

## BACKGROUND

### Background Information on Nanotechnology

#### NANOTECHNOLOGY HISTORY

Richard Feynmann (American physicist, 1918-1988) was the first scientist who raised the first discussions about nanosciences in 1959, with a speech entitled "There's Plenty of Room at the Bottom." Feynmann highlighted the importance of controlling and manipulating on a small scale. However, Norio Taniguchi (1912-1999) used for the first time the term "nanotechnology" in 1974 in a technology production paper that created objects and features on nanometer order.

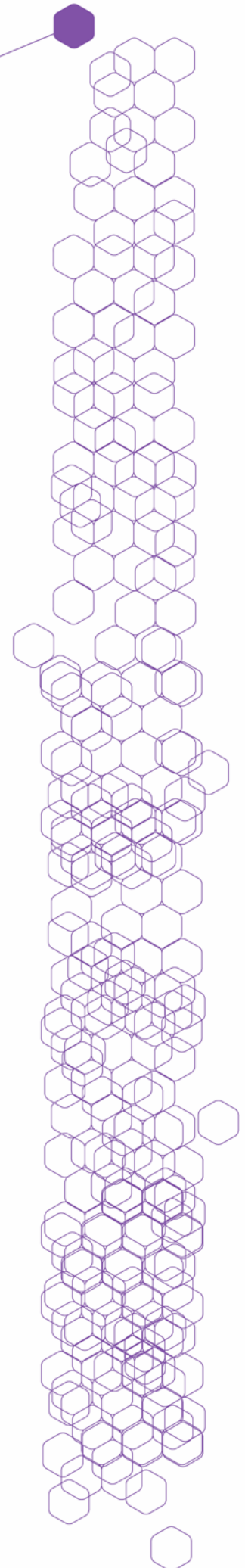
In the 1980s, IBM Zurich scientists invented the tunneling microscope, a significant mark in nanotechnology development, which allowed scientists to analyze materials at an unprecedented atomic level.

Over the past few years Nanotechnology expenditure on research and development has increased dramatically, science has reached an important place in the society development and many consider that the investment in Science may be the only key to a country's future.

#### BUT HOW CAN WE DEFINE NANOTECHNOLOGY?

Nanoscience and nanotechnologies are new approaches to research and development (R&D) aiming to control the fundamental structure and behavior of matter at the level of atoms and molecules. In fact, one nanometer (nm) is one billionth of a meter, tens of thousands times smaller than the width of a human hair.

Nanoscience is often defined as a "horizontal key," as it can be considered an interdisciplinary field of research and it can virtually change all technological sectors, leading to innovations that can contribute to facing today's social problems.



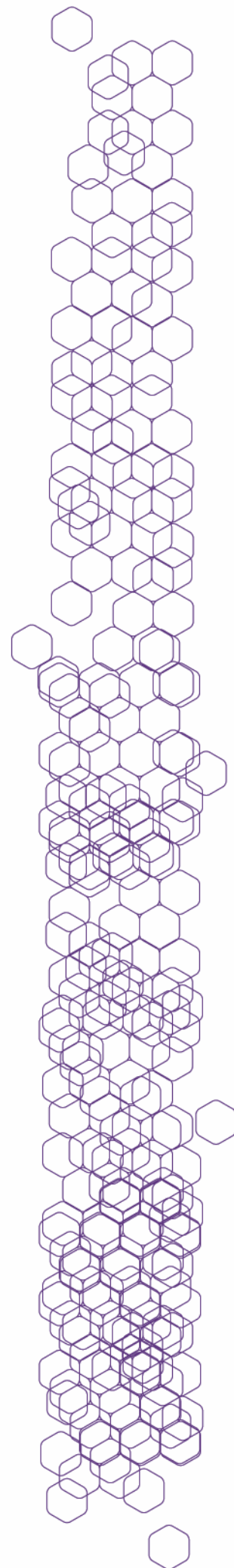
## MAIN APPLICATIONS

Nanotechnology has the potential to profoundly change our economy and to improve our standard of living, just as the impact that information technology has had in the past two decades.

Some present and emerging applications include:

- **Medical Applications:** nanotechnology-based coatings that improve implants' bioactivity and biocompatibility. Diagnostic chips for point of care use. Drug delivery systems and nanosystems.
- **Information Technologies:** data storage beyond present-day recording densities, new logic and non-volatile memory concepts beyond CMOS technologies, and new flexible display technologies.
- **Energy Production and Storage:** Through nanotechnological developments, energy savings could be anticipated, leading to improved insulation, transportation, and efficient lighting.
- **Materials Science:** Surfaces modified using nanostructures and nanoparticles are already being used for reinforcing materials or functionalizing cosmetics.
- **Manufacturing:** At a nanoscale, it will be possible to face manufacturing requiring a new interdisciplinary approach to both research and fabrication processes.
- **Instrumentation:** Instrumentation plays an essential role for developing the "top down" and "bottom up" manufacturing processes.
- **Food, water, and the environment:** This research area can advance through nanotechnology-based developments including tools to detect and neutralize micro-organisms or the presence of pesticides.
- **Security:** Nanotechnology-based drug and explosive detection systems.

Several nanotechnology-based products have already been marketed including medical products, electronic components, scratch-free paint, sports equipment, wrinkle and stain-resistant fabrics, and sun creams. Most computer hard drives, for instance, contain tunnel (TMR) heads that, through nano-thin layers of magnetic materials, allow for a significant



increase in storage capacity. Some other current uses that are already in the marketplace include catalysis, which are coatings for easier cleaning or glare reducing. It is likely that solar cells can be significantly improved with nanotechnology. The pharmaceutical and chemical industries are also being impacted by nanotechnology, both on advanced drug delivery systems and medical diagnostic tools. For instance, a new range of medical treatments is arising for certain diseases such as Alzheimer's and brain tumors.

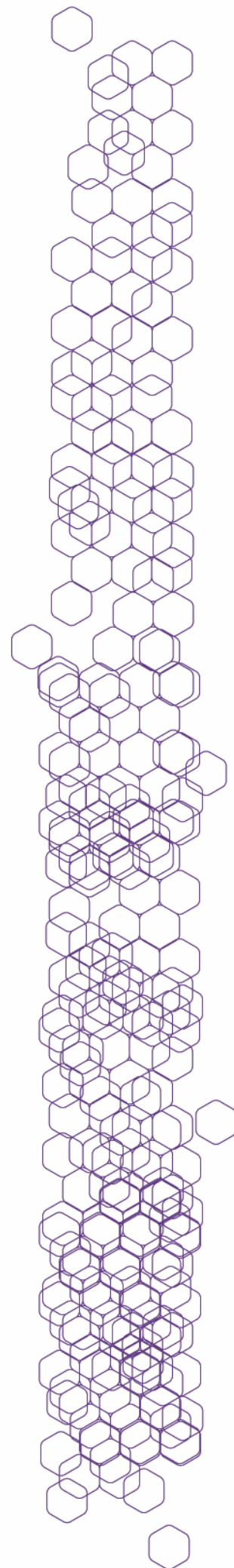
Nowadays it is clear that nations most actively participating in the international effort to harness nanoscience and nanotechnology will benefit earlier and to a greater extent from their benefits and will be able to play a leading role in the scientific, technical, and economic cooperation with other advanced regions as well as with less-developed nations in Latin America and Asia.

#### **SOCIETAL IMPACT OF NANOTECHNOLOGY**

A crucial part of the mission of INL will be to enhance public awareness of nanoscience and technology and to address the ethical, social, and environmental impact of nanotechnology. The INL will at all times drive a strong program of public outreach, popularizing nanoscience and strategic nanotechnology, approaching mass media, science, and technology museums, foundations, and publishers.

Public outreach, both to increase public knowledge about nanoscience and technology, but also to stimulate the young towards science and technology in general, will be an important task of the INL. An outreach office will be established, which will form strong connections with schools, universities, and science museums, and collaborate in their activities. INL researchers will be encouraged to dedicate some of their time to the community, in the form of off-site talks, laboratory visits, and demonstrations. The INL will hold "open-days," during which both scheduled and spontaneous visits to the Laboratory will be held.

Addressing the ethical, social and environmental impact of a technology with the disruptive potential of nanotechnology is essential. This will be made through the establishment of protocols with social science and



environmental departments of major universities. These agreements will put in contact nanoscience and technology researchers, who will be mostly engineers, chemists, physicists, or biologists, with social scientists and environmental engineers. These teams will be able to have the necessary technical expertise to tackle all the complex issues involved.

#### **NANOTECHNOLOGY RESEARCH IN PORTUGAL**

Regarding the scientific sector, Portugal has several entities, such as:

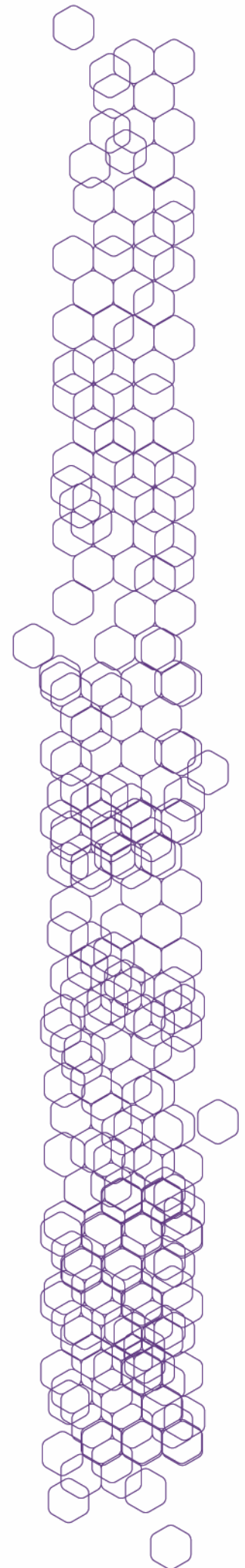
- Ministry of Science, Technology, and Higher Education - MCTES
- Knowledge Society Agency - UMIC
- Science and Technology Foundation - FCT
- Science and Higher Education International Relations Office - GRICES

As far as the Portuguese landscape goes, the Nanotechnology Research sector in Portugal is considered to have top-level quality, and its potential will exponentially increase, due to INL creation. It is possible to identify some institutes representing the Nanotechnology sector such as:

- Nanotechnology Institute (IN), coordinated by INESC MN and with partnership with CQFM at the Technical University of Lisbon (IST), and with IFIMUP, at University of Porto.
- Nanostructures, Nanomodelling, and Nanofabrication Institute (I3N), resulting from the partnership of New Lisbon University (Centre of Materials Research - CENIMAT), Minho University (Institute for Polymers and Composites - IPC), and Aveiro University (Semiconductor Physics, Optoelectronics, and Disordered Systems Unit - FSCOSD).

Several other research units are also active in the nanotechnology and nanoscience area, CICECO at the University of Aveiro and ICEMS at the Technical University of Lisbon respectively.

Regarding the Portuguese biotechnology sector, IBB, with its poles in Lisbon, Algarve, and Minho, and INEB at Porto play a significant role.



### **NANOTECHNOLOGY RESEARCH IN SPAIN**

Nanoscience and nanotechnology are some of the strategic areas where the Spanish Ministry of Science and Innovation invests its time and efforts. The most important public research entities in Spain are:

- CSIC (Superior Council of Scientific Research)
- ISICIII (Carlos III Health Institute)
- CIEMAT (Research Centre for Energy, Environment, and Technology)
- IGME (Spanish Institute of Geology and Mining Industry)
- INIA (National Institute of Agricultural and Alimentary Technology Research)
- INA (Aragon University Institute for Research in Nanoscience)
- CicNanogune
- ICN (Institute Catalá de Nanotecnología)
- IMDEA Nanociencia de Madrid

Regarding the Spanish biotechnology sector, we can identify several entities related with nanotechnology:

- IBMB (Molecular Biologic Institute in Barcelona)
- ISOM (Institute for Systems based on Optoelectronics and Microtechnology)
- BIOMAND (Centro Andaluz de Biotecnología y Nanomedicina)

