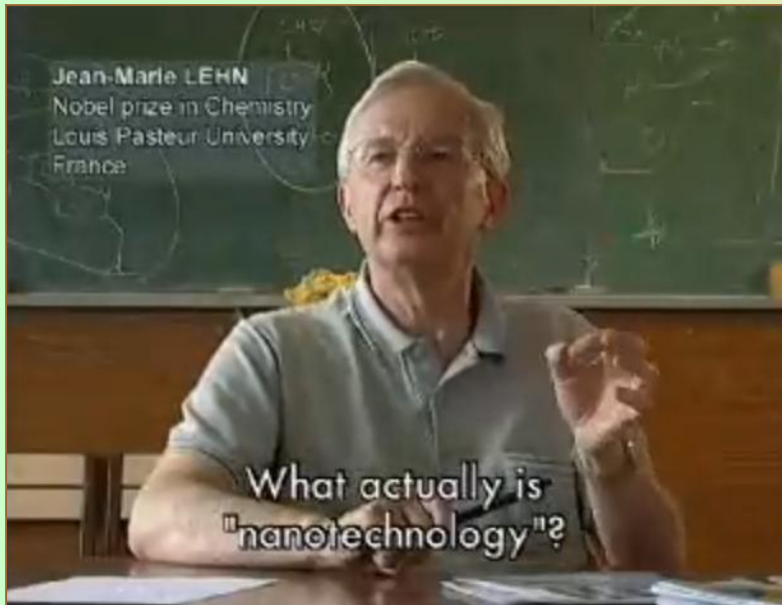


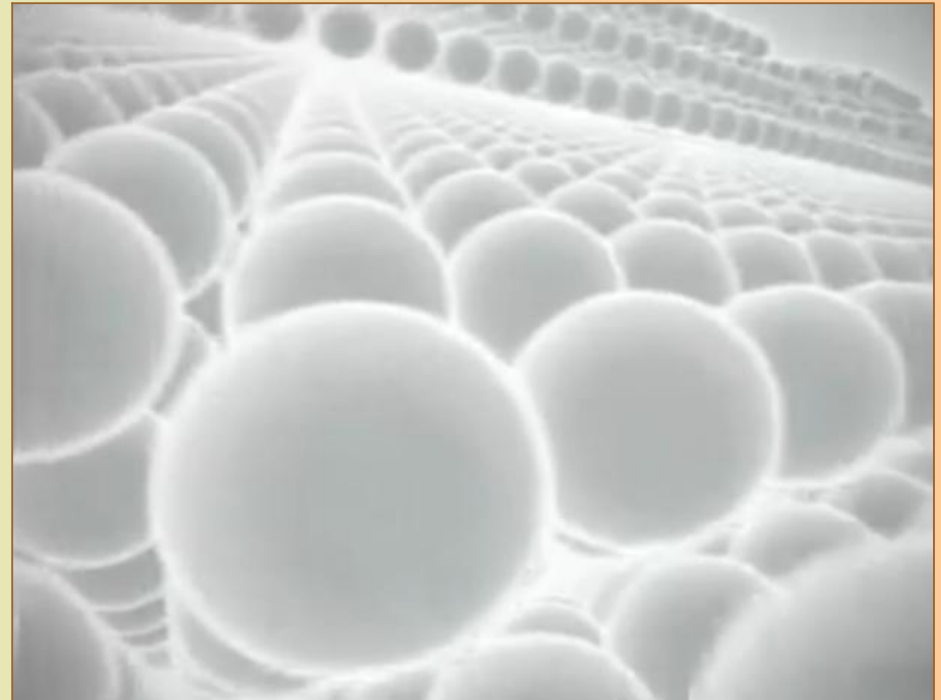
# Nano: The Next Dimension



What actually is "nanotechnology"?:  
doing things on a small scale.  
Nanotechnology is technology on a  
very small scale. It can be physics,  
chemistry or biology. It can be  
materials, or medicine, and so forth.  
The concept is extremely vast.

Each white ball is a cloud of  
electrons, concealing an atomic  
nucleus: the land of the atom.

This is a new field of research  
and practical applications.



# Nano: The Next Dimension



First of all, we can see increasing miniaturisation of components in the electronic or nanoelectronic industry ... storing, in tiny volumes of space for more processing power than is currently possible but also making use of biomedical applications: an artificial retine, replacing an ear which no longer works, ...

... being able to make molecular wires, like a nerve which could store all sorts of impulses that the brain would decode.

The economic and social consequences would be very great.



# Nano: The Next Dimension



The new concept which was developed there is not limited to research and fundamental research. It endeavours to lead all disciplines to the finished product and to take part in the whole engineering process.

On the left of the picture a coating containing new, improved nanoparticles, that can not be scratched, glasses that grow darker as light get stronger, a music CD can be engraved on this flexible plastic sheet, the nanoparticles on this surface repel water and make this surface hydrophobic too, straw and wood no longer burn ...



# Nano: The Next Dimension

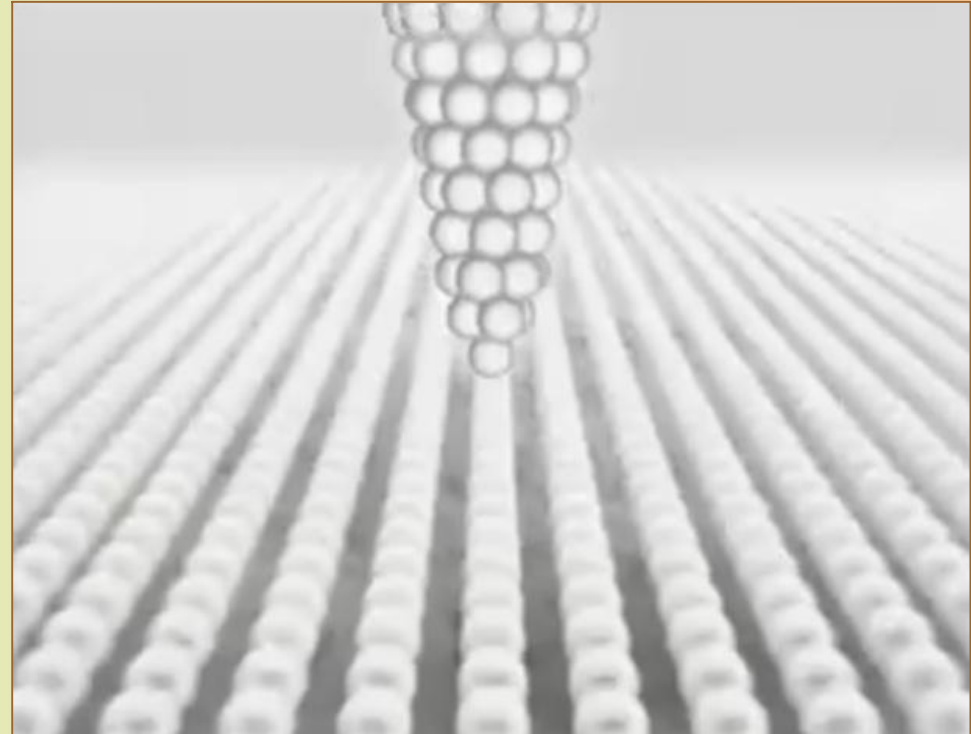
---



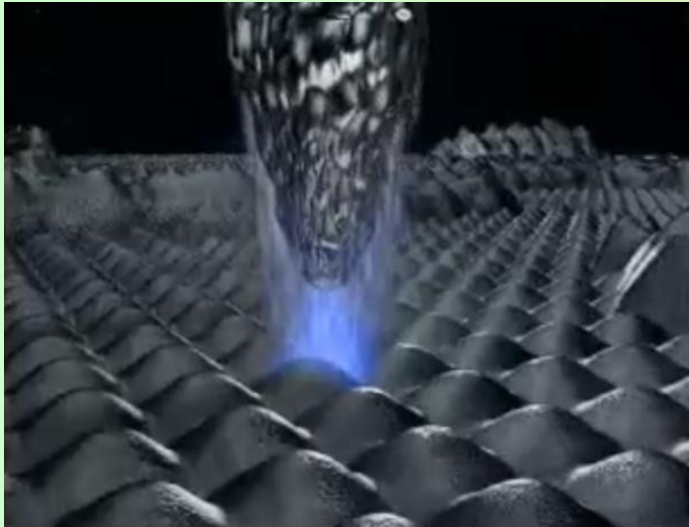
The reason for this phenomenon is the properties of these objects: nanoparticles at the surface or inside.

Researches invented a new microscope, that can manipulate atoms too.

The tip of the microscope feels the atoms to display its contours.



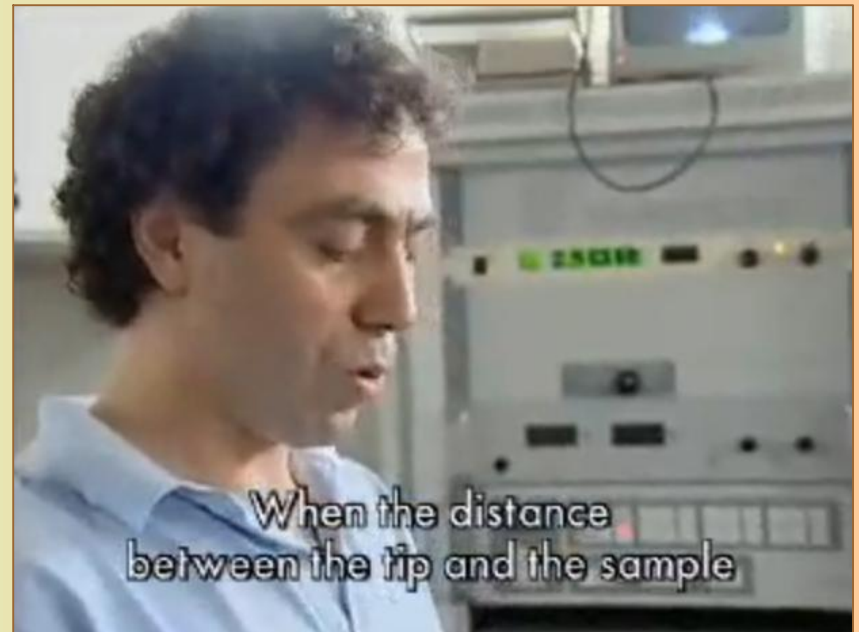
# Nano: The Next Dimension



In this animated sequence, the tip, made up of atoms is bathed in a blue glow that represents an electric current.

This scanning tunneling microscope (STM) represents on the screen the electron flow voltage and intensity: this provides a relief map of the surface, atom by atom.

When the distance between the tip and the sample is about a nanometre you get a current of electrons between them that depends on the distance between them.



When the distance  
between the tip and the sample

# Nano: The Next Dimension

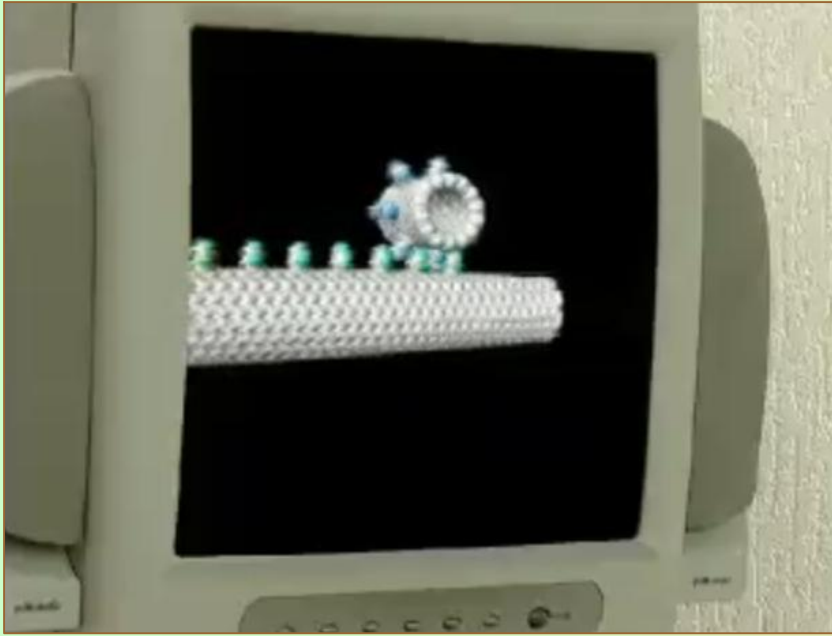


By generating a strong electron flow through the tip of the microscope, a given atom can be attracted and can sculpt a sample. This effect can be used to build electronic circuits.

In Europe and elsewhere, a lot of research is done to improve computer memory capacity by producing very tiny components.



# Nano: The Next Dimension

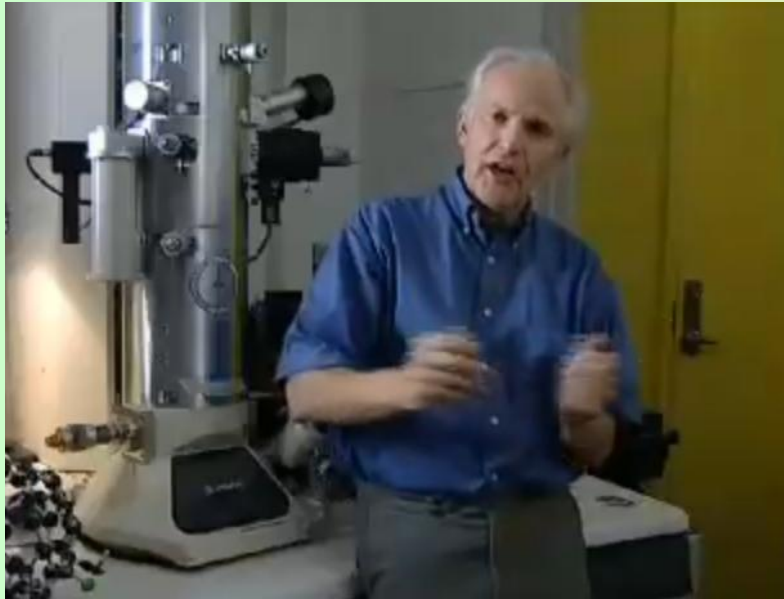


Pushed by the tip of the tunneling effect microscope it moves against the surface. By adding extensions to this molecule, we can control the motion of the molecule. Throughout Europe, scientist are working on nanorobots.

Instead of having to build these objects, which is becoming increasingly hard and expensive, there might be a way of exploiting a property of matter: that of self-assembling.



# Nano: The Next Dimension



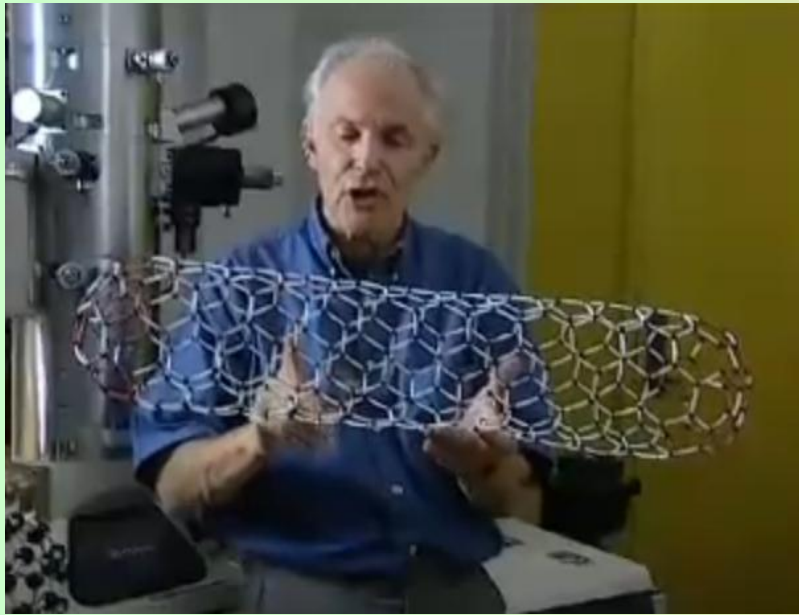
We discovered that beautiful molecular cage: a fullerene ( $C_{60}$ ).

A similar structure, the carbon nanotube, was also discovered. That carbon nanotube is stronger than diamond.

Carbon nanotubes can be obtained with graphite electrodes, by fusion at  $400^{\circ}\text{C}$  in an inert gas (helium).



# Nano: The Next Dimension



This material (carbon nanotube) is perhaps the strongest ever be made. In bundles, it can be 100 times stronger than steel and 6 times lighter.

Carbon nanotubes are ballistic conductors: they conduct without loss of energy and can replace copper wires we use to carry electricity.

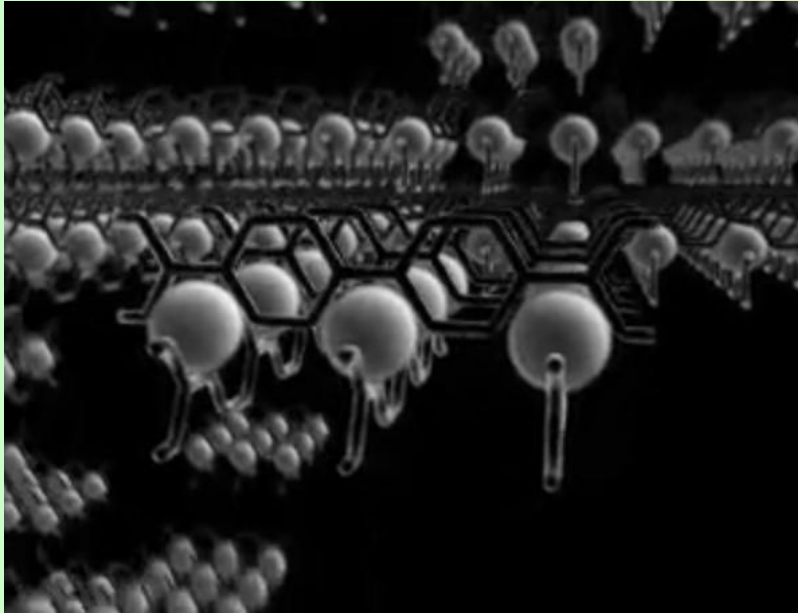
This property is being used to build microprocessors.

Here, one of the nanotubes is in contact with the electrodes and carries electrical current almost instantaneously.



# Nano: The Next Dimension

---

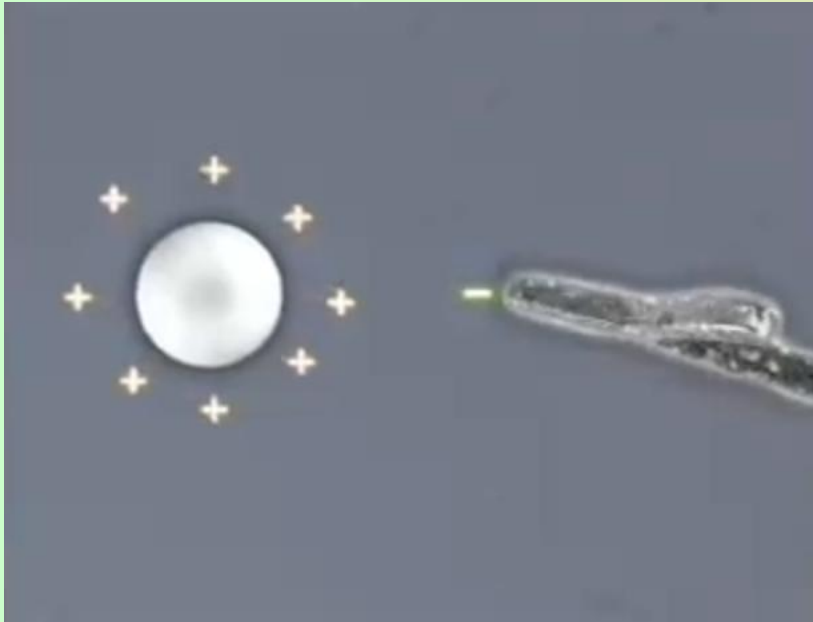


Each of these circuits can spontaneously connect, increasing memory capacity.

After all, if the matter self-assembles, then we should try to understand the mechanisms of self-assembly. From there, we can try to improve our understanding of the origins of life but also use self-assembly and its underlying concepts and principles to produce structures of a certain kind spontaneously, yet in a completely controlled way.

# Nano: The Next Dimension

---



On the left there is a magnetisable particle; on the right an AIDS virus antibody. They bind together because they have opposite charges.

If the virus is present, the antibody recognises it and sticks to it. Then, the magnetisable nanoparticle is extracted still bound to the virus.

This example shows the wide variety of roles the nanoparticles can play, particularly in the biomedical field.