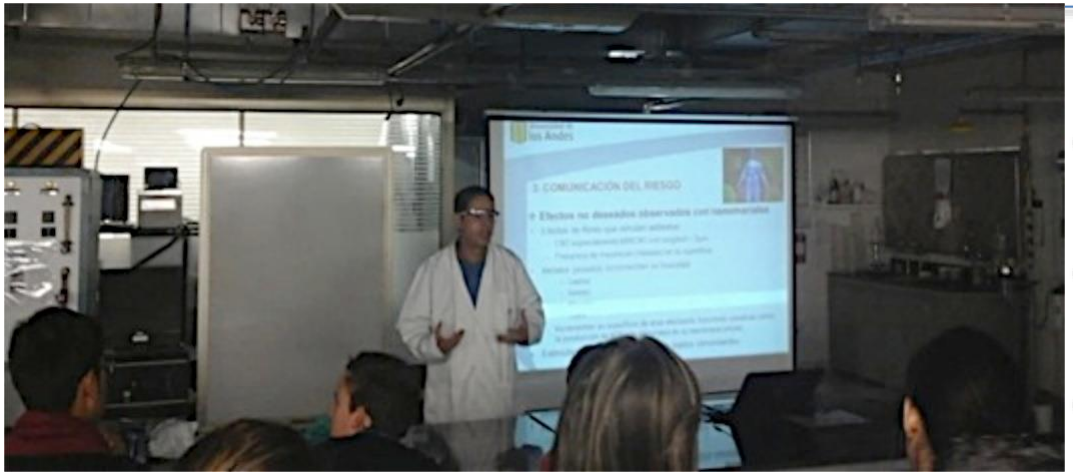
App to self-assessment of nano-risk
Aplicativo para auto-evaluación del riesgo nano

Use of potentially hazardous nanomaterials
Uso de nanomateriales potencialmente peligrosos

Preventive controls

Controles preventivos

Training based on lifecycle: handling,storage labeling and disposal



- 10 Lab's technicians
- 70 undergrad students
- 10 postgraduate students
- 5 Full time professors

- Definitions
- Properties
- Potential risks
- Cases/examples
- Proposed risk management plan at Uniandes
- Barriers (Personal, engineering)
- App Introduction

Preventive controls

Controles preventivos

Self-assessment of nano-risk, mobile app

Nanomaterial hazard identification

Identificación del peligro nano

Exposure liability

Riesgo de exposición

Suggested protective equipment

Equipos sugeridos de pretección

Corrective controls

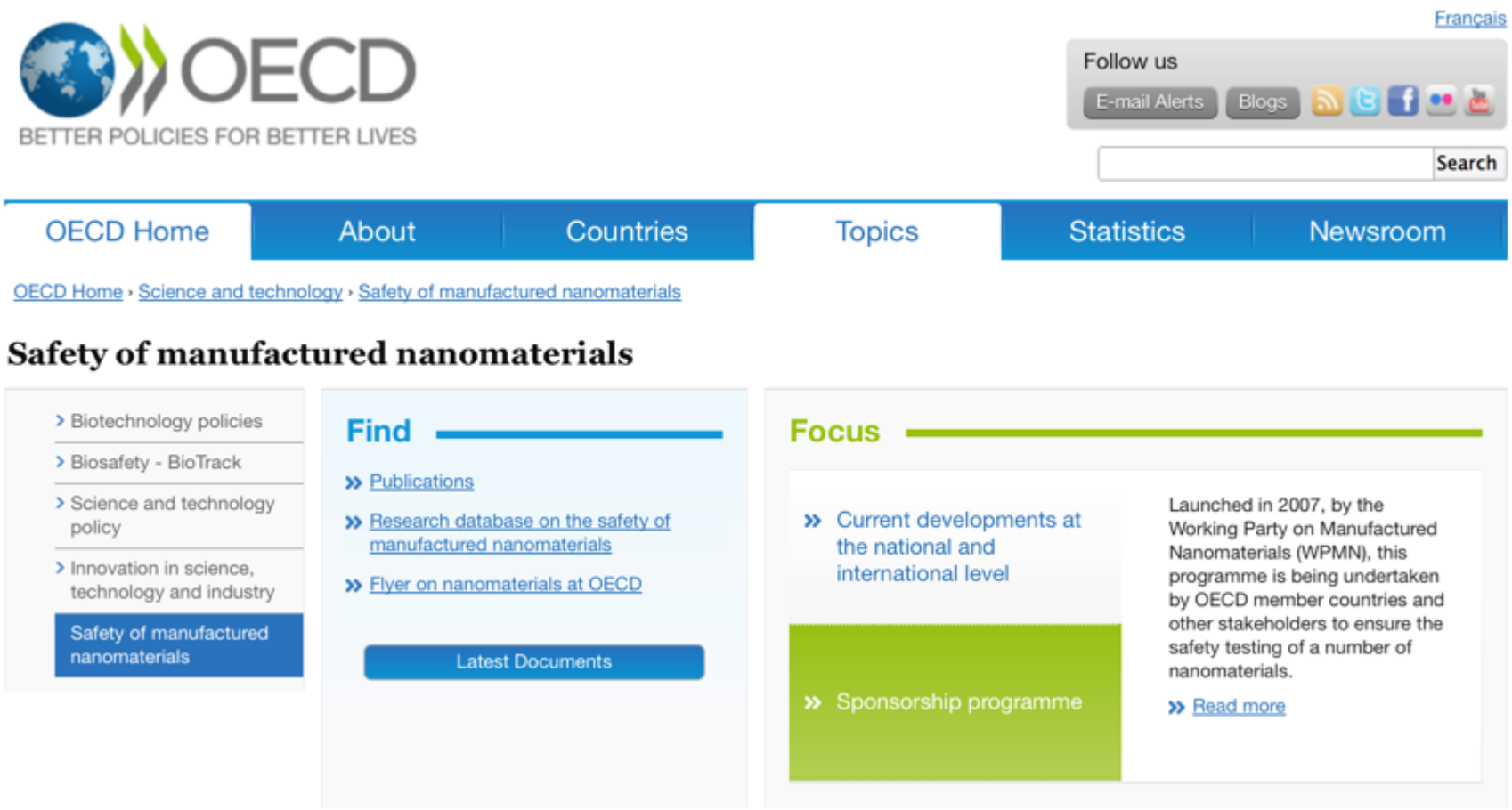
Controles correctivos

Safe handling of carbon based nanomaterials' protocols

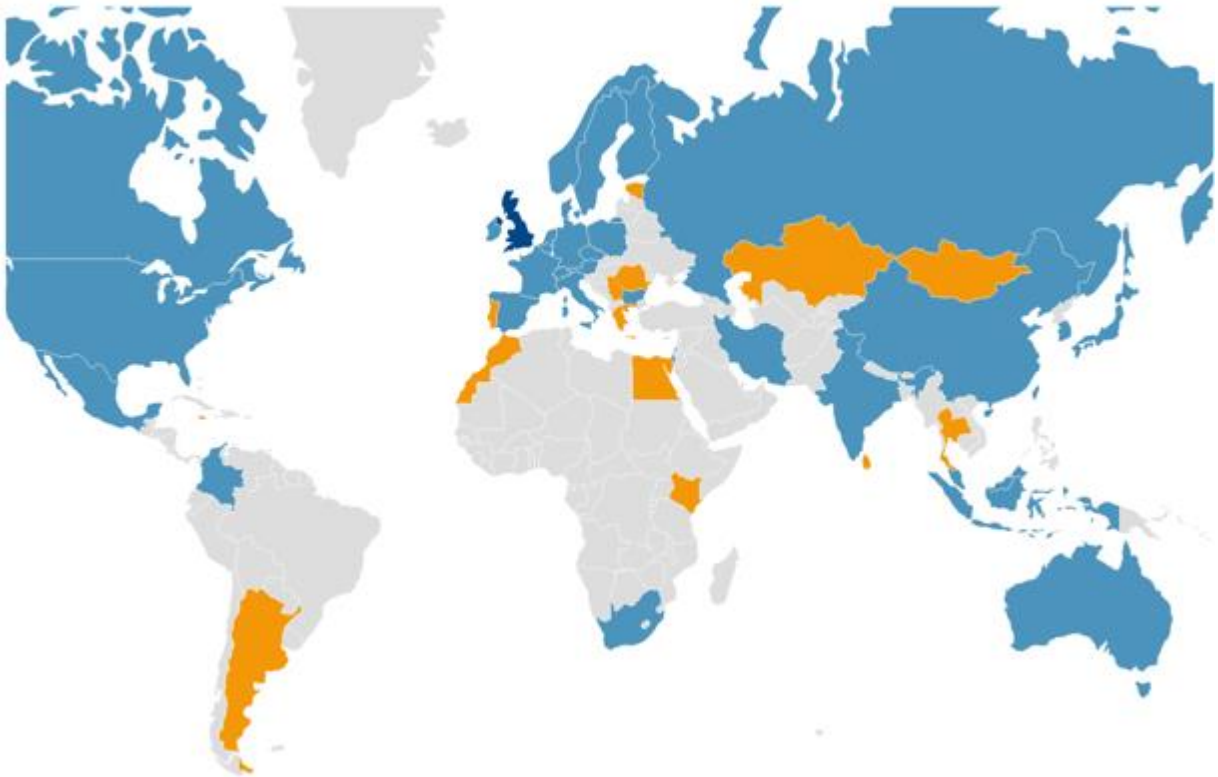
web

- Public access to the protocols by intranet
- Identify the different CNTs
- Explain the potential health risk
- Assess the risk according with the CNT & Activities
- Suggest the appropriate exposure barriers
  - Administrative
  - Engineering
  - Personal protective equipment
  - Waste disposal
  - Accident management

Some Strategic Programmes



ISO/TC 229 - Nanotechnologies



Total number of published ISO standards related to the TC and its SCs (number includes updates):	42
Number of published ISO standards under the direct responsibility of ISO/TC 229 (number includes updates):	42
Participating countries:	33
Observing countries:	15

Nano-safety roadmap for researchers

Is the material
- Solid?
- dimension< 100 nm ?
- Insoluble in water/bodily ?fluids?

Yes → Toxic

No → Is the nanomaterial PROVEN to be nontoxic and non pyrophoric?

Yes → Treat as normal chemical.

No → **Be cautious!!**

Prevent exposure to nanomaterial as much as possible.

Use the Occupation Hygiene Strategy to prevent exposure:

1. Eliminate the material
2. Isolate the material
3. Substitute the material with another.
4. Ventilate the environment
5. Wear personal protective equipment.

Is the nanomaterial embedded in a matrix such as a liquid?

Yes → Use gloves and replace them after contact. Clean up spills.

No → Are you handling the nanomaterial in a leakproof closed reaction vessel, 'closed' fume hood or a glove box?

Yes → Test the pyrophoric properties on small scale (bring a small amount in contact with air).

For reaction vessels, filter the exhaust gas with a HEPA filter.

No → Is the nanomaterial handled in a 'open' fume hood or a controlled open environment?

Yes → Use a full face mask with P3 certified cartridges to prevent inhalation exposure, use(double pair of) gloves and a lab coat.

Unknown material

Always

Use your knowledge and common sense.

Ask for advice when in doubt.

Assess the risks of your nano-material and incorporate it in your safety report.

Monitor the lab air- before, during and after handling the nanomaterial- and compare to the benchmark exposure limits.

Cleaning Procedure

Set a cleaning procedure in place.

Wipe with a wet cloth(use water or solvent) or clean with a vaccum cleaner suitable for nanomaterial(monitor the exhaust periodically).

Prevent (inhalation) exposure during cleaning by working in a fume hood when possible and wearing appropriate personal protective equipment.

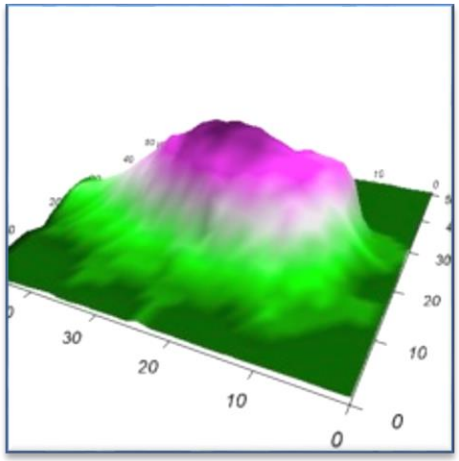
Dispose of cloth, gloves and solvents as chemical waste.

Next activity

Siguiente actividad

It will takes 40 min, in three labs

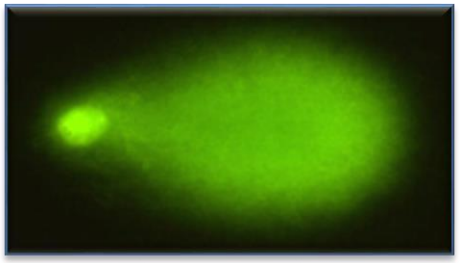
Tomará 40 min, en tres laboratorios



Atomic force microscopy (AFM)

Microscopía de fuerza átomica

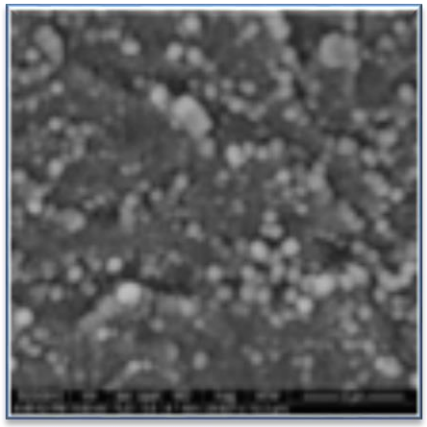
- tribology measurement of lubricants



Genotoxicity of nanomaterials on mammalian cells

Genotoxicidad de nanomateriales en células de mamíferos

- Comet assay
- MTT assay



Scanning electron microscopy (SEM)

Microscopía electrónica de barrido

Thanks

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Gracias