Basic information about nanotechnologies for energy

GoNano

What is nanotechnology?

Nanotechnology is generally referred to as ‘the science of the very small’. The prefix nano actually derives from the Greek νᾶνος (nanus in Latin), meaning dwarf.

A human hair can be used to illustrate size at the nanoscale. A human hair is approximately 80,000-100,000 nanometres wide. Another way to illustrate how small this is could be to say that comparing a nanoparticle to a basketball is roughly the same as comparing a basketball to planet earth. Nanomaterials can be found to occur “naturally” e.g. in dust or volcanic ash, in car exhaust fumes or in the smoke produced by a burning candle, or can be designed and fabricated artificially.

Nanotechnology today

Water-repellent fabrics

Some water-proof fabrics are not actually water-proof. In fact, the natural fabric may not repel water at all; however, nanotechnology can be used to create tiny patterns or nanostructures, or to add very thin layers, that then make the surface water-repellent.

Nano-cure for nail fungus

A new treatment for nail fungus is under development that combines nanoparticles with anti-fungal medication to deliver the drugs more effectively to affected area of the nail.

Nano-robots clear away bacteria and toxins

Researchers are developing tiny nano-robots (made from gold nanowires) that can be controlled with ultrasound. The nano-robots can be used to quickly clear bacteria and toxins from biological fluids like blood.

Risks and regulations nanotechnology, human and environmental health

There are many types of engineered nanomaterials; some are potentially hazardous but can be used safely under controlled circumstances. Most concerns relate to nanoparticles in free form, where they are harder to control and are not particles bound up in solid materials or fluids. But even then, are we able to control them?
Are they toxic? Do they evade the natural defences of the body, and what are the implications of this? Do they damage cells? Could nanotechnologies have different effects on men than women, and could there be differences in effects across ethnicities?

Some people argue that we already use many dangerous technologies and substances in our everyday life (e.g. gasoline). They think we should talk about how we regulate and use dangerous technologies and substances, instead of talking about if we should use them. Others worry that the very properties that make nanomaterials desirable, are the very properties that make them hard to control and regulate. They therefore think that we should talk about whether or not we should be developing nanotechnologies as all.

Your sunblock could contain nanoparticles

Many products already contain nanoparticles. E.g. A sunblock that rubs in clear on your skin could contain nanoparticles. Producers of sunblock are obliged to indicate on the label if your sunblock contains nanoparticles.

A lot of research has been carried out to confirm that sunblock containing nanoparticles is safe to use for humans, but what about when we wash the sunblock off our skin? Has enough evidence been gathered about the possible environmental impacts of such products before allowing their use?

How is nanotechnology regulated?

The question of whether and how to regulate nanomaterials has been ongoing in the European Union (EU) for over a decade. The EU was the first jurisdiction in the world to provide nano-specific legal provisions to address health and safety concerns of nanomaterials. Implementation of the EU legislation has, however, proven challenging. The various EU agencies need time to figure out who has the responsibility to implement oversight and regulation. Regulators need time to keep up with scientific developments. Industry and business need time to understand how to categorise and index their products.

Nanotechnology and energy: what are the visions?

Green energy production

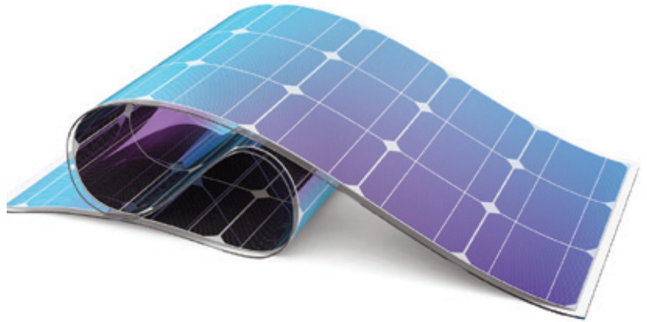
Imagine a future with flexible solar panels, which were only possible to manufacture due to the incorporation of ultra-thin layers (nanolayers) of light absorbers, or a paint full of semiconductor nanoparticles that could convert any surface into a photovoltaic panel. The widespread use of such technologies could help reduce our dependence on fossil fuels, and thus help reduce the emission of CO_2 and other greenhouse gases.

Portable energy devices

What if we could harvest the energy we produce when we walk and drive around every day? You could, for example, have nanofibers integrated into your clothes. The clothes would transform the energy produced by walking into electrical energy for powering your cell phone or smart watch. And what if the batteries in your cell phone had a higher storage capacity, a shorter charging time, or a longer shelf-life? More efficient batteries could prolong the useable life of our electronic devices, and therefore reduce the waste coming from them.

Energy in the home

Today you can harvest and store your own electrical energy at home, using solar panels and large batteries like the Tesla Powerwall, but nano-technology could make it possible to create and store energy in places you never imagined. You could install “smart windows” with a special nano-coating that would keep your house cool in Summer and warm in Winter – and generate electricity at the same time. The electricity could be stored in the structure of your house: the bricks in the walls, in wireless charging coils on the floor, on the kitchen worktop and in the furniture. Your smartphone and laptop could then be charged automatically no matter where you left them.



How should we design nanotechnologies?

Will nanotechnology lead to differences in treatment and access to treatment?

In order to work, nanotechnology innovations need to be implemented in our societies, everyday lives and (inter)national systems. We are not sure how nanotechnology applications would affect the organisation of our healthcare systems, or how they could affect your privacy. We don't know if nanotechnology will deepen the divide between 'rich' and 'poor' patients, consumers and countries. We also do not know if better individual treatments would favour some groups over others? Could we see more treatments available for men than for women, or for some ethnic groups above others?

Many healthcare applications involve the development of sensors. Nanotechnology sensors could be used to detect early signs of disease, and combine data on your biology with your eating habits to support a healthy lifestyle. It could prevent intoxicated person from driving, by detecting traces of alcohol in the air. One could imagine that insurance companies, businesses, employers or others would also like to have such information. Could the collection of such information change the way we perceive ourselves and others? Who should own your data?.

How could nanotechnologies be developed to suit your needs?

How do we make sure that

- We design nanotechnologies that fit with the wishes of citizens across the world?
- We avoid the risks and enjoy the benefits of nanotechnologies?

Research has shown that because nanoscience is dominated by men, ideas of future nanotechnology products are also male oriented. Men and women also think differently about risk. Perceptions of risk vary between some ethnic groups, with some men having a lower perception of risk. Women are more likely to think nanotechnologies are dangerous, and are less likely to engage with nanotechnologies because of this.

Research has also shown that religious beliefs and differences in culture can play a role in how we judge the potential of nanotechnologies, as well as how we believe nanotechnologies should or should not be used.

What do you think?

- **Do you think culture, gender or religion influence how you think about using nanotechnologies for applications in healthcare and to support healthy living?**
- **Do you think there are some traditional and cultural values we should support with new technologies for in healthcare and to support healthy living?**
- **How should nanotechnologies for health and healthcare be developed?**

Summary

- **Nanoparticles are very small.**
- **Nanomaterials have different properties than the materials we are used to.**
- **Nanotechnologies are imagined to provide new opportunities for diagnosis, prevention and treatment.**
- **There is uncertainty on how dangerous nanotechnologies could be to humans, animals and the environment.**
- **It is difficult to implement regulation and control of nanotechnologies.**
- **(inter)national Healthcare systems, governments and the healthcare industry industry is likely to influence the implementation of nanotechnologies.**
- **Culture, gender and other societal traditions (e.g. religion) are like to influence how nanotechnologies will be implemented in our societies.**

This material was developed for the GoNano citizen meeting in fall of 2018 on future nanotechnolgy for energy in Spain. The aim of the information material was to: present the citizen participants with short and easy-to-understand information about nanotechnology; align the discussion in the meetings with the research and innovation priorities with professional stakeholders; introduce visions of future nanotechnology in Health; and to introduce societal, cultural, legal and ethical questions and uncertainties.

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