NANOTECHNOLOGY

LICEO RICCI CURBASTRO – DE BRON TIELT

Niccolò Savioli
Benedetta Vecchi
Marta Nigro
Ella Vanlaere
Lotte Derhore
Juliette Galle

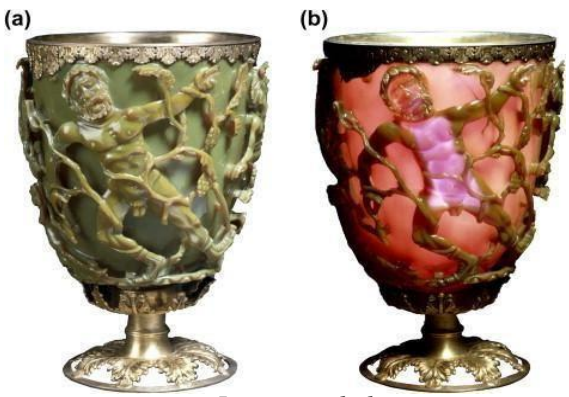
Nanotechnology, a technology that makes us think of possibilities, futuristic sciences, risks and danger. But nanotechnology isn't a reality that is so far removed from us that we cannot imagine it. What exactly is nanotechnology and what possibilities does it offer? How will it evolve in the future, and where did it all start? Importantly, what is the impact of nanotechnology in everyday life and to what extent are the fears well-founded?

1.What is nanotechnology?

Nanotechnology is a technology that makes it possible to work with very small particles. These particles are smaller than 1 billionth of a metre. It is a multidisciplinary field of study, because it concerns not only physics but also chemistry and biology. This scientific knowledge is already being used in numerous practical applications and this number will only increase in the future.

2.History of nanotechnology

The term nanotechnology has not existed for very long, but the technique has actually been used since antiquity, although unconsciously." The oldest object in which this technique is found is the so-called Lycurgus chalice, a Roman cup from the 4th century that without no light inside looks green, while, if there is, red. Research has explained that this extraordinary object is made of nanoparticles of silver, gold and copper embedded in glass. The phenomenon is due to the absorption of light: different nanomaterials absorb different wavelengths.



Lycurgus chalice

This concept was confirmed in the last century, but the first person to discover that nano particles exist is Michael Faraday who predicted in 1857 a link between the size of gold particles and the wavelength of light. Later, the physicist Freyman came up with the theory that one could manipulate an individual atom and that this would have many technological applications. The rise of nanotechnology began with the introduction of computers in the 1970s. Transistors of that time were very large and therefore not practical, so science and industry set out to make these transistors smaller. This was one of the first steps towards nanotechnology. After that, it went forward in large leaps. This was mainly due to Eric Drexler, people say he is the father of nanotechnology. He published some ground-breaking papers on nanotechnology in the 1980s. At that time, many studies were carried out on the small particles and their possible applications. In recent years, the amount of research into nanomaterials has increased enormously. Nowadays, you find them everywhere in sun creams, electrical separators and so many other things.

3.Nanotechnology in everyday life

When hearing the word nanotechnology, the majority certainly thinks that these are just complicated technical developments. That is certainly true. But nanotechnology is more than that and it is used in our daily lives much more often than you would suspect. Nanotechnology has already been integrated into our daily lives on a large scale. Think, for example, of toothpaste with nanoparticles to promote the remineralisation of teeth. PET bottles also contain nanoparticles, which increase the shelf life of soft drinks. Or think of water-repellent windows, clothing and surgical instruments. Or contrast agents with magnetic nanoparticles, which enable sharper MRI images.

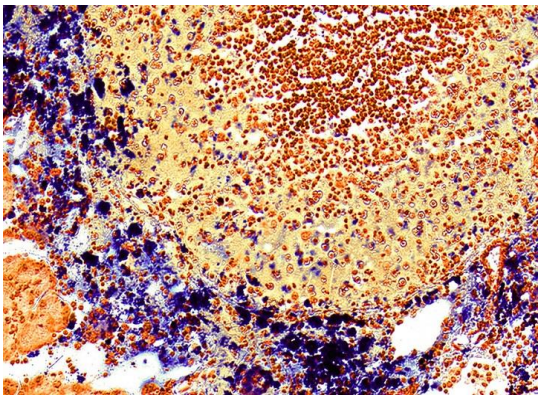
As you can see, nanotechnology is not an application for the future. It is already widely used in food and industry, we just don't give it much thought. And you can be sure that there will be many more applications of nanotechnology in the future, for example in medicine or in the battle against climate changes

4.Nanotechnology and medicine

Nanomedicine is the application of nanotechnology in order to preserve human health with the help of molecular tools.

Nanotechnology, for example, can help us find a wide range of diseases, like cancer and internal bleeding, or also reduce the frequency with which we have to take our medications. In fact the human body can very quickly and effectively remove medicines, reducing the duration of action. However, if the medication is released continuously from the inside of a nanoparticle, the effect will be more powerful and last longer. These tools also biodegrade slowly into components that naturally occur in the body and are removed after the pharmaceutical has done its job.

This is possible because with nanoscale particles we can send drug molecules into the body exclusively in parts which are needed, for example against cancers. The use of chemotherapy, in fact, not only kills tumour cells, but also injures the healthy ones. Nanoparticles are engineered so that they are attracted to diseased cells, which allows direct treatment of those cells too. This technique reduces damage to healthy cells in the body and permits the earlier detection of diseases.



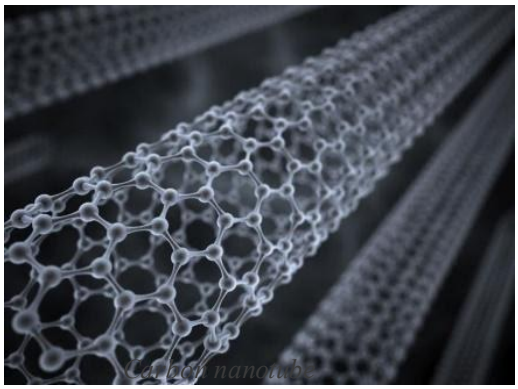
Nanoparticles attacking tumour

Another employment of nanotechnology in the cure of tumours is the creation of devices that can discover corrupted cells. Researchers at Worcester Polytechnic Institute are using antibodies attached to carbon nanotubes that work as chips to detect cancer cells in the bloodstream. The researchers believe this method could be used in simple lab tests that could provide early detection of cancer cells in the bloodstream.

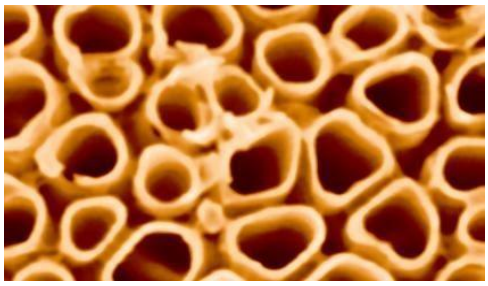
Of course, there are limitations in the use of nanotechnology in medicine like the high research and development cost, that is beyond the reach of the great part of the global population, but continuing the research will be beneficial to our health in the long run.

5. Nanotechnology against climate crisis

The growing interest in atoms and particles in the nanoscale is crucial to fight one of the most alarming wars of these years, the one against the climate crisis. Recently science is trying to discover new sustainable ways so that the human impact could be reduced, including nanotechnology. So the amount of problems the world has to face with are big, but the strategies for solving them are incredibly small.Water pollution can be defeated through nanomaterials: research pointed out that the efficiency of these materials is due to their very extended surfaces,



which can interact with numerous elements capturing pollutants.
The most suitable example is that of Rice University and Penn State University, where research created small, spongy and reusable blocks made of carbon nanotube, with the ability to absorb oil into water. Furthermore, the blocks are on the one hand hydrophobic, on the other hand oleophilic, and the sponge can also conduct electricity and be directed through magnets.
This method may be an efficient weapon against water pollutants.



Titanium dioxide nanotubes

Another unexplored horizon concerns the "hydrogen economy", using hydrogen as a particular source of energy, not renewable like solar power nor a fuel like coal. This innovation is linked to lots of practical applications, from the elimination of all the dangerous emissions due to road transports to a more efficient insulation. But how is nanotechnology linked to it?

Nanotechnology could be useful to solve the major issues in the realization of this project, how to produce and conserve hydrogen, also considering its extremely high flammability in gaseous state. Particular materials, such as titanium dioxide nanotubes have shown very strong photocatalytic activity, that is they are able to split water into hydrogen and oxygen utilizing energy from the sun. Then hydrogen can be conserved bound to another element: recent researches are using nanoparticles of metal hydrides into models of carbon nanotubes, working as scaffoldings, which release hydrogen after being heated.

6. Can nanomaterials be harmful and risky?

The dark side with new technologies is that we don't exactly know what their impact will be. There is often uncertainty and ignorance about the positive and negative effects at the beginning of development. Many disadvantages are still not known. Therefore, scientists working with nanoparticles have to protect themselves very well and treat the particles as a hazardous substance.

Even if it has just been said that nanotechnology can improve both human health and environment, if it is not treated properly, it may cause lots of damages.

Infected lungs

When inhaling these tiny particles, the lungs can become inflamed. The particles become part of the lungs and go deep into the cell because they are so small. Allergic reactions can develop this way. Some "nanofibers" can cause a reaction like that of asbestos. The best-known example of this is Nanocarbon tubes, which make electronics much smaller. The particles can also form reactive oxygen compounds, which can cause damage in the placenta and other tissues. The harmful substances can be passed on from the mother. Because they are non-degradable, they will remain in the body. As a result, the particles can spread very quickly on various organisms.

The nanoparticles can get into the blood. They will start to accumulate in the liver and spleen. Via the blood, they can get into the cells. There they affect the proteins and the DNA. This can lead to the growth of cancer cells.

Another effect of these extremely small particles is that hormones can be disrupted. Hormones are very important in our bodies and play a

major role in pregnancy. The disruption of hormones can therefore cause damage to the unborn child.

But not only does it affect our health, as already mentioned, it also harms the environment.

Damaged DNA

But most of the dangers are not yet known. Nanotechnology has many applications, but is it safe? We have standard safety tests for a wide range of chemicals, but nanomaterials have specific properties that we cannot easily test in the same way.

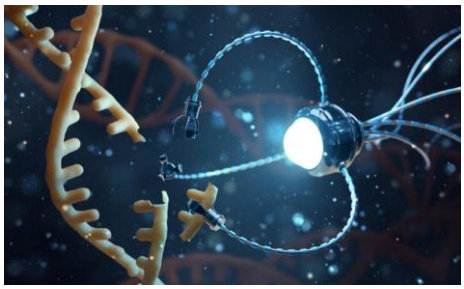
7. What is the future of nanotechnology?

Nanotechnology is an emerging science and it can develop rapidly in the course of the years. Scientists supposed that the study of nanotechnologies can be divided into four phases or generations.

Passive nanostructures
The first generation deals with materials science. In fact the properties of materials could change by working on the structure of them when it comes to a nanometres scale. This can be done in the form of coatings and/or the use of carbon nanotubes to reinforce plastics.

Active nanostructures
The second generation is a phase where nanotechnologies started to have applications in medicine, for example it is concerned about the use of active nanostructures to provide a drug that has a target like a cell or an organ.

Nanosystems
The third generation is more complicated, it will deal with advanced systems for example nanorobotics. More specifically nanorobotics is related to the engineering discipline of designing and building nanorobots; it could be potentially used in medicine.



Nanorobot

Molecular nanosystems
The fourth generation will concern molecular nanosystems. At this point this technology will probably be greatly increased; the control that experts will have on it will allow them to work on a fourth-generation of nanomachines made from different molecules with specific structures where each molecule has a specific structure and function.

Now we are currently between the first and the second generation and these are only suppositions but we will see what the future will prospect us.

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