



# NANO@ir

## Iran Nano-Technology Initiative Council Quarterly

### Editorial

Nanotechnology is not only a part of future, but it is all of it.

The history of mankind has always experienced waves of growth and development which have affected societies; chances developed by Mankind and employed to enhance the quality of life and create wealth. Nanotechnology is one of these waves emerged to make a superior future.

Taking into account nanotechnology's remarkable contribution to various industries, based on its 20 years vision, Iran has placed this technology as a priority within its 10-year strategy plan starting from 2005. This plan aims to create wealth and enhance life quality as it contributes to medical, energy, oil and gas and finally water and environmental industries as well as training innovator expert professionals and performing innovative plans to introduce nanotechnology to daily life.

Iran nanotechnology development programs in raising of public knowledge, e.g. through schools and also by training human resources in universities and through creating or reinforcement of general and specialized infrastructures, are moving forward while, at the same time, primary steps have been taken in technology transfer, commercialization, investment and production and marketing of products. Currently, Iran can share its notable potential in nanotechnology with other countries at regional and international level.

In this context, this quarterly intends to introduce nanotechnology potentials of Iran to the world and also aims to display scientific and technological inventions including the collaborations with other countries.

# The Future Strategy



The strategic plan of nano-science and technology provides the outline of nationwide activities in this field from 2005 to 2015. This so-called “The Future Strategy”, approved by government cabinet in July 2005, explains the vision of nano-science and technology development of Iran as follows:

“For materialization of the twenty year vision of the Islamic Republic of Iran, the software movement and the improvement of level, quality and security of people’s life, in ten years horizon, the Islamic Republic of Iran will be a developed country in nanotechnology with:

- Indigenous and advanced infrastructures and enjoying higher share of expert human resources
- Having effective and constructive internal and international interactions
- Generator of economic added value resulting from nanotechnology
- Enjoying competition capability at global level”

Main goals, strategies and structure of overall-management of nanotechnology development are clearly stated in this plan. Ten

Table 2: Time Schedule of the Future Strategy

Period	Time-span	Beginning Date	End Date
1st Period	3 years	2006	2008
2nd Period	3 years	2008	2011
3rd period	2 years	20012	2013
4th period	2 years	20014	2015

years horizon of the future strategy is divided into four periods as shown in table 2.

In the first 3 years period, 53 programs have been implemented. Based on their evaluation, the second complementary plan for the next three years was provided and approved. In this plan, the programs are categorized into a series of topics covering all wealth creation steps, that is, from idea to market. The private sector role in development of nanotechnology in Iran is highlighted in this plan.

Topics are as follows:

- 1.Policy Making and Evaluation
- 2.Publicity and increasing public awareness
- 3.Scientific and Technological Infrastructures
- 4.Scientific and Technological Initiative
- 5.Technology Transfer and development
- 6.Production and Market

This plan, including 33 programs, considers international interactions in various approaches. The followings are the most important measures taken by Iranian Nanotechnology Initiative (INI) to escalate the international interactions:

- 1.Enhancement of International Scientific and Technological Collaboration

In the Future Strategy plan, the improvement of scientific and technological collaborations with other countries is encouraged.

- 2.International Sharing of Laboratorial Services

The INI encourages international collaboration of nanotechnology laboratories. International sharing of laboratorial services, construction of experimental equipment and development of crucial technologies in collaboration with more developed centers worldwide are supported by the INI.

3. Iranian Nanotechnology Initiative (INI)

The INI is highly motivated in interrelations with regional and international organizations for nano development as it has already interactions with the International Committee of Nanotechnology Standardization (ISO/TC 229, UNIDO, ECO, etc. Also INI has established nanotechnology development network between regional and Islamic nations.

- 4.Enhancement of International Investments in Nanotechnology

INI intends to attract more foreign investments in nanotechnology considering domestic advantages such as professional human resources, appropriate infrastructures and sustainable support policies by government.

- 5.Supporting Agencies to Expand International Interactions

INI supports national nanotechnology agencies by, for instance, finding international partners, facilitating participation in international fairs and markets and opening new international collaborations with other scientific, technological and industrial centers of nanotechnology.

# National Nanotechnology Exhibition of Iran



## Introduction

With rapid changes in nanotechnology, the advent of various new products and lack of knowledge among public and authorities made Iranian Nano Initiative Council (INIC) to establish the first exhibition in this field.



## Objectives of The Exhibition

This exhibition is going to be held with the purpose of commercializing the nanotechnology in Iran.

“The First National Nanotechnology Exhibition of Iran” is indeed an assembly for introducing, technologies, services, new techniques and innovations to authorities, researchers, manufacturers and the general public.

This exhibition brings the domestic potentials in nanotechnology and new production methods to the public which may result in more investment attraction and contracts signed for technology transfer.

In this exhibition, products, facilities and national innovations in nanotechnology are brought to the public eye by more than 100 stands in a 5000 sqm space.

The followings are displayed in the exhibition:

- Nanotechnology products (in industrial and pilot scale)
- Production methods improved by nanotechnology
- Patents, books, papers, and successful nano-based research projects
- Pilot technology-based researches

## Parallel Programs of the Exhibition

- Three Meetings:

- 1.The International symposium of Nanotechnology Authorities from Different countries and International Organizations
- 2.The Meeting of Iranian Nanotechnology Laboratory Network (INLN) Directors
- 3.The Meeting of Iranian Nanotechnology Business Network CEOs

- Seven Lectures:

- 1.The Nano-packaging Effects in Reduction of Agricultural Wastes
- 2.Nanotechnology and Plant Medicine
- 3.Nanotechnology Applications in Agriculture
- 4.The Introduction of Products via Gold and Titanium Dioxide Nano-particles
- 5.A Survey of High-Tech Companies
- 6.A Successful Case in Biotechnology
- 7.The Financial Support Mechanism of Science and Technology

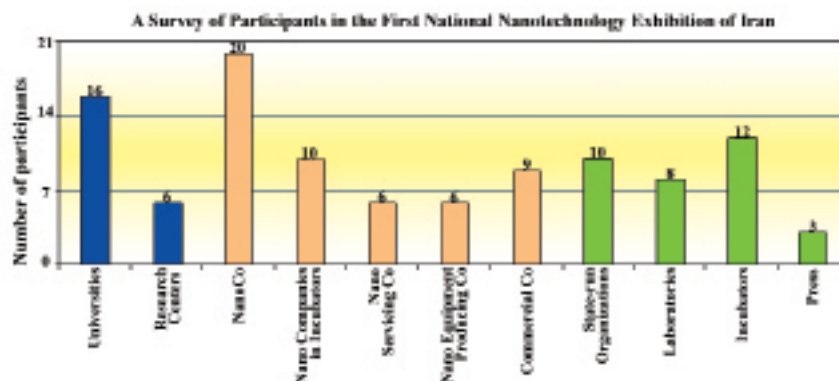
- Two Workshops:

- 1.Educational Workshop on Scanning Tunneling Microscope (STM)
- 2.Educational Workshop on Patent Analysis

- Open Stand of Nanotechnology Education

- TopTen Nanotechnologists

As it is the first national nanotechnology exhibition which demonstrate innovations and products of I.R.Iran, ambassadors and special foreign guests are invited to visit, hoping to witness a prominent international exhibition in near future.



dards in the field of health and safety and environment. Giving advice on personal safety and engineering control equipment, developing safety procedures and examination of toxicity and possible risks are of other services provided by this workgroup.

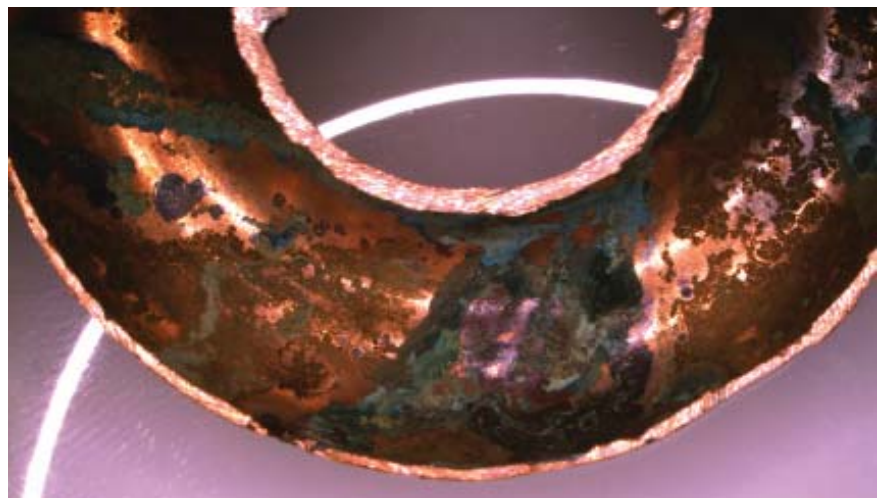
By now, the followings have been the most important activities of the committee:

- As an active participant, Iran has developed 22 new international standard proposals
- Active participation in four meetings of International Nanotechnology Standardization Committee
- Support for establishment of several high-capability research teams in the field of safety and environment standards
- Interactions with research centers, manufacturers and related organizations such as Ministry of Health and Medical Education to make them involved in nanotechnology standardization
- Starting the establishment of five national standards in the field of silver nano-particles and products, safety procedures in nano-related work places and national standard of nanotechnology definitions and nomenclature
- Publication of four professional reports on environmental effects, toxicity and safety of nano-particles
- A proposal submitted to ISO technical committee on a new international standard in nanotechnology, approved as a joint project between the committee workgroups
- Iran is to host the meeting of International Nanotechnology Standardization Committee in 2011 (ISO/TC229>s 12th meeting)

### The Global Efforts in Nanotechnology Standardization and Position of Iran

Already, six international organizations as well as ISO have established committees on nanotechnology standardization. So far, only six standards, one by ISO and five by ASTM, have been published.

Furthermore, several few countries which had earlier founded a national body on nanotechnology, have offered national standards in this field. These countries include UK, China, South Korea, Japan and Taiwan to which Iran will be added in the near future. Some of the national standards, now in pro-



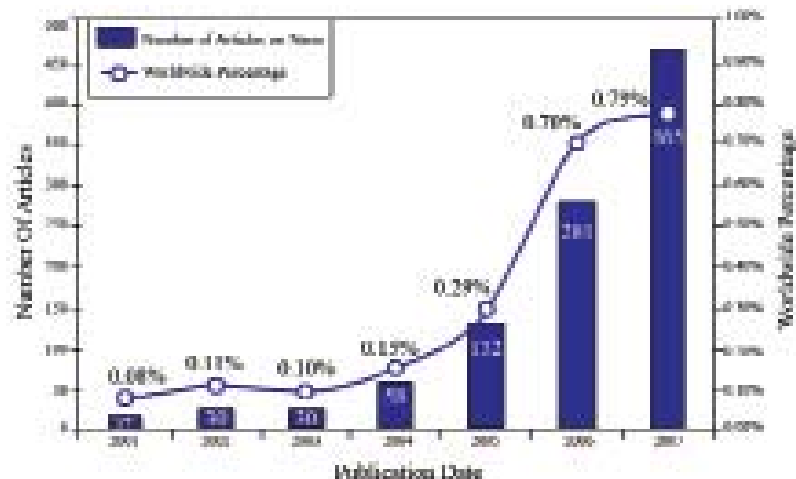
cess in Iran, are planned to be proposed in ISO to be employed as international standards as Iran is one of the few countries worldwide enjoying definite nanotechnology standardization plan. Among Islamic and regional countries, Malaysia and Russia are respectively the only main members of International Nanotechnology Standardization Committee

### International Collaborations of Iranian Nanotechnology Standardization Committee

Iran, as one of 30 main members of International Nanotechnology Standardization Committee (ISO/TC229), actively participates in its periodical meetings. Iran, besides some few members like US, Japan, South Korea, Canada, Germany, UK and China, has currently approved running projects in this committee. Another key activity of Iran is to hold professional arbitration in ISO/TC229, presented on the standards submitted to the committee by other member countries. Due to these efficient activities, the hosting of committee meeting in 2011 has been awarded to Iran.

# Iran Contribution to Science Development and Innovation in Nanotechnology

Nowadays, development level of the countries is evaluated based on scientific indexes including number of published scientific articles, number of references made on published articles and number of patents registered by that country.





# Iran Nanotechnology Laboratory Network (INLN)



Iran Nanotechnology Laboratory Network (INLN) established with 34 member laboratories on April 04, has been extended to 40 members in 08. These are selected from the best 120 applicant labs nationwide.

INLN is a virtual network which provides all academic and industrial researchers with services shared by member labs without physical interventions in laboratories.

Offering experimental services to researchers and nano-industries, this network covers all major fields of nano-based technology including engineering, medicine, basic sciences, agriculture, nano-biotechnology and computational nano-technology.

The comprehensive information of more than 450 lab equipment including those for measurement and characteristics of nano-structured materials and those used in medicine and nano-biotechnology research are now listed in this network.

Labs to become member in INLN would be ranked based on human resources capabilities and laboratory facilities they offer. Now, the network has members in 12 major cities of Iran which almost cover all academically and industrially main parts of the country.

Human resources and physical capabilities of member labs are shared through professional training courses and advices provided by superior members to other labs.

Moreover, member labs are evaluated in six-month periods by INLN, based on customer satisfaction level and resources management, on which

various supports are provided by Iranian Nanotechnology Initiative (INI) including education, international standards qualification, maintenance and purchase of new lab facilities.

The INLN member labs are encouraged to reinforce their international credit through ISO17025; three members were qualified in 2006, 07 and five are to be qualified soon.

In addition, INLN encourages the laboratorial equipment fabrication related to nanotechnology by Iranian innovators and companies. Scanning Tunneling Microscope (STM) is an accomplished example presented in 2007 and 15 units have already been sold to domestic and foreign customers. Five other relevant cases are on the final development stages by domestic companies.

[www.nano.ir](http://www.nano.ir) provides complete and updated information on facilities, expertise and servicing procedure of member labs, all accessible by the search tool integrated in the website.

Moreover, advisory services are provided by network specialists through email on facilities and services offered by various labs.

INLN aims to be renowned worldwide through its international collaborations particularly with regional and Asian countries and have servicing and experience interchanges with other prominent laboratories globally. By now, it has had collaborations in the field of human resources training with various countries including Japan, Sweden, Canada, Germany and Oman.

## Iranian Nanotechnology Standardization Committee (ISIRI/TC229)

### Introduction

With respect to the important role of standardization in development and commercialization of nanotechnology, a technical committee was established in which Institute of Standard and Industrial Research of Iran and Iranian Nanotechnology Initiative took part. This so-called ISIRI/TC229 technical committee, established on July 2006, mainly pursues the following objectives:

- Development and publication of nanotechnology standards based on national necessities and supervising their implementation

- Active participation in international programs of nanotechnology standardization

Iranian Nanotechnology Standardization Committee comprises three specialized workgroups in which more than 40 university professors, researchers and standardization officials take part. Their titles and activity domains are as follows:

- First workgroup, "Terminology, Nomenclature and Definition", which provide these in nanotechnology related fields to facilitate international relations and develop a unique nomenclature as well as building an appropriate perfect categorization of nanotechnology subjects.

- Second workgroup, "Measurement and Characterization", which standardize the measurement and characterization methods of nano-materials, nano-structures, nano-machineries and products.

- Third workgroup, "Health, Safety and Environment", which develop stan-

**www.nano.ir provides complete and updated information on facilities, expertise and servicing procedure of member labs, all accessible by the search tool integrated in the website.**

# Iran and International Interactions



In the contemporary global village, in order to witness scientific and technological development, constructive international relations seem inevitable. Iran, seeking to play a major role in nanotechnology through obtaining at least one percent of the global contribution, requires relations with remaining 99 percent contributors. For this, it has held three joint scientific conferences with three prominent countries in this field:

Iran and Germany, 2-3 May, 2004:

This first collaborative conference was held in Iran University of Science and Technology, Tehran, Iran, with focus on facilitating the next scientific mutual meetings and also to make Iranian students familiar with the field and giving them foresight in related global activities. Besides, 25 scientific papers were presented and a nanotechnology equipment exhibition was held along with the main conference.

Iran and Russia, 28-29 May, 2005:

This was held by the Iranian Ministry of Mines and Industries aiming to share the latest accomplishments of the two countries' researchers in the field. The first day was devoted to paper presentation and the second to technical workshops, all of which in English.

**Iran-India Joint Conference on Nanotechnology (IJCN), 27-29 April, 2008:**

considering that India is among the top-ten countries in the production of science ranking eight with considerable advances in nanotechnology, the Medical University of Tehran in collaboration with Iran Nano-Technology Initiative Council (INIC) came to hold a joint conference with India to advance mutual collaborations on the field. The major aims were:

- Establishing collaborations between the two governments in the field,
- Spreading science and technology,
- Becoming aware of the two countries' potentials.

## Conference Topics

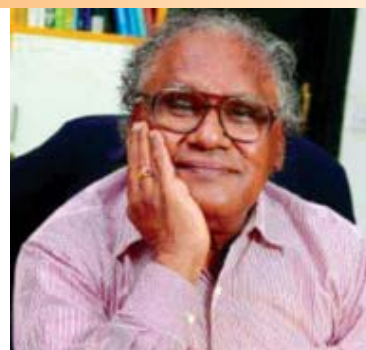
Conference lectures were given in four chief topics namely nano-physics

and nano-medicine on the first day, nano-chemistry on the second day and nano-materials on the third day. 150 papers from Iran, India, Saudi Arabia, Oman and Iraq were submitted to the conference, out of which 110 were accepted and presented as posters and four received prizes.

## Lecturers:

•Professor Rao, a chief adviser of the Indian prime minister in science and technology, as the major lecturer who directed a delegation of 14 other Indian top lecturers in the conference,

•Professor Rafietabar, a chief Iranian researcher in nanotechnology as well as other Iranian top researchers in this field.



## Pro CNR Rao:

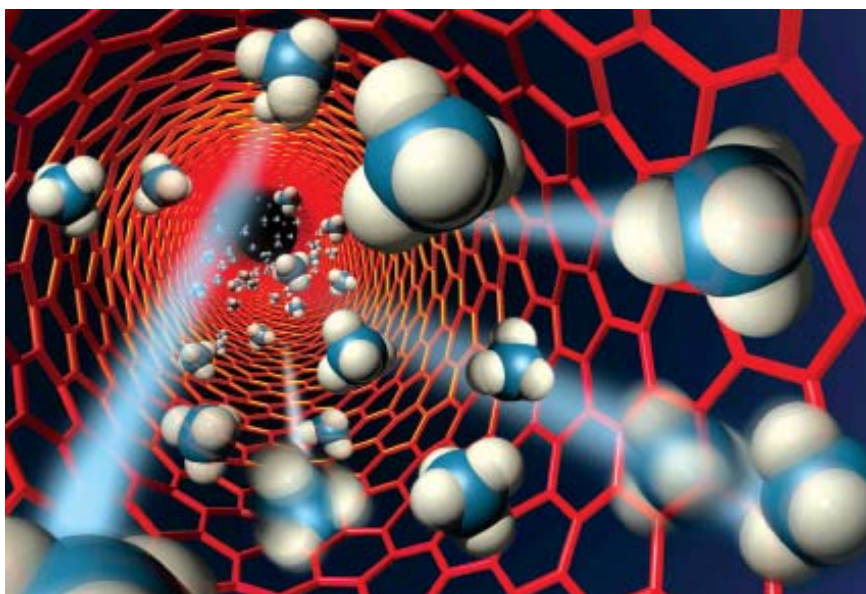
Prof. C.N.R. Rao is the National Research Professor as well as Honorary President and Linus Pauling Research Professor at the Jawaharlal Nehru Centre for Advanced Scientific Research. He is also an Honorary Professor at the Indian Institute of science.

## Parallel Programs:

Educational workshops and mutual meetings to exchange information between Iranian and Indian experts, facilitating future collaborations and holding an exhibition of products and accomplishments by 10 Iranian companies, were among the parallel programs of the conference. On the last day, an agreement was signed to facilitate mutual research programs by Iranian and Indian students, hold summer and winter joint courses, open a joint fund for research purposes, supervise Iranian and Indian students' projects collaboratively by the two countries' professors, and give Iranian projects the opportunity to use Indian research centers' equipment.

## Future Plans

As the conference came successful and fruitful for both governments to enhance scientific relations, it is expected to continue technological relations between Iran and India.



Considering Iran's contribution to nanotechnology, based on published articles as an index for science development and patents for technology development, an eye-catching growth in this field of technology is observed from 2001 to 2007.

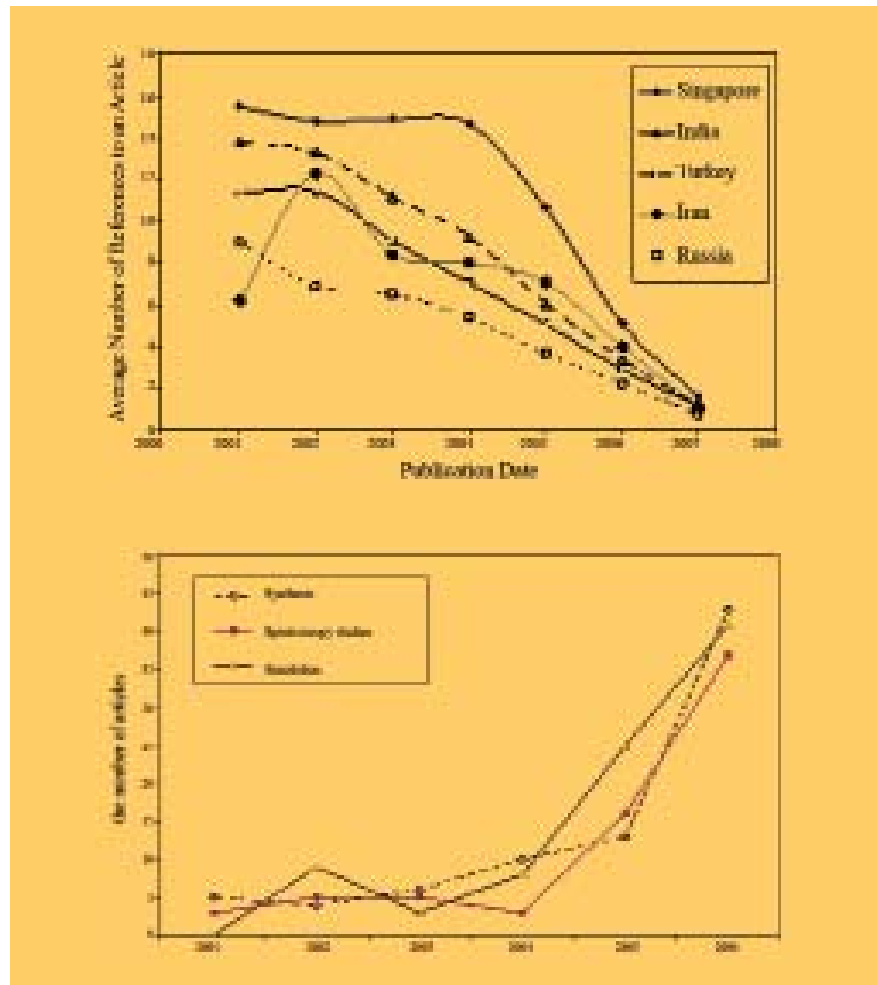
According to the statistics by prominent international databases such as Web of Science (ISI) and QPAT, Iran has gone up from 52nd in 2001 to 25th in 2007 in the ranking for articles publication in nanotechnology-related fields by an increase from 17 to 465 articles, representing about 0.8 percent of all articles worldwide. The largest growth in the number of articles was observed during 2005 and 2006, i.e. 126 and 112 percent respectively. Iran has also the first place between Islamic and Persian Gulf countries in nanotechnological science development.

US with 21.4 percent, China with 19.7 percent and Japan with 9.1 percent has respectively the highest number of published articles in this field.

Furthermore, Iran's rank regarding the average number of references to its papers on nanotechnology has drastically increased from 52nd in 2001 to 25th in 2007. The following figure illustrates these averages for some countries in comparison with Iran.

Simulation and nano-materials synthesis and characterization are three dominant fields of study in Iranian nanotechnology articles. In recent years, however, other new topics are studied in the Iranian articles. The following figure shows the number of articles in the three main fields.

On the other side, Iran has contributed to nano-related technologies by seven patents registered in European Patent Office (EPO) and World Intellectual Property Organization, five of which are patented in 2007. Due to the considerable time needed for fundamental researches to result in technology development, besides the recently introduced governmental support policies on nanotechnology innovations and newly established professional patent consulting offices in Iran, a more rapid growth rate is expected in the near future. Iran, along with Finland, Brazil and Norway, is in the 22nd rank regarding the number of patents in EPO. US, Japan, Germany, South Korea and France occupy the first five positions respectively.



## Incentive Supports in Nanotechnology

Iranian Nanotechnology Initiative encourages the academic research and scientific activities in nanotechnology to enhance the scientific level of Iran in this field worldwide. These supports focus on student graduate theses, publication of ISI articles, participation in international conferences, international patents, book publications and establishment of nanotechnology Ph.D. programs in universities.

### Support Statistics

Starting in March 2005, thus far, 320 Ph.D. theses and 1600 master's theses are approved to be supported by initiative. Moreover, 1064 ISI Articles, 70 other journal articles and 420 Articles published in renowned international conference proceedings, as well as 13 international patents and 35 published books have enjoyed these supports. Granting over 35 billion Rials (~ €260000) to 3500 researchers in recent four years has attracted more researchers to get involved in nanotechnology.

Approves Cases to be Supported By INI, Mar. 2005 to Aug. 2008	
Ph.D. Theses	320
Master's Theses	1600
ISI Articles	1064
Other Journal Articles	70
Conference Proceedings	420
Book Publication	35
Patents	13

# Iranian Nanotechnology Business Network

Nanotechnology has proved to be effective in all industrial fields such as electronics, automobile, textile, oil and gas, petrochemistry, construction, etc. High added value, fresh markets, and available opportunities and advantages all show that nano-related businesses would benefit financially in Iran.

Generating wealth in the modern world with out-of-the-Ark equipment is bound to fail and that Iranian enterprises possess no option but to refer to novel technologies to increase quality and lower prices. Thus, nanotechnology has turned into an obligation not an option to compete in the global markets.

## On Iranian Nanotechnology Business Network

It is composed of a group of Iranian companies active or at least enthusiastic to become active in the field of nanotechnology under one common umbrella and identity. Being a member of the Network, they can benefit from:

- Government support. The aim is to strengthen Iranian businesses through providing business information; identifying opportunities; feasibility study; credit evaluation; providing business plans; financing; providing technologies, licenses, certificates; developing prototypes; general and professional educations.
- Business information. The website of the Network is responsible to provide or purchase necessary information for member companies.
- Shared financial resources. This service, apart from resolving the companies' monetary problems, presents new resources for research and development as well as for more investments.
- Cost efficiency. The Network's large unique identity and large-scale purchase of materials and equipment result in lower costs for products and services.
- Communal effort. The Network's large unique identity facilitates international cooperation, marketing, market making and competition with giants through one common brand and, on the other hand, avoids destructive internal competitions.
- Continuous assessment of the products, services, and approaches of the major competitors and pioneers in the field.
- Reasonable accumulation of national plans in the field of nano.
- Higher efficiency. This includes communal contributions, flexibility, competitiveness, accumulation of skills, investment and knowledge, removal of common threats and introduction of new opportunities.
- Communal education, innovation, unique well-known brand, finance, etc.

## Objectives and Plans of the Network

- supporting nano companies
- Working to achieve a common brand
- Adding up the resources in production, input, modification, and spread of nanotechnology
- Establishment of a reliable base to share knowledge, information and skill among companies
- Supporting the existing and new companies to advance
- Designing comprehensive systems to resolve the companies' problems
- Organizing governmental support and market
- Having advantages of being a small and being a large business at the same time

## Companies Active in Nano:

Today, out of the 20 companies, some are producing nanomaterials like nanosilver, nanocarbon, zinc nano-oxide, titanium nano-oxide, nanocopper, and nanodiamond. Others produce nanocomposites and enhanced materials using nanotechnology like car fuel supplementary to decrease fuel consumption, oil supplementary to increase the efficiency of car engine lubrication system, materials to increase the durability of road systems, and laboratory equipment like STM. More than 50 percent of the companies have large-scale production and the rest are passing through the ultimate stages of commercializing their products.

# Top Products

**Scanning Tunneling Microscope (STM), manufactured by Pars Nanosystem Company.**



## Features:

- Scanning quality in static current and static height with maximum panning of 10×10 microns,
- Electronic noises of about 25 picoamperes, compared with foreign devices with noises of about 1 to 5 nanoamperes,
- Very high efficiency in the present noisy environments (electronic and mechanical vibration noises),
- Mechanical design with very low thermal drift and full automatic mechanism for prototype approaching, coming with a camera and nanomotor,
- Attractive design and case,
- On-line display of height Z, and current I while scanning, without touching the sample surface to avoid any damage,
- Custom PID parameters, current, and voltage while scanning with a variety of software filters,
- 2 and 3-D pictures on nanoscale which can be put together and compared,
- 3-D scanning on every angle and focusing on one part for closer analysis,
- Scanning biologic molecules like DNA or antibody, that is, it scans a nanoparticle or nanotube while attaching to a biologic material and gives the chance for the reinvestigation of the process.

## Pilot Nano-Filtration (NF)

A Nano-Filtration system with a capacity of 60 square meters has been designed and installed on Karun River, Iran, to study the feasibility of nanotechnology-enabled drinking water treatment.



## Project Innovations:

In most parts of the world, due to the sensitive nature of drinking water treatment projects, pilot units are used for the commissioning of large scale treatment projects. These units, apart from minimizing risks, can identify environmental and seasonal changes with a low cost. This has a great influence on the durability of the machinery and the decrease in costs. However, pilot types are rarely used in Iran. Meanwhile, the low capacity of this equipment allows it to be used as a pilot unit which is unique in Iran until now.

## Social Impact:

Due to the lack of appropriate drinking water, polluted water of the Karun River and lack of advanced water treatment facilities, diseases are emerging in the region. In this project, nanotechnology-enabled water treatment will be studied economically and technically. In case the project is successful, it will replace the available systems for residents to enjoy a higher quality of life.