

# Nanotechnology in Italy: National Programs, Players and Activities

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## ABSTRACT

The interest for nanotechnology has increased steadily in Italy during the last years and at present the R&D activity in this field is rather intense. Public financial support has been instrumental to this growth and even now public is the main source of funding. The action takes place primarily in public research organizations, but also industry, large enterprises as well as SMEs, plays an important role. Several initiatives have been taken to promote the efforts in this field, but still the activity is somehow fragmented and there is not yet a specific national initiative to promote and better coordinate the efforts. The commitment at both public organizations and industry to promote nanotechnology and its applications is, nevertheless, getting more and more convinced and the activities better focused and effective.

**Keywords:** Nanotechnology, Italy, R&D, players, programs.

## 1 INTRODUCTION

Nanotechnology has in the last years captured the interest of the research community, industry and public planners also in Italy. Today, R&D in this field results rather intense and spanning from structural and functional materials, to instrumentation, from energy to life sciences and biomedical applications.

Public financing, albeit not at the level seen in some other advanced countries, has been the propeller of the past growth and it is still the main source of support for the present activity.

In the National Research Programs nanotechnology is amongst the priority themes of research. Specific funds for R&D in nanotechnology have, in fact, been made available since 2001-2002 by the Ministry of Education, University and Research (MIUR). Prior that date research dealing with nanotechnology was funded within projects aimed to microelectronics and advanced materials. Funds supporting nanotechnology can be obtained also at other public bodies.

A national programme for nanotechnology to promote the initiatives in this field, funnel funds and optimize the use of the resources available doesn't exist in Italy and it is therefore not easy to get solid figures about the entity of public funding. It can be nonetheless estimated that public expenditures for nanotechnology R&D in 2005 amounted to around 50 million of euro.

Nanotec IT (Italian Centre for Nanotechnology), created in 2003 by AIRI (Italian Association for Industrial Research) with the objective to promote nanotechnology and provide a national focal point for industry and public

research, has published in 2004 the 1st Census of Nanotechnology in Italy. The census identify the great majority of the people working in the field and is highly representative of the situation. Following it is given what resulted from the survey, with some updates coming from the 2nd Census (to be published in English) presently under way.

## 2 GENERAL OVERVIEW

As indicated by the Nanotec Census, R&D nanotechnology is in Italy, as elsewhere, concentrated primarily within the public research institutions (Universities and research organizations), but the interest for nanotechnology has in the past years gained ground also within the industrial camp and there are now both big enterprises and SMEs, engaged in this field.

The activity, which in the period 2000-2003 has generated about 2500 publications and some 150 patents, is quite spread across the National territory.

The distribution by region of R&D personnel/structures involved in nanotechnology is depicted in figure 1 which indicates that the major concentration is in the centre-north part of the country, but it must be stressed, that also the activity in the south, where the numbers are smaller, play an important role on the Italian scene.

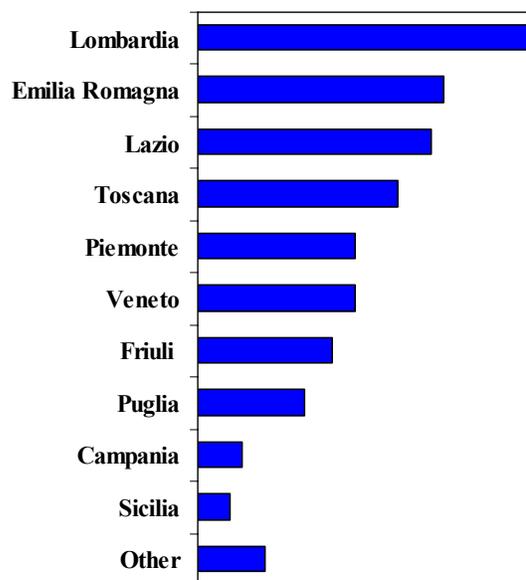


Fig 1. Geographical distribution of R&D activities in nanotechnology in Italy

The overall situation is illustrated in more detail in the paragraphs below.

## 2.1 Public Research

Nanotechnology research within the public research organizations is rather articulated and it involves several subjects and research structures. This activity accounts for over 80% of the effort in nanotechnology in Italy. The players are:

- National Research Council (CNR), included the National Institute of the Structure of Matter (INFN) merged into CNR in 2004;
- Inter-University Consortium for Material Sciences and Technologies (INSTM);
- National Institute for Nuclear Physics (INFN);
- National Agency for New Technologies, Energy, Environment (ENEA).

In particular, CNR/INFN and INSTM have the lion share of the action while INFN and ENEA play an important, but lesser role.

The research under way at the Italian Universities refers in great part to INFN and INSTM. In particular, most of the activity carried out within the Physics Departments is associated to the former, while that going on within the Chemistry Departments mostly to INSTM.

Considering CNR/INFN, it must be pointed out that nanotechnology has its major focus in a certain number of institutes, with research units sometimes located in more than one city. In particular:

- CNR-Institute of Photonics and Nanotechnology (IFN), Roma (Milano, Trento)
- CNR-Institute of Molecular Science and Technologies (ISTM), Milan (Padova, Perugia)
- CNR-Institute of Studies for Nanostructured Materials (ISMN), Roma (Bologna, Palermo)
- CNR-Institute for the Study of Macromolecules (ISMAC), Milano (Biella)
- INFN-National Nanotechnology Laboratory (NNL), Lecce
- INFN-National Enterprise for Nanoscience and Nanotechnology (NEST), Pisa
- INFN-NanoStructures and Biosystems at Surfaces (S<sup>3</sup>), Modena
- INFN-Advanced Technologies and nanoSCience (TASC), Trieste

The above institutes do not exhaust, of course, the number of structures which at CNR/INFN are involved in research in nanotechnology. Worth of mention are, among other, also the Institute of Composite and Biomedical Materials (IMCB) in Napoli and Pisa, the Institute of Electronics and Engineering of Information and Telecommunication (IEIT), Pisa and the Liquid Crystal Laboratory (LYCRIL) at the University of Calabria (Rende).

At INSTM, the activity in nanotechnology is more distributed and it is organized in a network which links together research units (the complete list can be obtained from Nanotec IT) located in several Italian Universities. In some of them, 6 National Centers of Excellence for nanoscience and nanotechnology have recently been set up. These are:

- Centre for Nanostructured Surfaces and Interface, University of Torino;
- Centre for Engineering of Nanostructured Materials and Surfaces, Polytechnic of Milano;
- Interdisciplinary Centre for Materials and Nanostructured Interfaces (CIMAINA), University of Milano;
- Centre for Preparation, Development and Characterisation of Nanostructured Materials and Surfaces, University of Trieste;
- Centre for Nanostructured Innovative Materials for Chemical, Physical and Biomedical Application, University of Perugia;
- Centre for the Preparation and Treatment of Organized Material at Nano-scale for Application in Photonics, Optoelectronics, Transformation and Separation, University of Calabria.

Other University organizations where nanotechnology research is getting increasingly relevant are:

- Centre of Micro-engineering Research (CRIM), Scuola S. Anna, Pisa.
- Consortium for Development of Systems at Great Interphases (CSGI), Firenze.
- Inter-University Research Centre for advanced Medical System (C.R.I.S.M.A.), Siena.

To complete the picture of the public camp other important organizations need to be mentioned. These are Synchrotron Lab (ELETTRA) of Trieste, which can give an important contribution, for example, in the study of the molecular/atomic structure of materials or dynamic phenomena at the surfaces, ITC-Irst - Microsystems Division, in Trento, for nanostructured materials, sensors, instrumentation, the National Institute for Metrology Research (INRiM) in Torino, for nanometrology.

During the last 3 years, the Italian Ministry for University and Research (MIUR) has supported the creation in areas which combine strong research competences with a relevant industrial background of the so called *technological districts* with the aim of promoting technological development in specific advanced sectors in the region. Nanotechnology is one of them and Veneto Nanotech, which started in 2003, has been the first technological districts specifically focused on nanotechnology, with a total investment from MIUR and Veneto region of about 58 Million of euro. In 2005 it has been open in its premises a nanofabrication facility, NanoFab, to support R&D in the field of nanomaterials.

More recently, other technological districts focused on nanotechnology are been created in the Regions of Sicilia and Campania with an investment from MIUR of about 42 Million of euro. Nanotechnology is one of the priority of research also in other technological districts. In Piemonte and in the just created districts in Friuli and Puglia, with an investment from MIUR of about 30 Million of euro. The all picture is given in table 1.

Region	Research area	Coordinator
Veneto	Nanotechnology applied to materials	Veneto Nanotech
Friuli Venezia Giulia	Nano-Biotechnology	Center for Molecular Biomedicine (CBM)
Sicilia	Micro and nanosystems	In definition
Campania	Polymeric and Composite Materials Engineering and Structures	IMAST
Piemonte	ICT wireless and wire-line technologies	Torino Wireless
Puglia	Biotechnology	In definition

Table 1. Italian districts with activities in nanotechnology

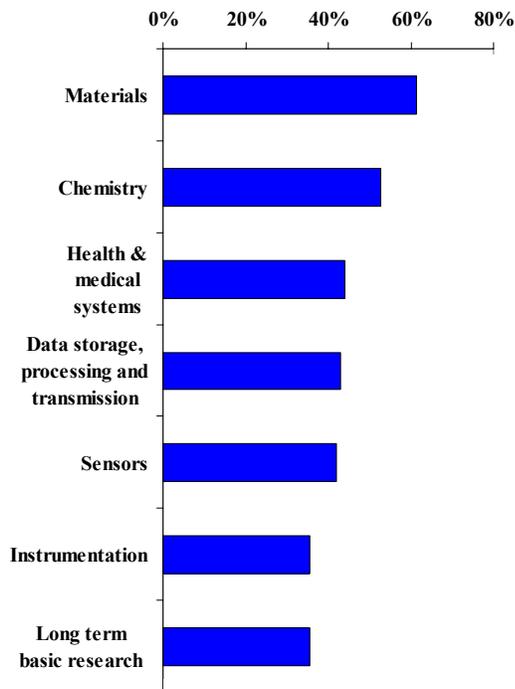


Fig 2. Research areas in public organizations (multiple choice allowed)

Ample is the spectrum of the research areas in the public sector, but besides long term basic research, the activity refers, in particular, to structural and functional materials, chemistry (including catalysis), health and medical products and systems, instrumentations, data storage and transmission (Figure 2).

The attention is focused on organic, inorganic and multifunctional materials, supramolecular systems, surfaces, interfaces and nanostructured systems, molecular electronics, quantum computing, spintronics and photonics, life sciences/biomedicine.

## 2.2 Industry

The interest for nanotechnology has steadily grown during the last years in the industrial sector and from the census emerged around 50 companies active in this field. There are in fact a certain number of large enterprises, and a score of SMEs, usually spin off or start ups, many of them micro.

The big enterprises are internationally known players such as Finmeccanica Group that has lately organized a number of its companies (i.e. Selex Integrated Systems, Selex Communication, Alenia Aeronautica, Alcatel Alenia Space Italy) into the *Nanomaterials and Nanotechnology Focus Group* to better address and coordinate their activities in nanotechnology, STMicroelectronics, FIAT Research Center (CRF), Pirelli Labs, Olivetti i-jet, Saes Getters, CTG-Italcementi, CSM, Agilent Technologies, Colorobbia.

Quantitatively the effort is obviously concentrated within the big companies, but the SMEs have an important role in promoting nanotechnology application.

To name a few, there can be indicated: Ape Research (instrumentation), MBN (nanomaterials), Microcoat, Grinp (surfaces), Tethis, Nanodiagnostic (biomed), Organic Spintronics (devices).

The number of the fields of the research in the private sectors is ample. In the case of the big companies it is, of course, related in first place to the sector in which these companies operate and considering the above: ICs, transport, ITC, materials, aerospace, defense.

When compared with the public research where the the activity is more or less evenly distributed on the various areas (figure 2), it turns out that industrial research is more focused. In particular R&D in the field of materials takes the lion share.

This is understandable considering that materials are the starting point for the development of many industrial products/processes/devices and advancement in this sector may have an impact in a variety of sectors.

Health and medical systems and instrumentation plays also an important role, with some new micro companies, now approaching the market.

It's worth to mention that data storage and transmission research, though not in the first positions of the graph, is the main activity of some Italian nanotechnology top players, like the already mentioned STMicroelectronics and Pirelli Labs.

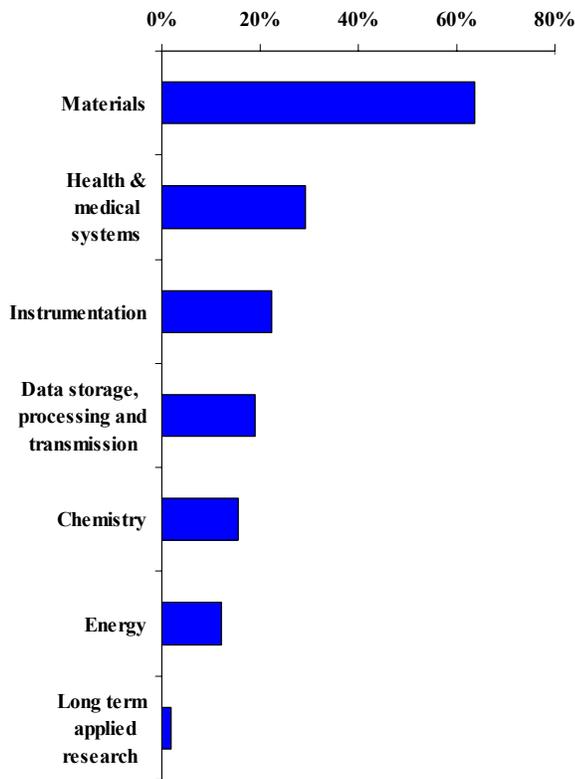


Fig 3. Research areas of industry (multiple choice allowed)

### 3 CONCLUSION

In conclusion, nanotechnology is at present well established in the Italian landscape and as it has been illustrated above there are now numerous players active in this field in the public sector as well as in industry. The attention has been stepped up during the last 3-4 years and various initiatives have been taken to improve the use of the resources and make more effective the efforts. To this end particular attention has been directed toward education/formation. Post-graduate courses related to nanotechnology are under way at various Italian Universities. At the University of Padua and Venice, Polytechnic of Turin, University of Rome “La Sapienza”, University of Perugia, University of Pavia. Working groups have been set up to tackle the problem of standardization and metrology for nanotechnology and on bionanotechnology. Growing attention is dedicated to health and safety issues.