Nanomaterial Safety Complementary directive

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DSE-OHS
Occupational Health and Safety

Nanomaterial safety

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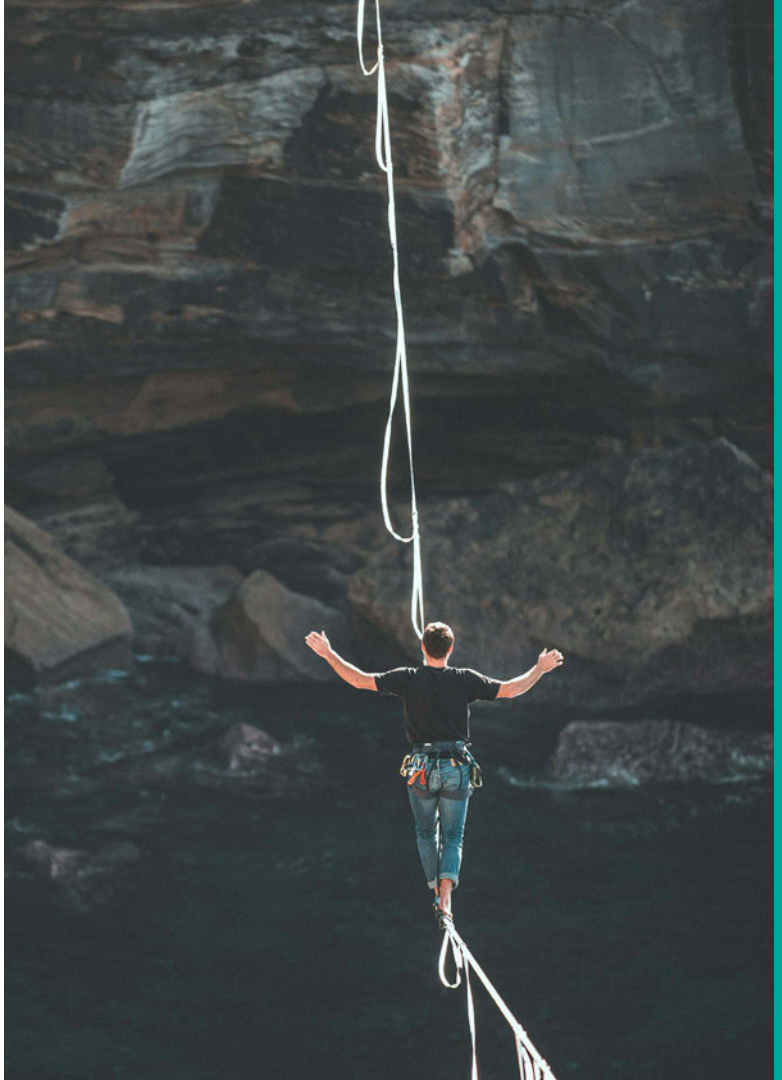
Introduction on risk management

Nanomaterial hazard and exposure

EPFL policy on nanomaterial safety



Risk Management

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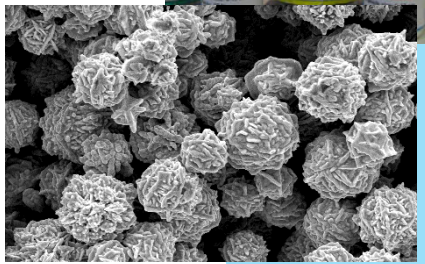
Key safety parameters



Hazard

A **hazard** is something that has the potential to harm you.

Risk

Exposure

The **exposure** is the contact you have with the hazard

Risk is a combination of **Exposure** and **Hazard** that could lead to potential injury or disease.

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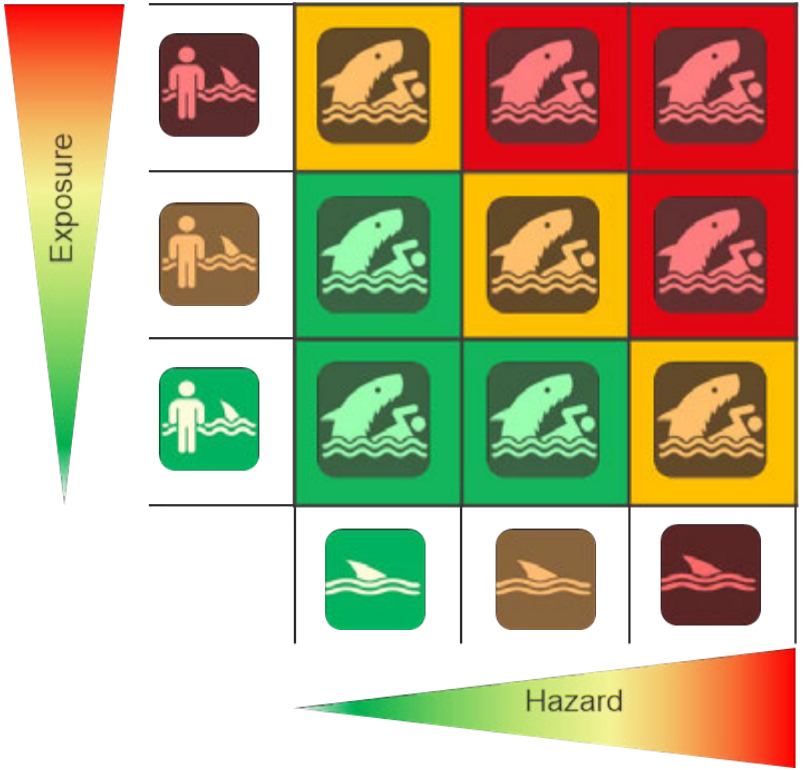
Reduce the risk



You must know the **hazards** you are exposed to!

The goal of successful risk management is to move from the red zone (unacceptable risk) towards the green zone (acceptable risk) in the risk matrix.

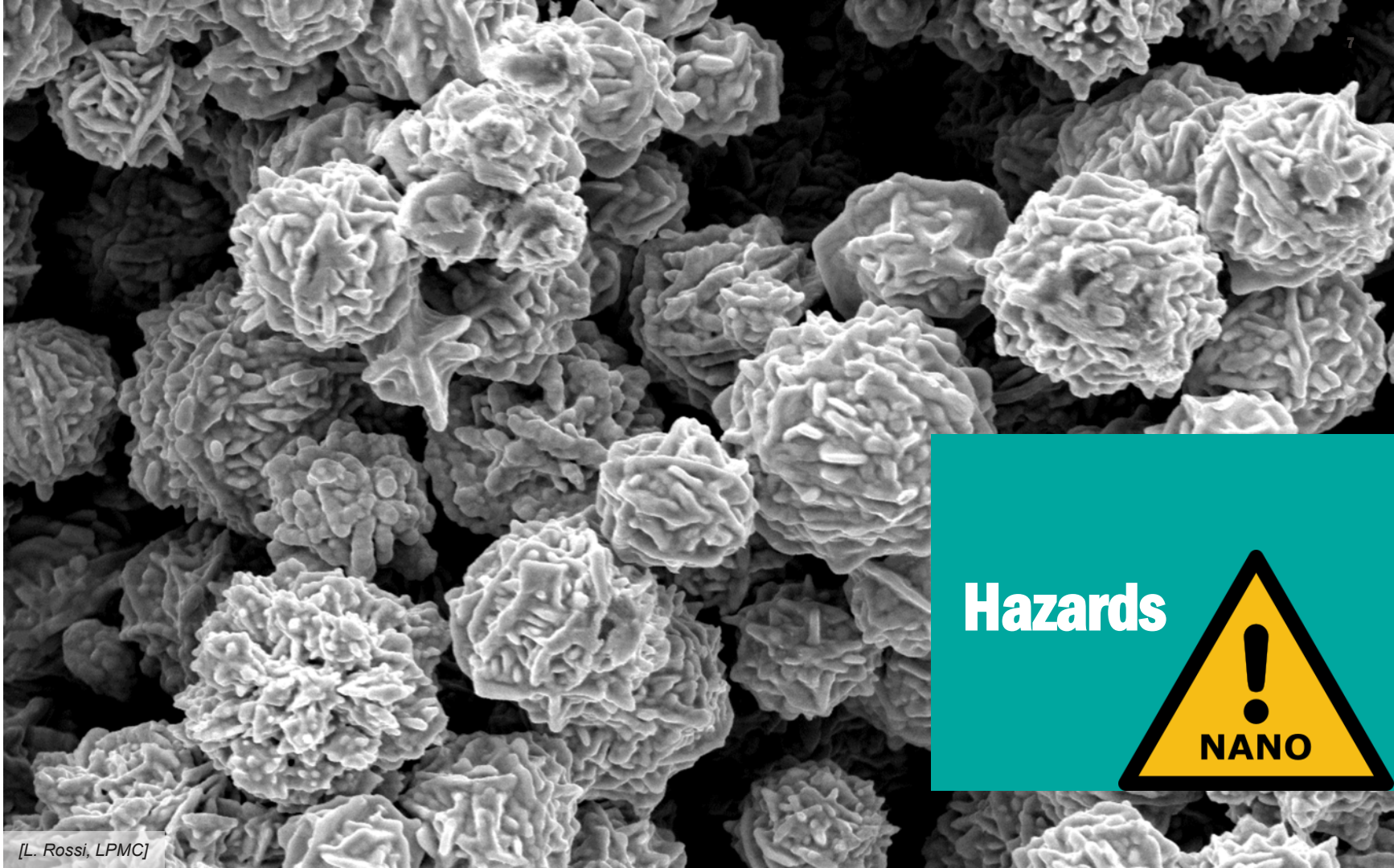
1. **You can reduce the risk by <u>reducing the hazard</u>.**

Example: Using a less hazardous nanomaterial, changing the size of the nanomaterial.

2. **You can reduce the risk by <u>reducing the exposure</u>.**

Examples: wearing respiratory protection, working in an enclosure.

Hazard and exposure



[L. Rossi, LPMC]

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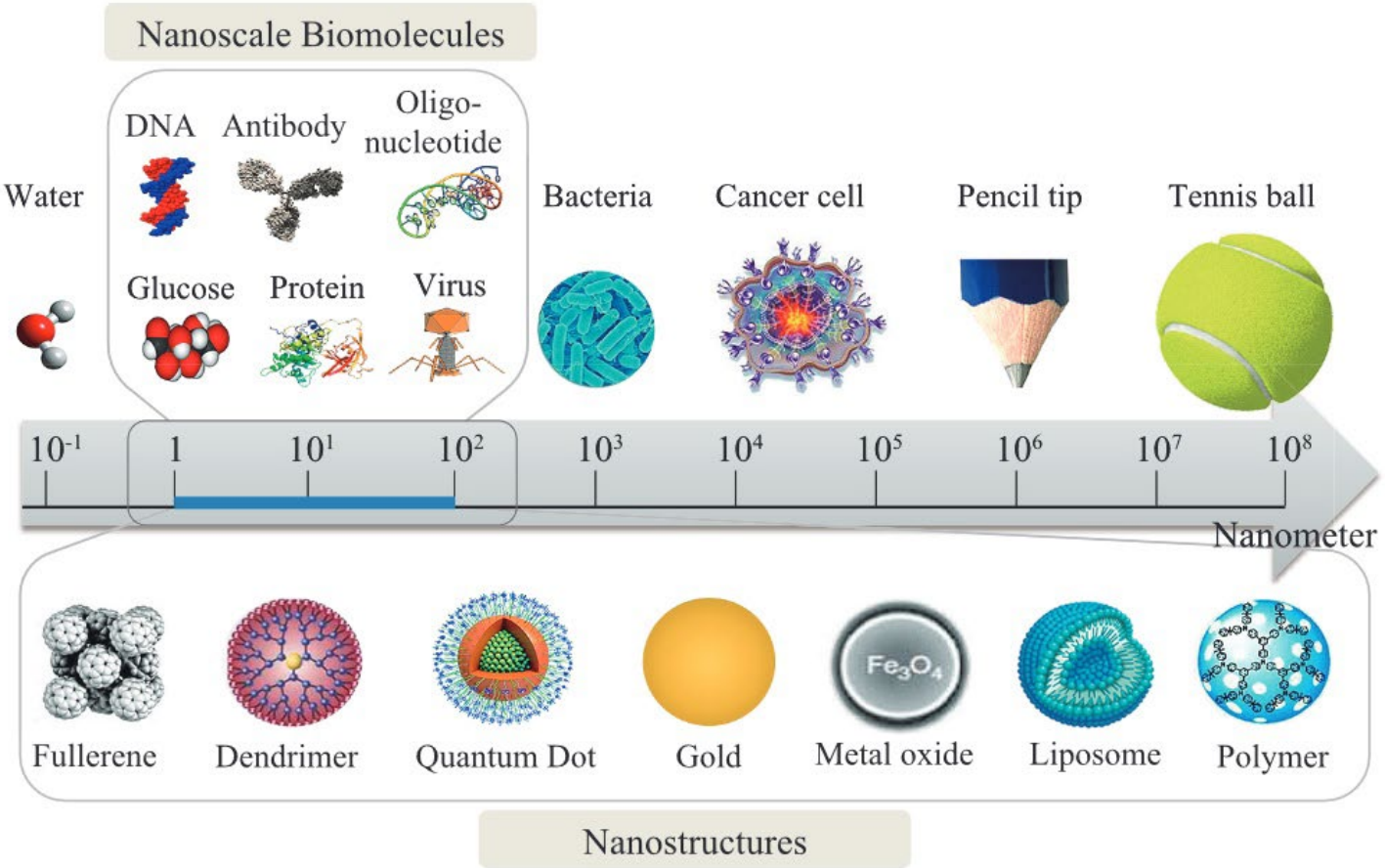
The nanometer scale



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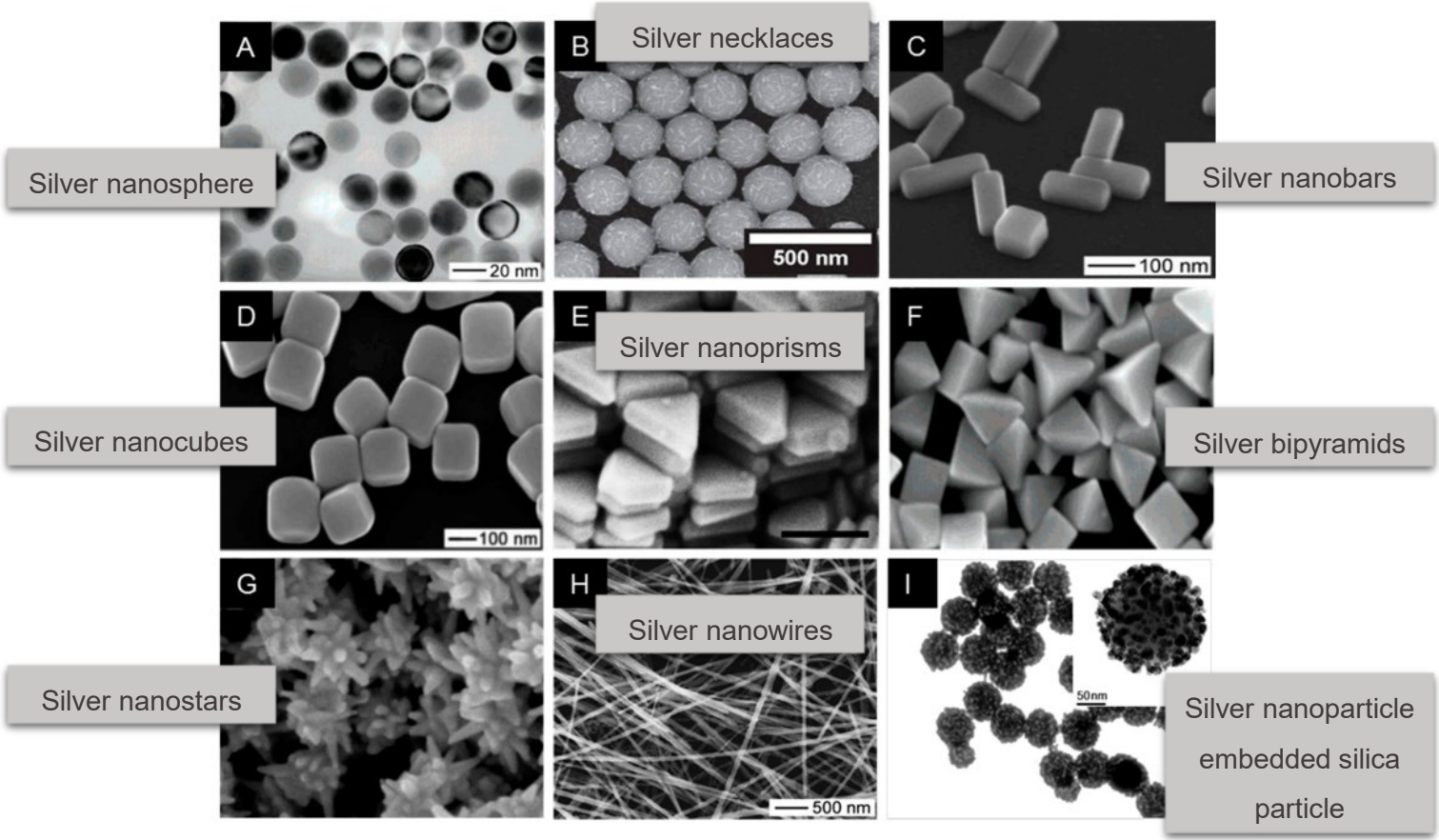
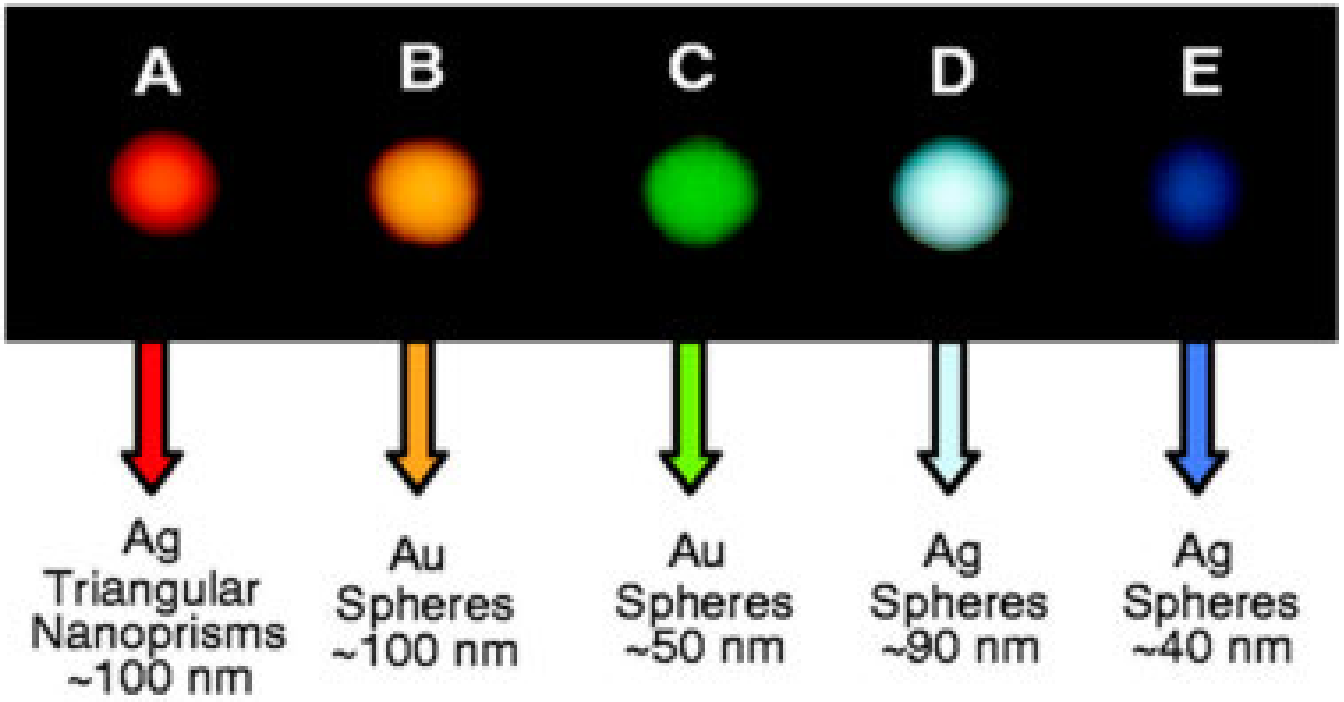
One chemical (Silver) and multiple shapes



S. H. Lee and B.H: Jun, Int. J. Mol. Med, 2019

Changes of the optical properties according to the size and shape



S. H. Lee and B.H: Jun, Int. J. Mol. Med, 2019

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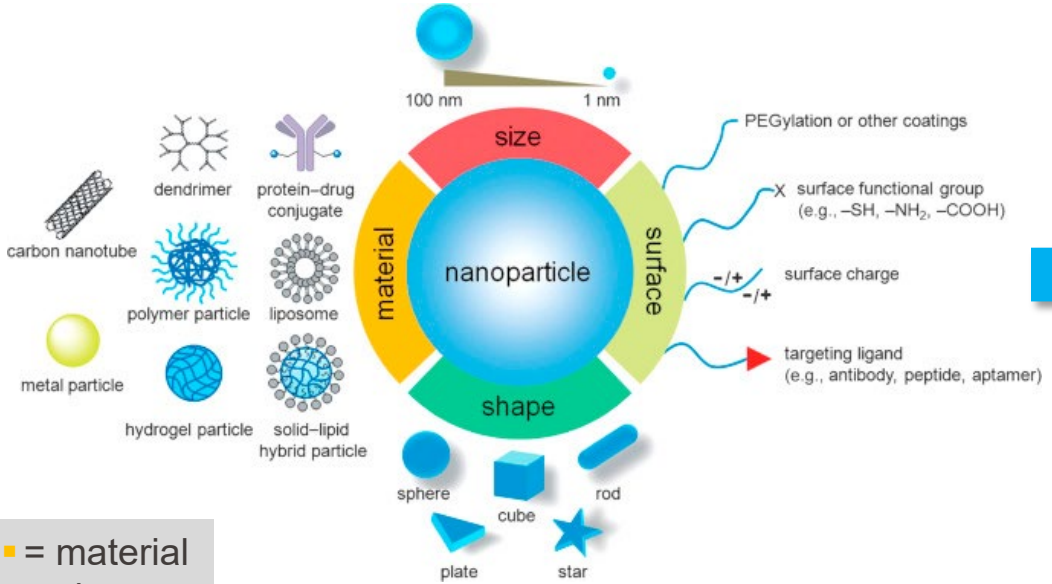
Nanomaterial properties and toxicity



determine

- Chemical Reactivity
- Biological Reactivity
- Toxicity
- Flammability
- Explosiveness

- = material
- = size
- = surface
- = shape

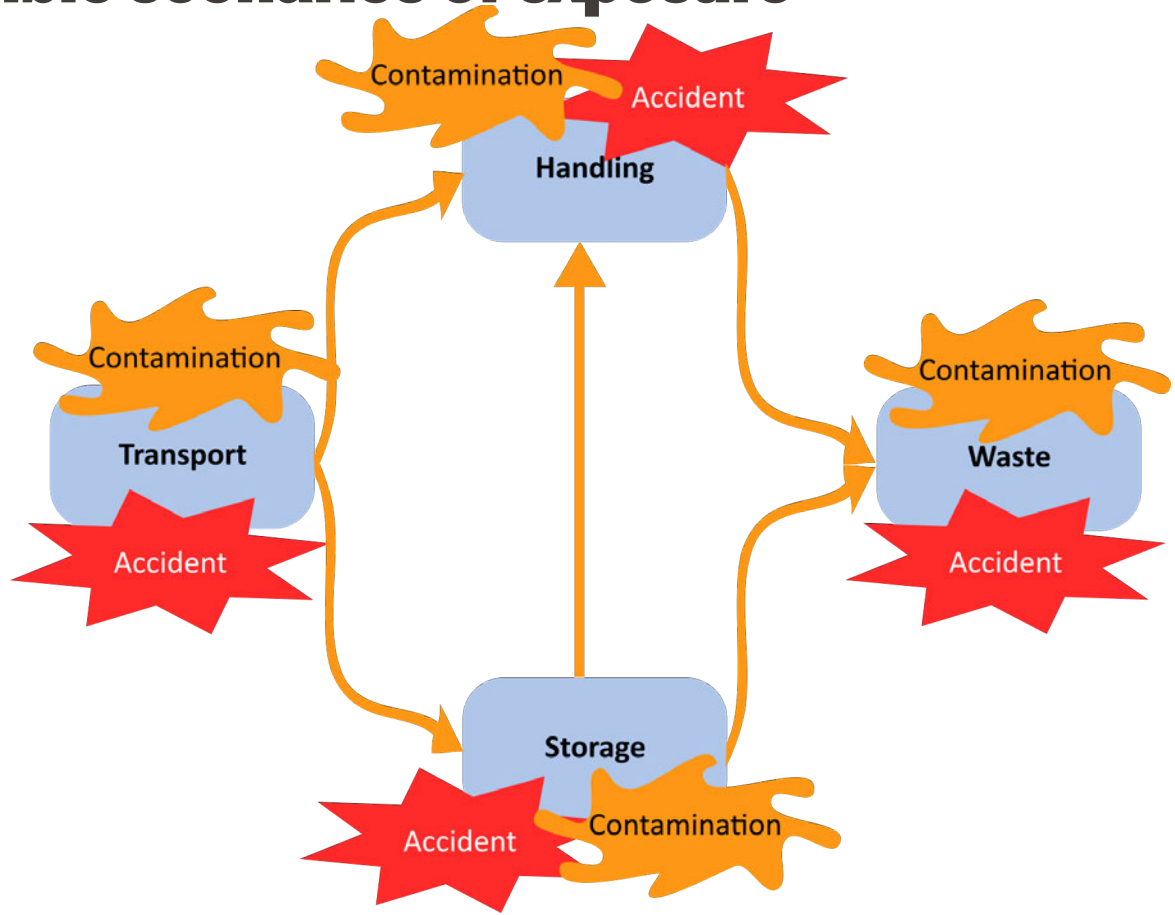
- Chemical composition
- Crystal structure
- Size and particle size distribution
- Solubility
- Specific Surface Area
- Surface properties (charge, reactivity, chemistry and surface defects)
- Morphology
- Degree of agglomeration and aggregation

[T. Sun et al, Angewandte Chemie International Edition (2014)]

Exposure

[Polina Tankilevitch from Pexels]

Possible scenarios of exposure



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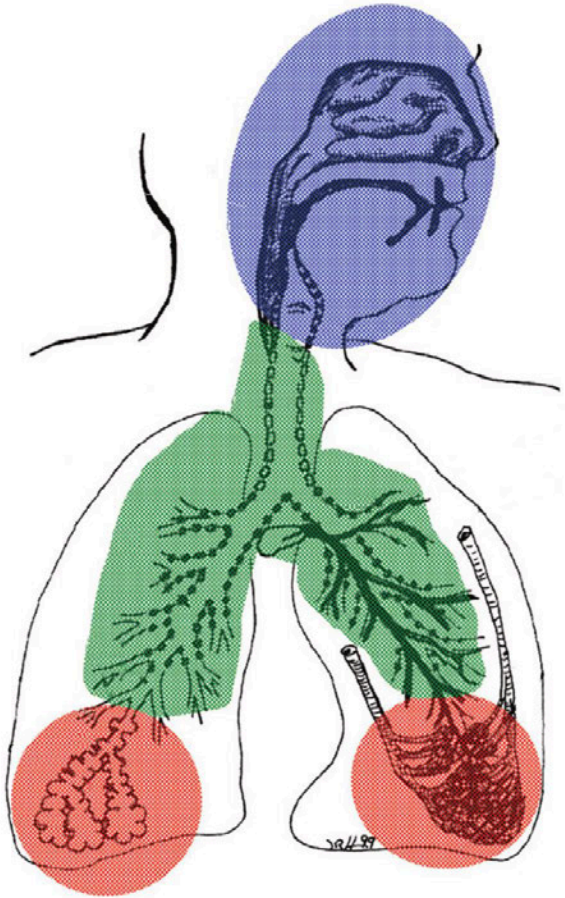
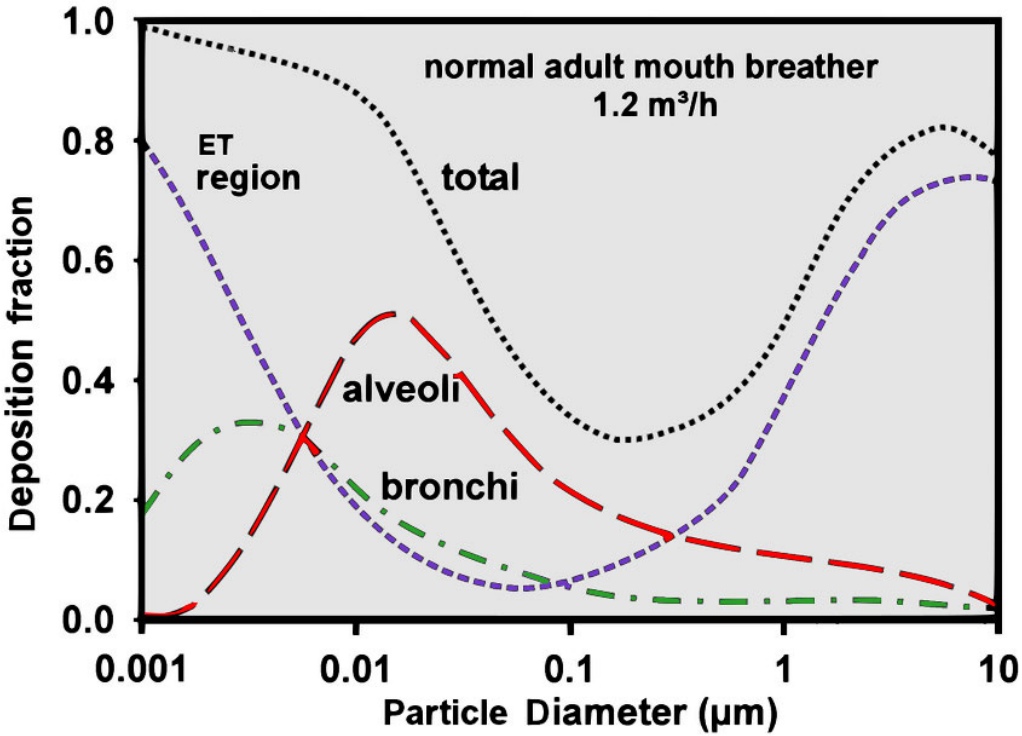
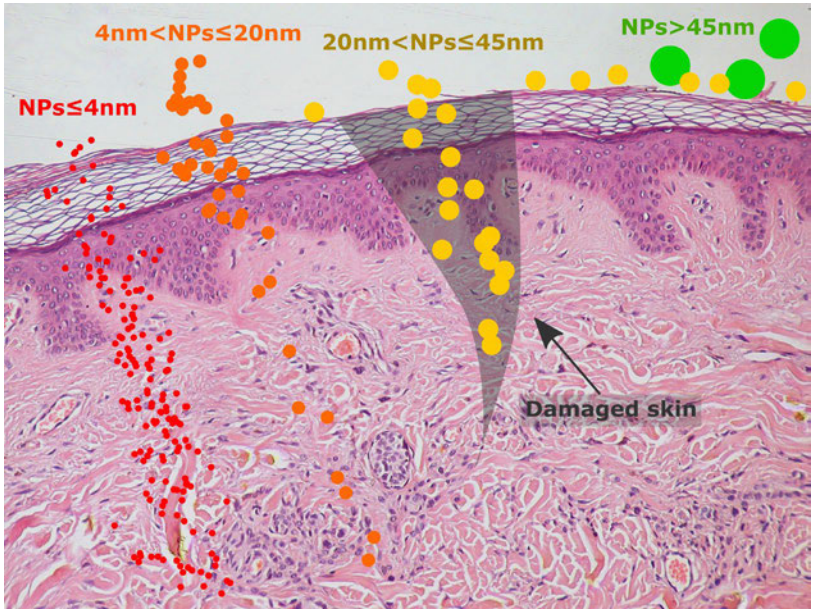
Inhalation exposure





[Oberdörster G et al., Environ Health Perspect. (2005)]

Skin exposure



[adapted from Wikipedia]

- **NPs ≤ 4 nm** can penetrate and permeate intact skin
- **4 nm < NPs ≤ 20 nm** can potentially penetrate the skin
- **20 nm < NPs ≤ 45 nm** can penetrate and permeate only damaged skin
- **NPs > 45 nm** cannot penetrate nor permeate the skin

[F. L. Filon et al, Reg. Tox. Pharmacology (2015)]

EPFL approach to nanosafety

- Hazard assessment
- Exposure assessment
- Mitigation measures

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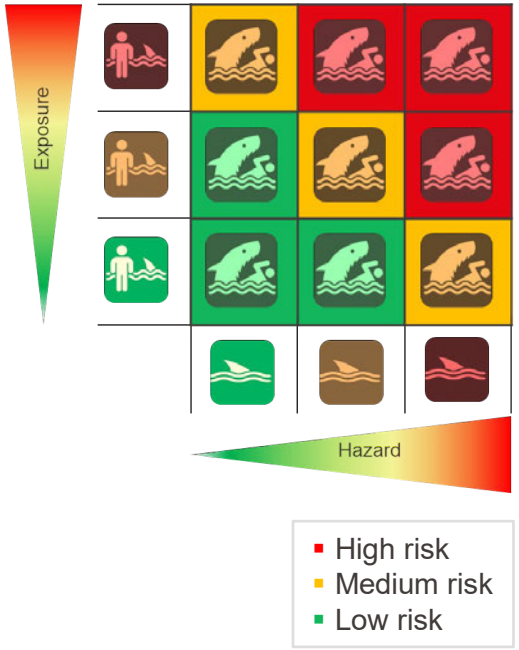
Complementary directive (old Lex 1.5.5)

Control banding is a pragmatic approach used for the control of workplace exposure to possibly hazardous materials when:

- The toxicological properties are unknown or uncertain.
- Quantitative exposure estimations are limited or lacking.

The greater the potential for harm, the greater the levels of protection needed for exposure control.

The **precautionary principle** is applied when preliminary scientific evaluation indicates reasonable grounds for concern.

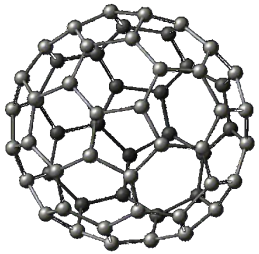


The EPFL tool for nanomaterial risk management is based on a **control banding approach** and the **precautionary principle**.

ISO/TS 12901-2:2014 - *Control banding*

Nanomaterial definition

Nanomaterial *means a natural, incidental or manufactured material consisting of solid particles that are present, either on their own or as identifiable constituent particles in aggregates or agglomerates, and where* ***50 % or more*** *of these particles in the* ***number-based size distribution*** *fulfil at least one of the following conditions:*



Particles
size range
1 nm to100 nm

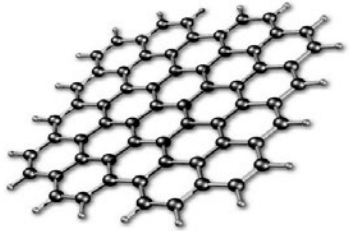
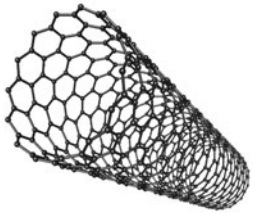


Plate-like shape
width < 1 nm
sides > 100 nm



Elongated shape
diameter <1 nm
length > 100 nm

[COMMISSION RECOMMENDATION of 10.6.2022 on the definition of nanomaterial (Text with EEA relevance) 2022/C 229/01]

Engineered nanomaterial (ENM)

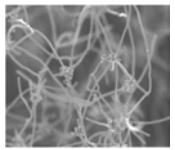
Nanomaterial designed for a specific purpose or function. [ISO/TS 80004–1 (2010)]

EPFL risk management method

Three step process

1. Hazard assessment of nanomaterial
2. Determination of Nano level of laboratory
3. Implementation of mitigation measures

Self-evaluation using the annexes of the internal directive



The laboratory head announces to OHS that the research unit will start working with nanomaterials

The hazard level is determined based on the intrinsic properties of the nanomaterials

- H1
- H2
- H3

The acceptable exposure is evaluated based on the hazard level of the materials

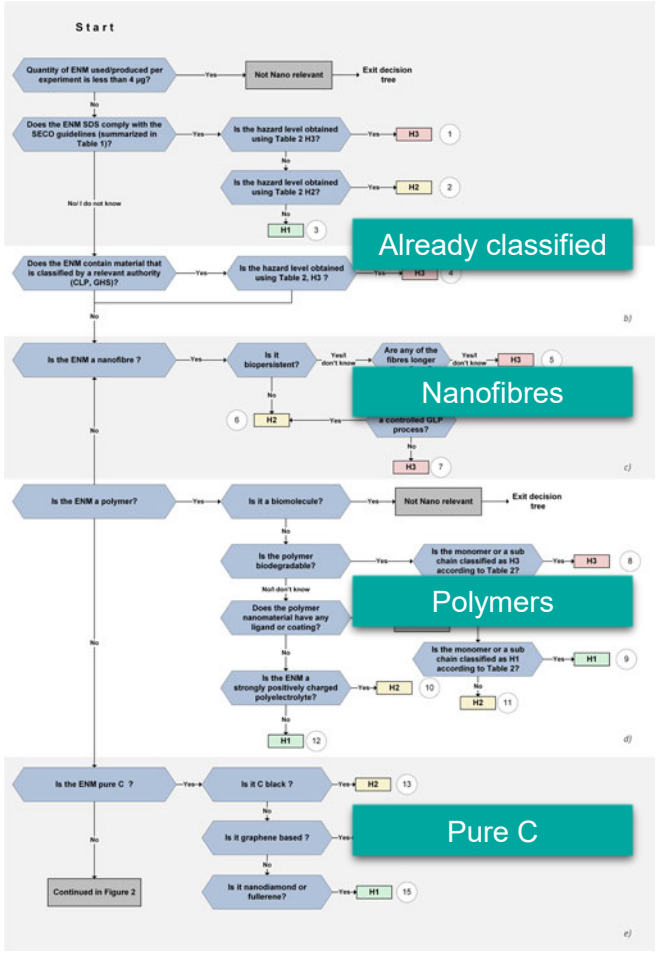
The laboratory is classified into a Nano level based on the materials and the total amount of nanomaterial used

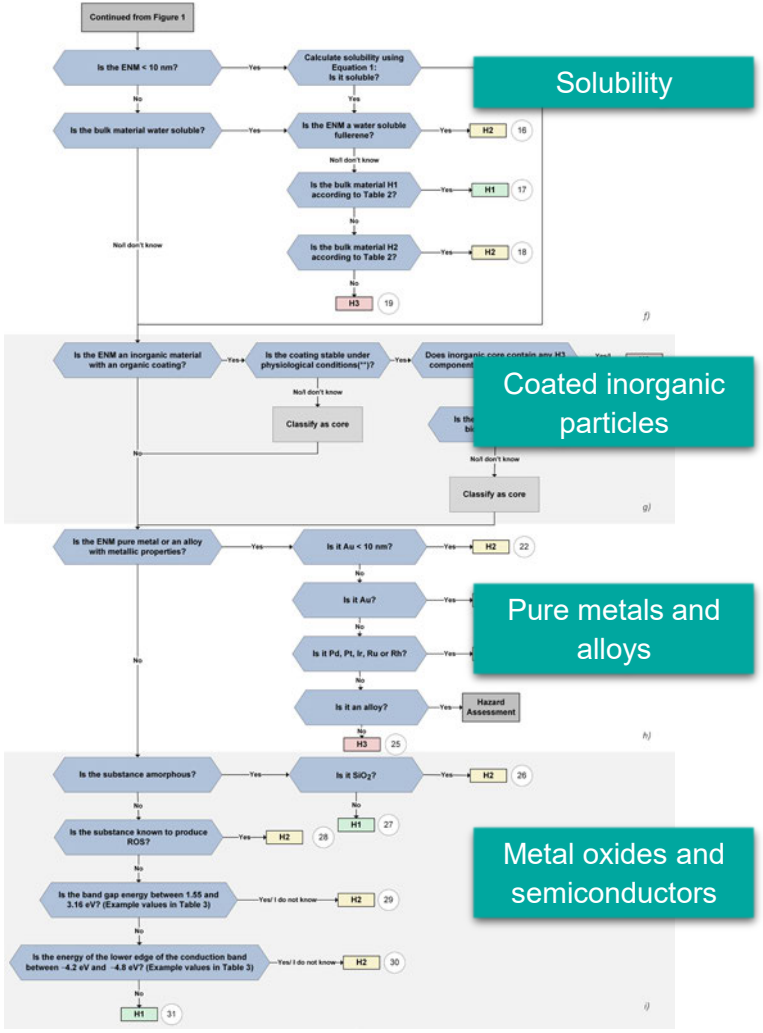
- Nano 1
- Nano 2
- Nano 3

A series of safety measures is implemented to protect the workers

Final evaluation with OHS

Step1 - Hazard evaluation





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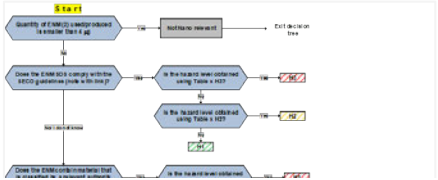
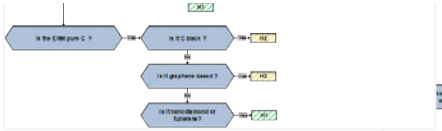
Step 1 - Hazard classes

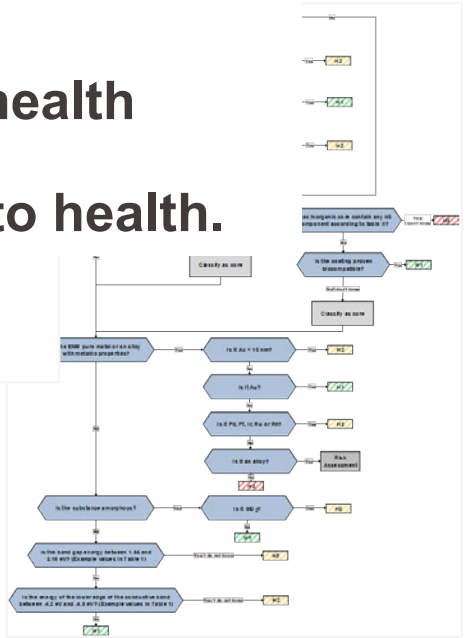


H1 substances : **low effects to health**

H2 substances : **moderate or transient effects to health**

H3 substances : **significant or permanent effects to health.**





https://www.epfl.ch/about/overview/wp-content/uploads/2019/09/1.5.5_Dir_travail_avec_nanomateriaux_an.pdf

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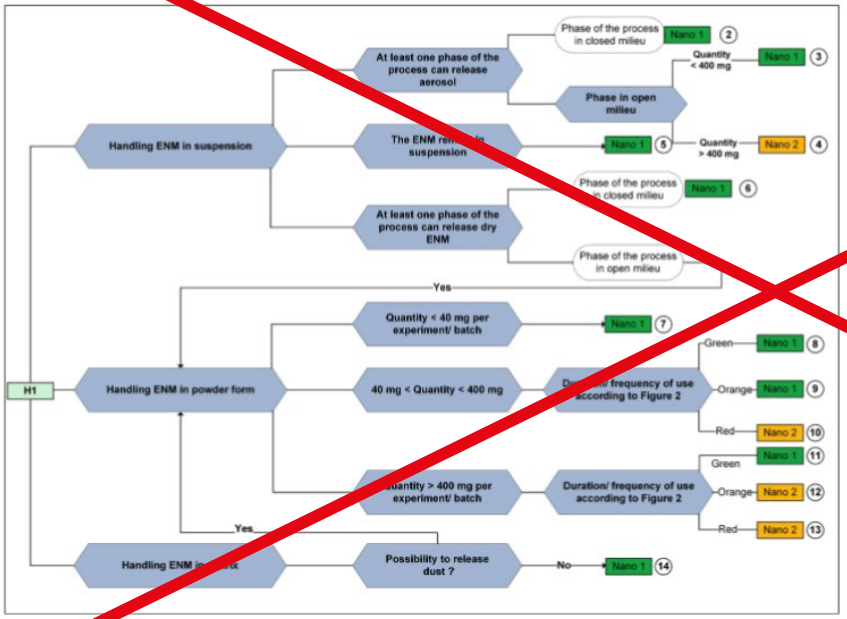
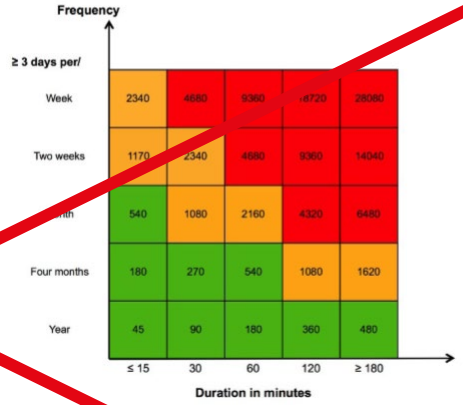
Step 2
Determination of the nano level : Old directive (Lex 1.5.5)





Distinction between suspension and powder/aerosols

Step 2
Determination of the nano level - New directive

- Who is working in your lab with nanomaterials?
- Type of nanomaterials? → H classification
- Maximum amount used per day in your lab?
- Enclosed process?
- Possibility to generate aerosols?

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Step 2
Determination of the nano level - New directive

Starting information

1. Quantity of nanomaterial handled per day
2. Hazard level

Special cases

- Are the nanomaterials exclusively handled in a confined environment? If yes, Nano 1.
- Are the nanomaterials embedded in a solid support? Nano 1 if there is no possibility of releasing powder, otherwise go to the classification table.
- Can the process release more than 10% of aerosols [e.g. pulverization, spraying, sonication, sanding]? Ask for a risk assessment.

Nano classification

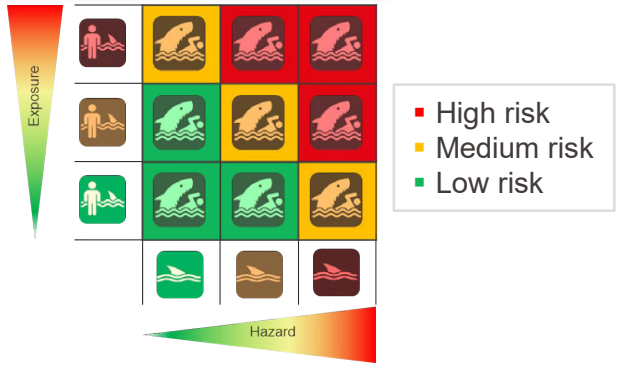
Hazard level	Total authorized daily amount per lab			
	Nano 1 (outside fume hood)	Nano 1 (inside fume hood)	Nano 2	Nano 3
H1	≤ 300 mg	300 mg < X ≤ 3 g	3g < X ≤ 30g	> 30 g
H2	Risk assessment	≤ 300 mg	300 mg < X ≤ 3g	> 3 g
H3	Risk assessment	≤ 3 mg	30 mg < X ≤ 300 mg	> 300 mg
H3 *nanofibers*	Risk assessment	Risk assessment	≤ 30 mg	> 30 mg

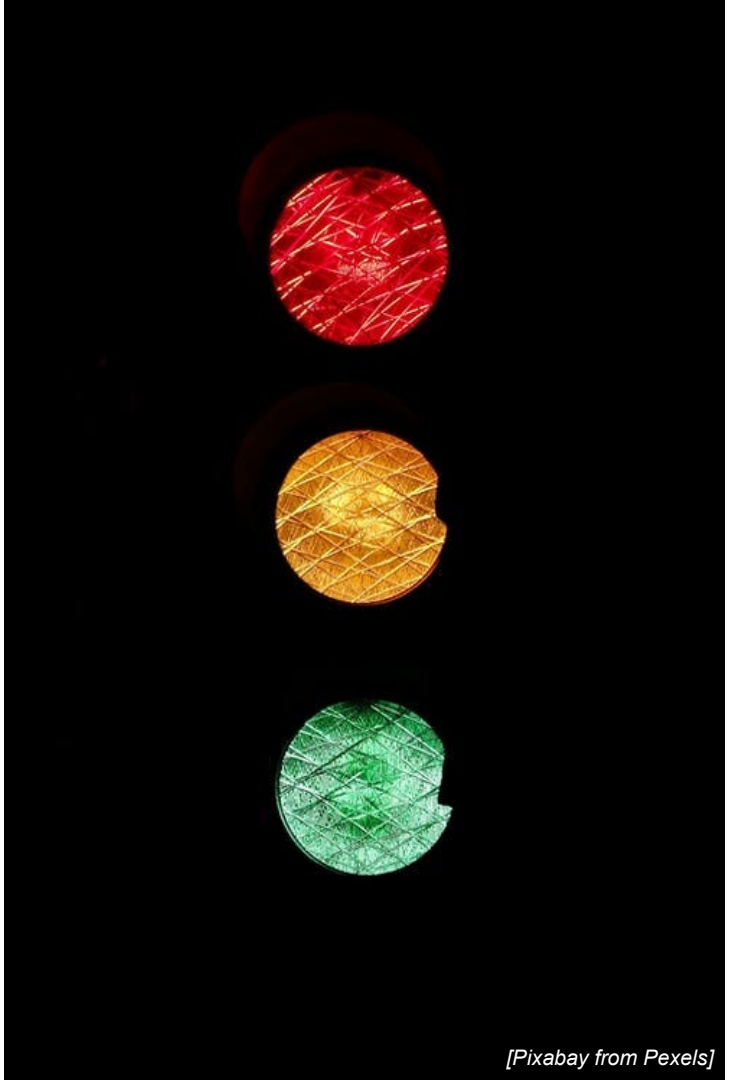
Step 2 – Risk levels

- **Nano1** – lowest risk level
- **Nano2** – medium risk level
- **Nano3** – high risk level

A set of **mitigation measures** is proposed for each nano level.

Remember the risk matrix!





[Pixabay from Pexels]

Step 3 - PPE nano labs

Nano 1

- Cotton lab coat
- Safety glasses
- Protective gloves

Nano 2

- Shoe covers
- Tyvek® lab coat
- Safety glasses
- Protective gloves

Nano 3

- Two pairs of gloves
- Shoe covers
- Tyvek® suit
- Respiratory protection
- Safety goggles

[pictures: Damien Stricker from EPFL]

Step 3 - General mitigation measures

Transport, storage and waste

- All nanomaterial waste must be **double packed** in a sealed secondary container for disposal
- Nanomaterials and waste must be stored ventilated
- Nanomaterials that are stored refrigerated must be stored in a sealed secondary container
- Nanomaterials and nanomaterial waste is transported in a secondary container

Restricted access

- Access to Nano2 and Nano3 labs must be restricted with a **CAMIPRO** reader at the entrance
- **Only trained** and authorized people are allowed access in these labs

[pictures: Damien Stricker from EPFL]

Step 3 - Medical follow up

The medical examination is a mandatory preventive examination (with 5 year intervals) for all those who:

- Work in areas classified as **Nano2 and 3**;
- For an annual exposure duration of more than 200 hours.

Pregnant women: work authorization issued by occupational physician after confidential consultation.

EPFL

Merci

Moodle: FOBS-102

Nanomaterial Safety Training

07.03.2024 09:30 › 11:30

Speaker: Anna Maria Novello

Location: BS 182

Category: Internal trainings

Target audience: Informed public