



Iran Nanotechnology
Innovation Council
(INIC)

Progress Review of Iran Nanotechnology Plan

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Damavand Mountain, Tehran, Iran



In Pursuit of Excellence



» Introduction

Initially, an expert Committee began formulating policies for nanotechnology development in Iran in 2001. The establishment of the Iran Nanotechnology Innovation Council (INIC) in 2003 was a key milestone in the country's strategic development of nanotechnology. The government approved the first development plan prepared by the council in 2005. By the end of the first plan, Iran had witnessed progress in developing the needed infrastructures. With the commencement of the second nanotechnology development plan in 2017, focusing on expanding the technology applications, the country started benefiting from economic and social outputs of nanotechnology applications.

Iran's Nanotechnology development plan entails structured programs for all rings of the value chain from science and technology development towards commercialization.

The programs and activities of the plan focused on the following aspects:

- Nanotechnology Human Resources
- Nanotechnology Research
- Nanotechnology Infrastructure and Technology development
- Nanotechnology Industrialization
- Nanotechnology Commercialisation



Future Strategy



Nanotechnology in Iran 2025

INIC has been publishing the performance report of the plan annually since its initiation. In the following, progress review of Iran nanotechnology plan is presented in separate categories.



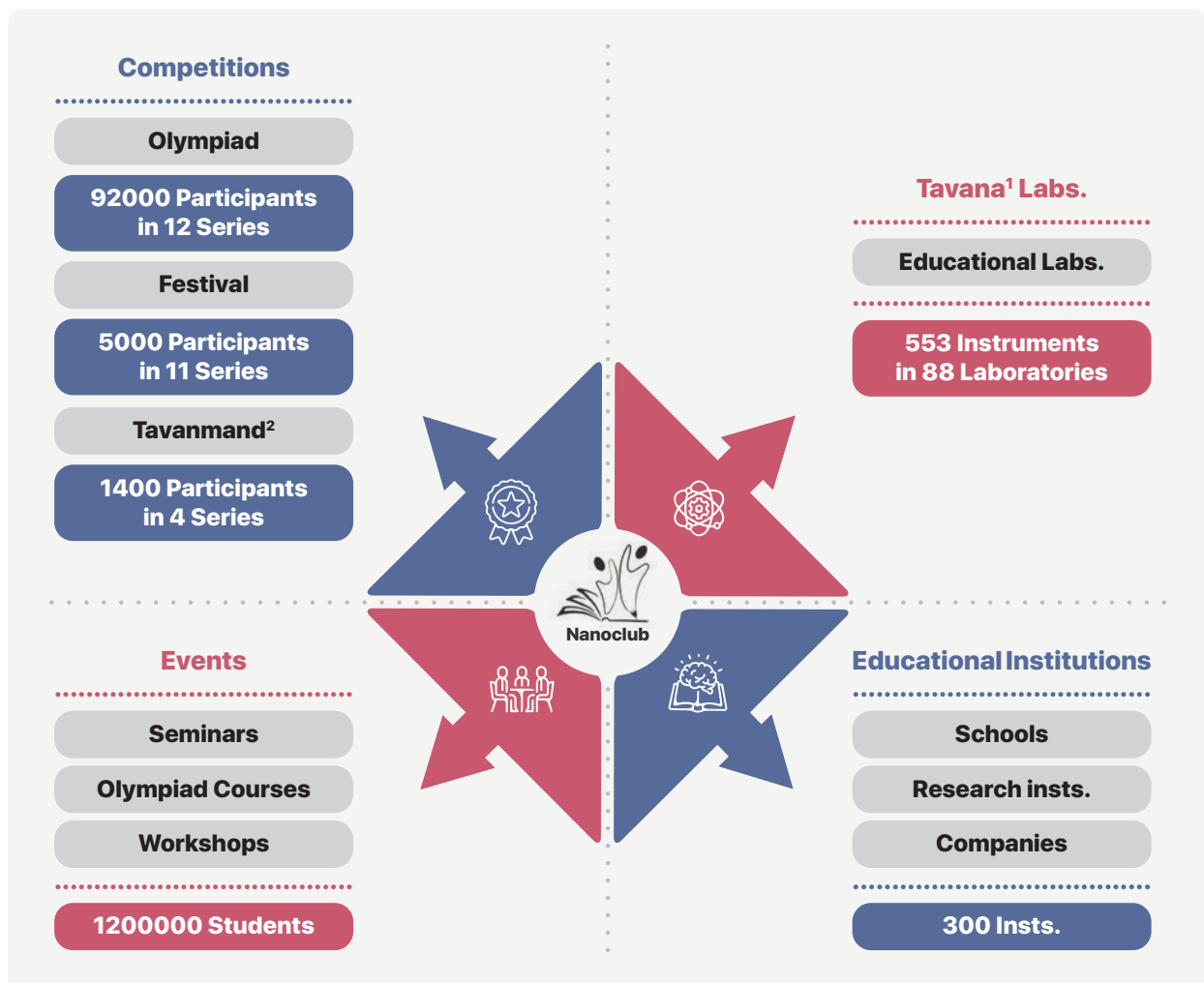


Nanotechnology Human Resources



High School Students Education

Iran's activities in promoting nanotechnology among high school students were initiated in 2001, aiming to identify and nurture talented pupils. Since 2008, with the establishment of *Nanoclub*, these activities have continued under the institution's guidance. To date, more than 1.2 million high school students have been familiarized with nanotechnology principles and applications through a variety of programs, including competitions, workshops, festivals, and Olympiads. Through these programs, talented pupils are selected to play a role in the nano ecosystem. During this period, NanoClub's virtual platform has proved extremely popular, focusing on introducing nanotechnology in simple language. A nanotechnology laboratory network has also been established, equipped with instruments built by Iranian companies, to heighten high school students' engagement and to persuade them towards practical and hands-on experience in nanotechnologies.



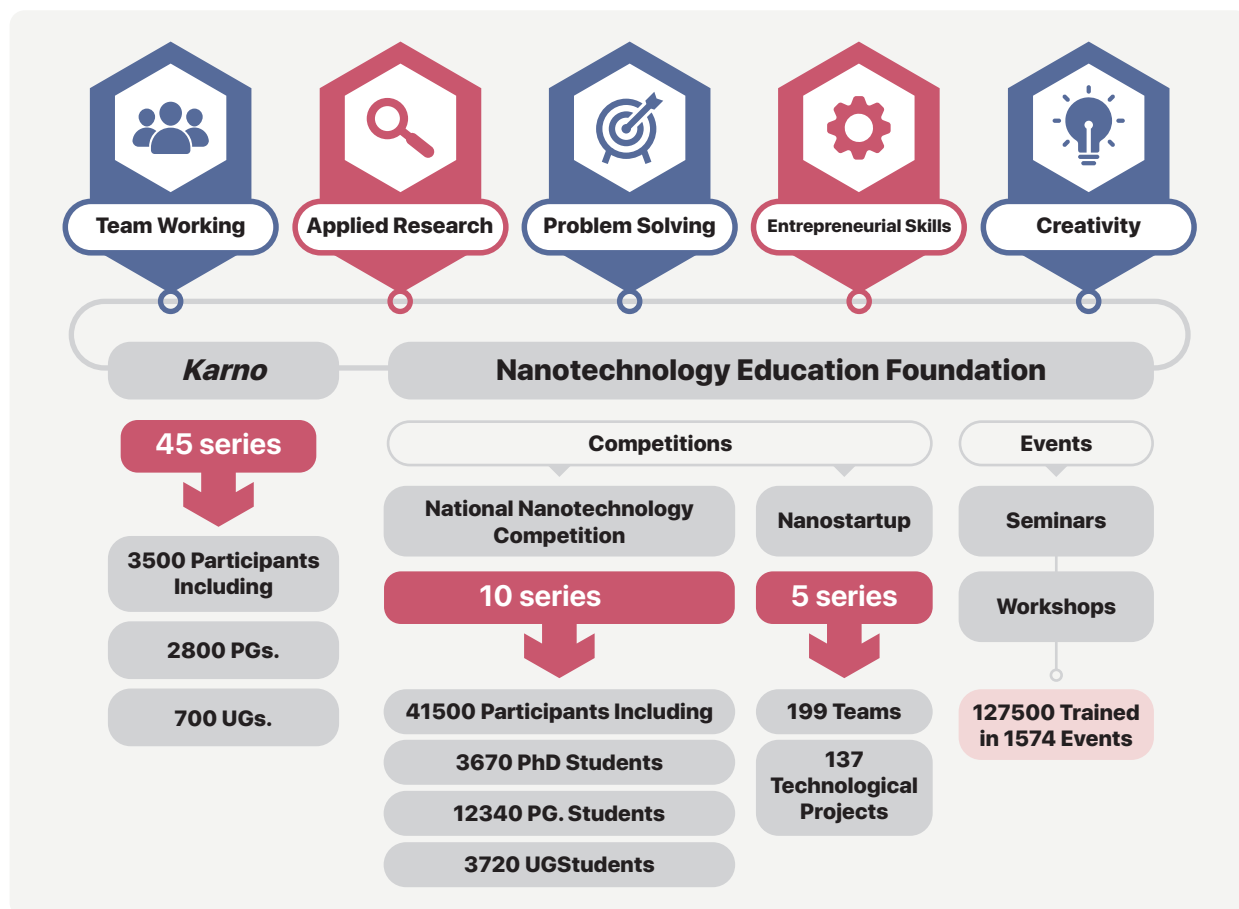
1. *Tavana* is a Persian word that means powerful.

2. *Tavanmand* is a Persian word that means capable.



» University Students Empowerment

University Students are important human resources in nanotechnology and play an essential role in developing this technology. Improving students' skills and abilities has been considered one of the key policies of INIC, resulting in various programs. For example, since 2010, a scientific competition called *National Nano Competition* has been held annually among students of different university levels. Providing special training to students to lead them towards applied research is one of the most important goals of these programs. To develop entrepreneurial skills and familiarity with the needs of the nanotechnology labor market, nanotechnology empowerment courses as *Karno*¹ have been held for graduate students of nanotechnology at various universities Since 2011. Since 2017, A competition called *NanoStartup* has helped capable and professional student teams that intend to offer their Minimum Viable Product (MVP). Nanostartup provides facilities for selected teams to develop their idea and connects the teams to other support programs, investors, or customers. From 2015, With the establishment of the *Nano Education Foundation*, National Nano Competition and NanoStartup will be held under the supervision of this institution.



1. *Karno* is a Persian word that means new work.



Nanotechnology Research

Nanotechnology Publications

From 2001 to the end of 2021, Iranian researchers have published nearly 93000 ISI-indexed papers, securing the world's eighth rank in this regard. This is while in 2001, Iran ranked 57th, having published only 9 papers a year (see figure 1 and table 1).

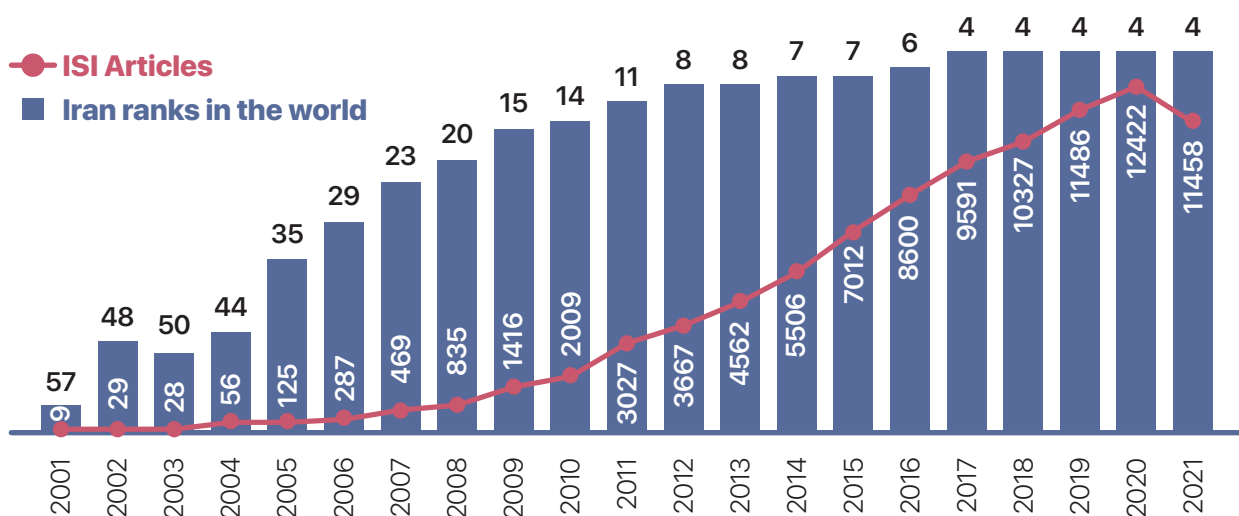


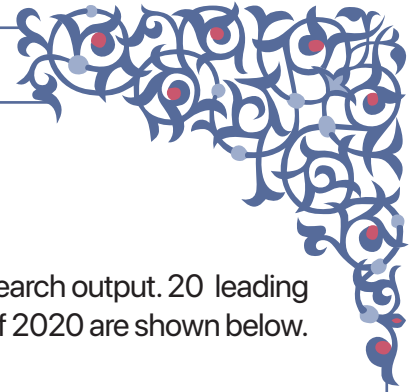
Figure 1. Iran's ISI-indexed nanotechnology articles (2001-2021)¹

Table 1. 20 leading countries in nanotechnology publications (2001-2021)²

Rank	Country	Number	Rank	Country	Number
1	China	717253	11	Italy	65206
2	USA	383076	12	Spain	64986
3	India	158926	13	Canada	51907
4	Germany	139142	14	Taiwan	51607
5	Japan	137391	15	Australia	51469
6	South Korea	126715	16	Brazil	37633
7	France	93779	17	Poland	35192
8	Iran	92920	18	Singapore	33765
9	UK	81661	19	Saudi Arabia	33709
10	Russia	74168	20	Switzerland	29292

1. <https://statnano.com/report/s29>

2. <https://statnano.com/report/s29>



Also, the h-index determines both the quantity and quality of scientific research output. 20 leading countries in the h-index of nanotechnology articles from 2016 to the end of 2020 are shown below. Iran ranks 11th in the world.

Table 2. 20 leading countries in h-index of nanotechnology articles (2016-2020)¹

Rank	Country	Number	Rank	Country	Number
1	China	338	11	Iran	142
2	USA	316	12	Switzerland	137
3	Australia	185	13	India	134
4	Singapore	182	14	France	132
5	Germany	180	15	Spain	128
6	South Korea	173	16	Italy	121
7	Japan	170	17	Netherlands	118
8	UK	169	18	Sweden	111
9	Saudi Arabia	167	19	Taiwan	111
10	Canada	146	20	Pakistan	105

» Nanotechnology Academic Scholars

In Iran, more than 37000 experts at MSc and Ph.D. levels, as well as academic scholars, actively partake in nanotechnology research. Ph.D. courses have been organized in 24 universities, and 76 universities organize nanotechnology courses at the MSc level.

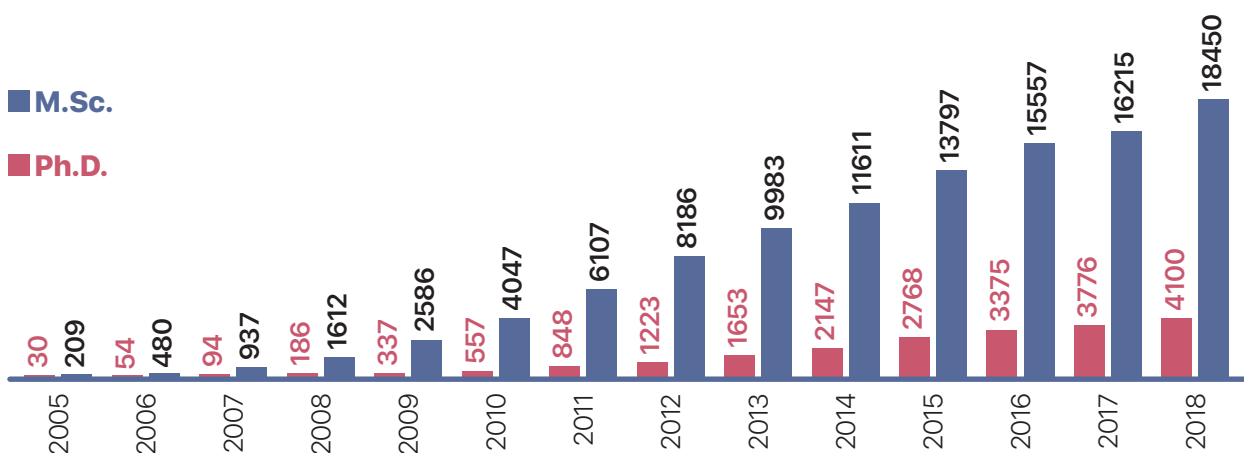
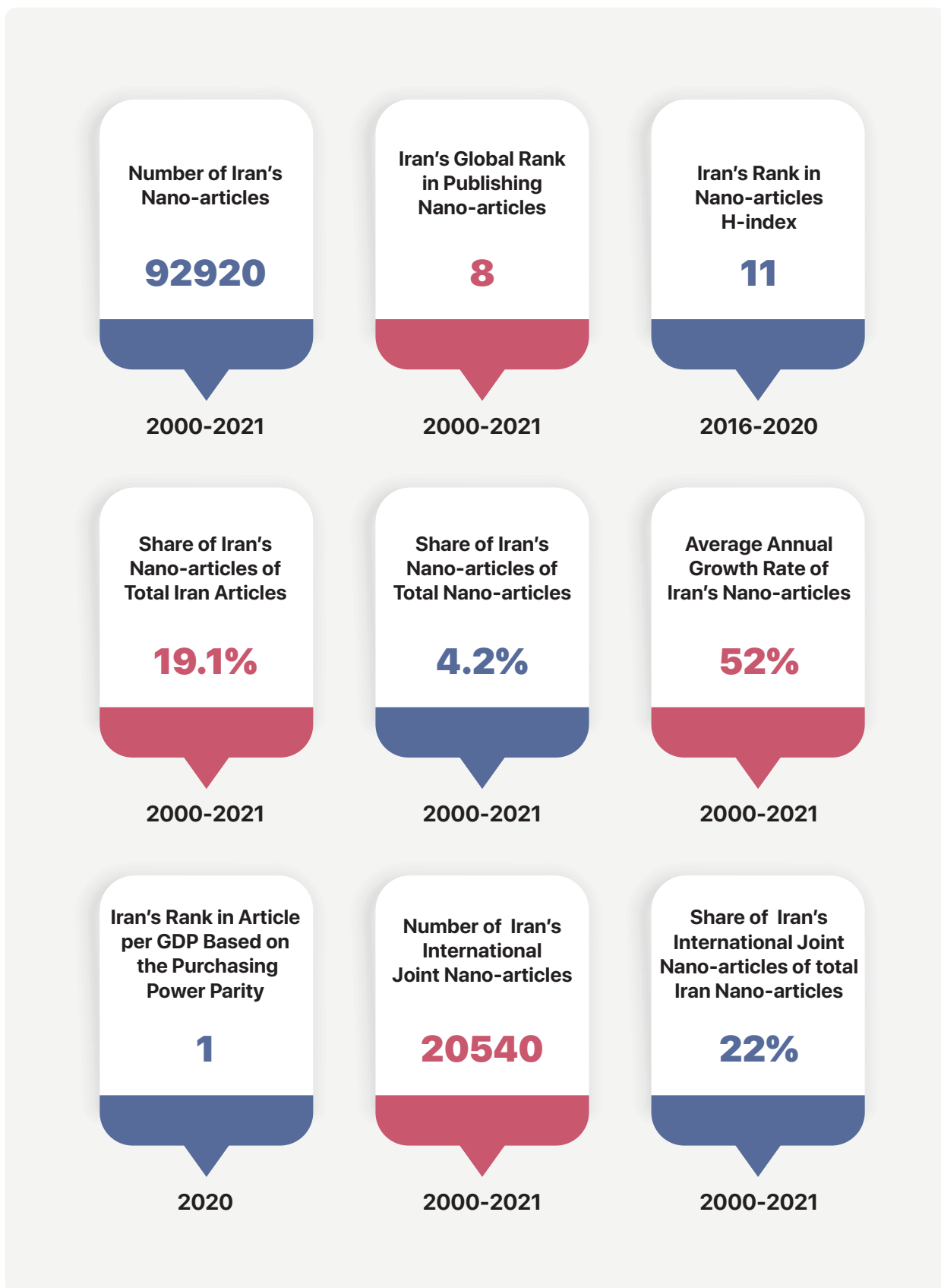


Figure 2. Number of nano university graduates in Iran (2005-2018)

1. <https://statnano.com/report/s132>







Iranian Hybrid PVD System

Nanotechnology Infrastructure and Technology Development

Nanotechnology Patents

Over the past 15 years, 307 patents in nanotechnology have been registered in USPTO and EPO, and other credible patent offices by Iranian inventors, which comprises about 30 percent of the registered patents by Iran in various fields of science and technology.

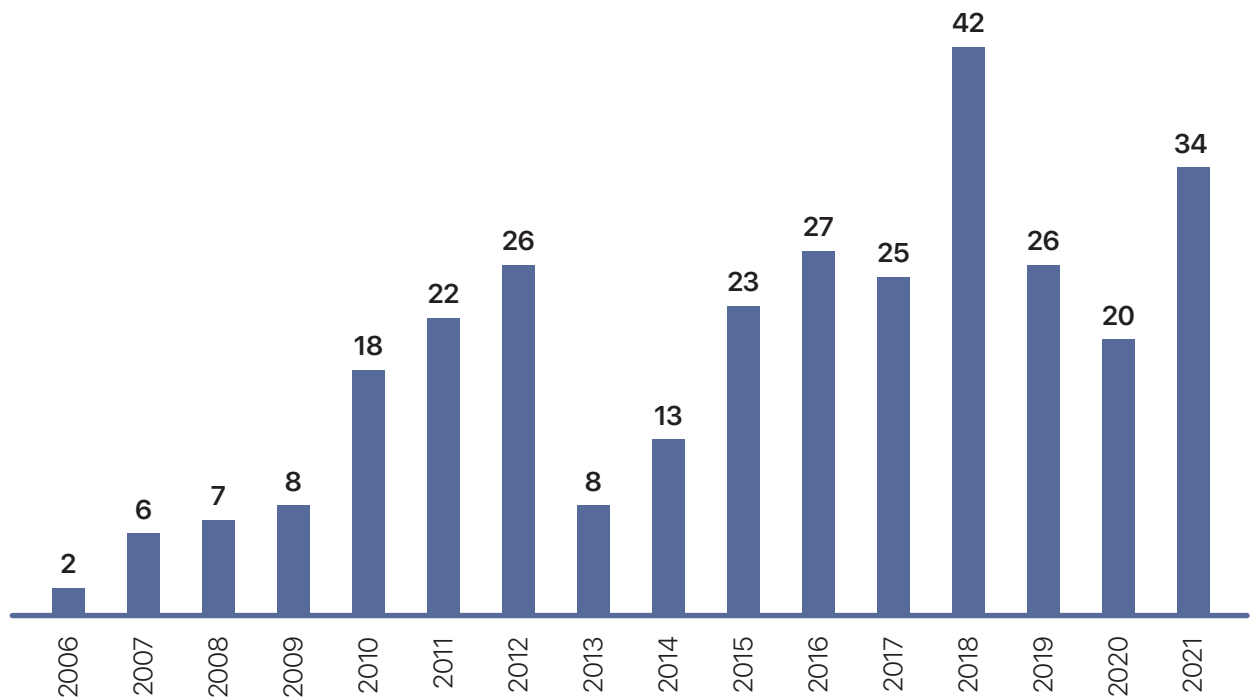
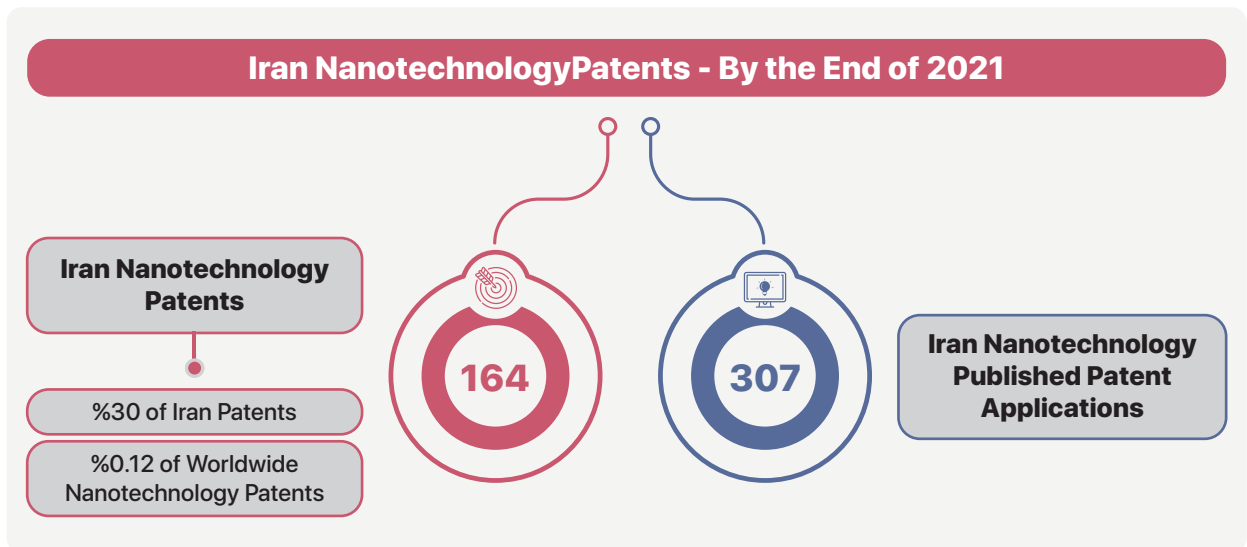


Figure 3. The number of Iran's nanotechnology published patents (2006-2021)¹

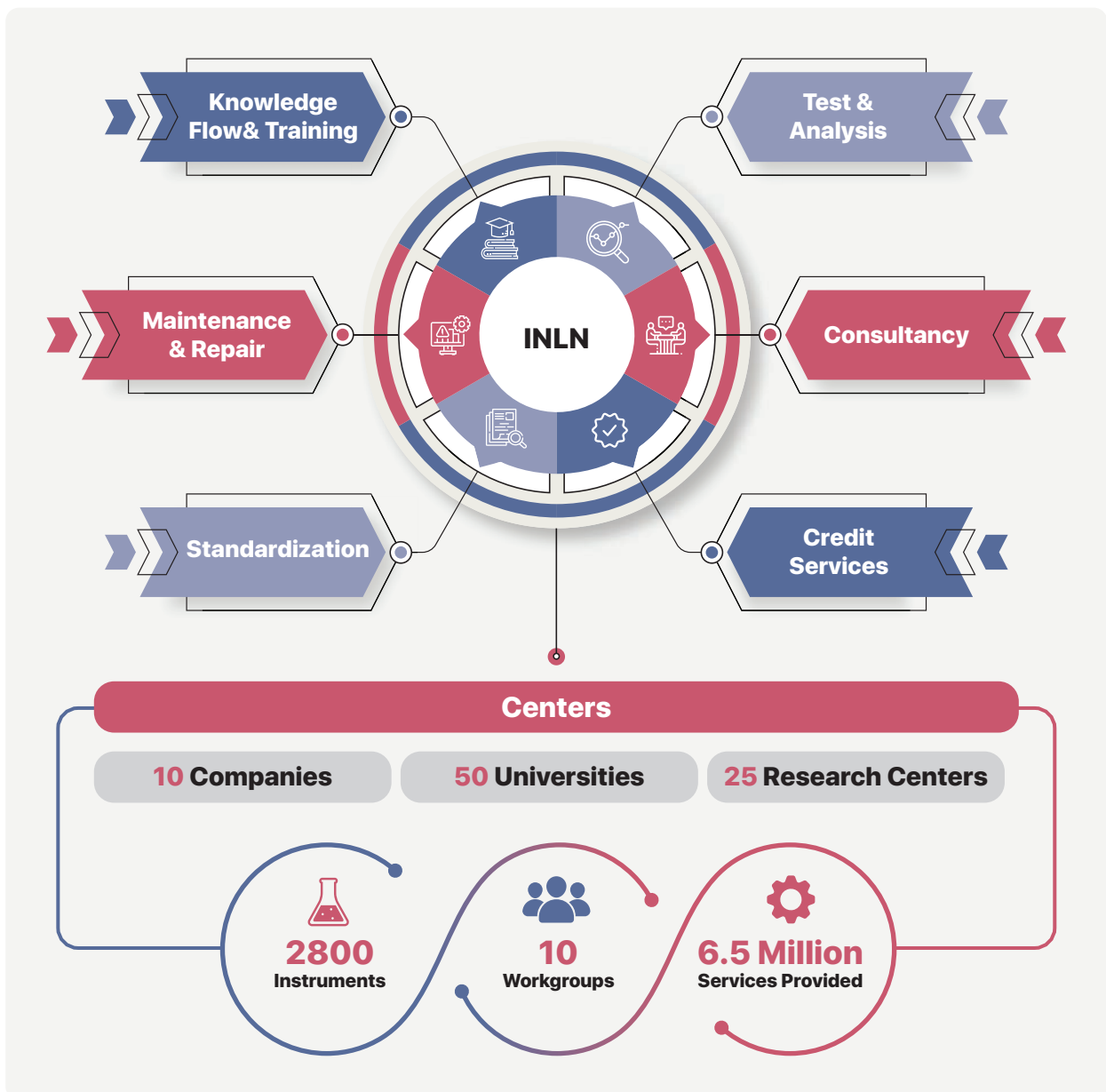


1. <https://statnano.com/report/s102> | <https://statnano.com/report/s103>



»» Nanotechnology Laboratory Network

Iran Nanotechnology Laboratory Network (INLN) was established in 2004 as a platform for providing nanotechnology laboratory services to researchers and better utilization of the existing labs. INLN provides its members with a unique opportunity to share their capabilities, experiences, and knowledge and provides funding opportunities for the renovation and standardization of facilities at member laboratories. Ten workgroups are currently active in TEM, SEM, X-ray, SPM, standard and calibration, chromatography, element analysis zones, particle size analysis, surface analysis, and thermal analysis. At present, 2800 nanotech-related instruments supplied through INLN are being utilized in 85 laboratories.



➤ Nanotechnology Standards

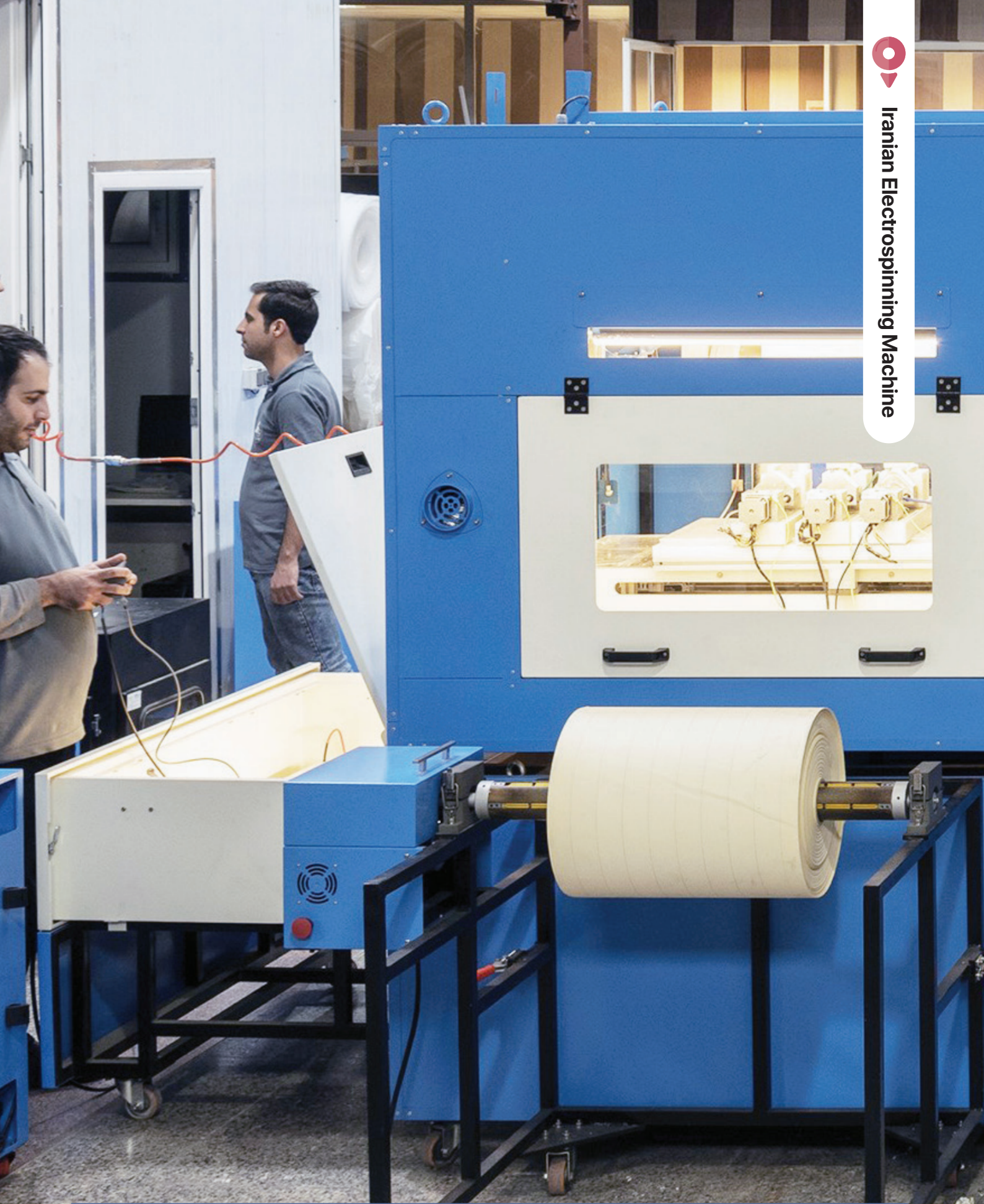
Iran Nanotechnology Standardization Committee was established in 2006, aiming to develop standards in the field of nanotechnology. The Committee is an active member of ISO's technical committee on nanotechnologies (ISO/TC229). Up to the end of 2021, this committee has developed 132 national nanotechnology standards. By the end of ,2021 9 international nanotechnology standards have been published in ISO/TC229 under the leadership of Iran.

Table 3. International nanotechnology standards under Iran's leadership

Number	Title	Year
ISO/TR 11360	Nanotechnologies — Methodology for the classification and categorization of nanomaterials	2010
ISO/TS 16550	Nanotechnologies — Determination of silver nanoparticles potency by release of muramic acid from <i>Staphylococcus aureus</i>	2014
ISO/TS 18110	Nanotechnologies — Vocabularies for science, technology and innovation indicators	2015
ISO/TS 20787	Nanotechnologies — Aquatic toxicity assessment of manufactured nanomaterials in saltwater lakes using <i>Artemia</i> sp. Nauplii	2017
ISO/TS 21236-1	Nanotechnologies — Clay nanomaterials — Part 1: Specification of characteristics and measurement methods for layered clay nanomaterials	2019
ISO/TS 21237	Nanotechnologies — Air filter media containing polymeric nanofibres — Specification of characteristics and measurement methods	2020
ISO/TS 21975	Nanotechnologies — Polymeric nanocomposite films for food packaging with barrier properties — Specification of characteristics and measurement methods	2020
ISO/TS 23459	Nanotechnologies — Assessment of protein secondary structure during an interaction with nanomaterials using ultraviolet circular dichroism	2021
ISO/TS 23650	Nanotechnologies — Evaluation of the antimicrobial performance of textiles containing manufactured nanomaterials	2021



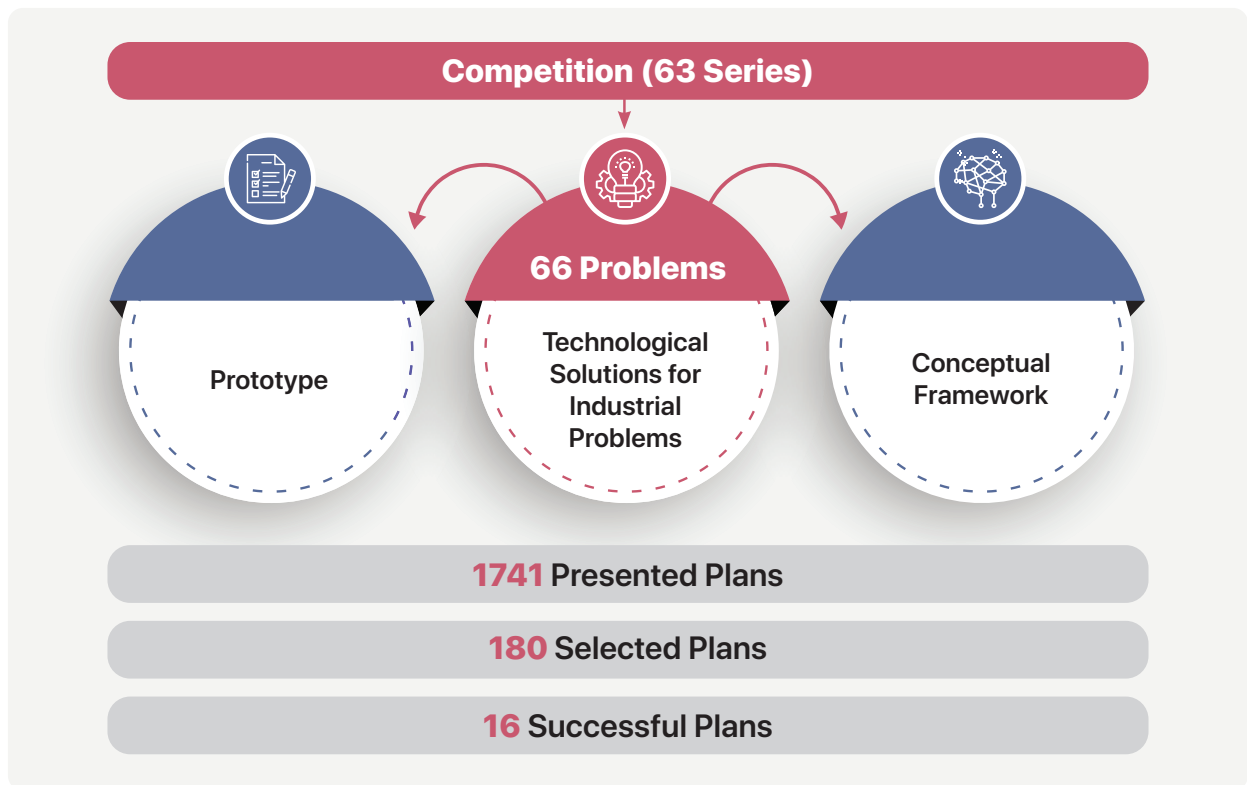
Iranian Electrospinning Machine



Nanotechnology Industrialization

» NanoChallenge

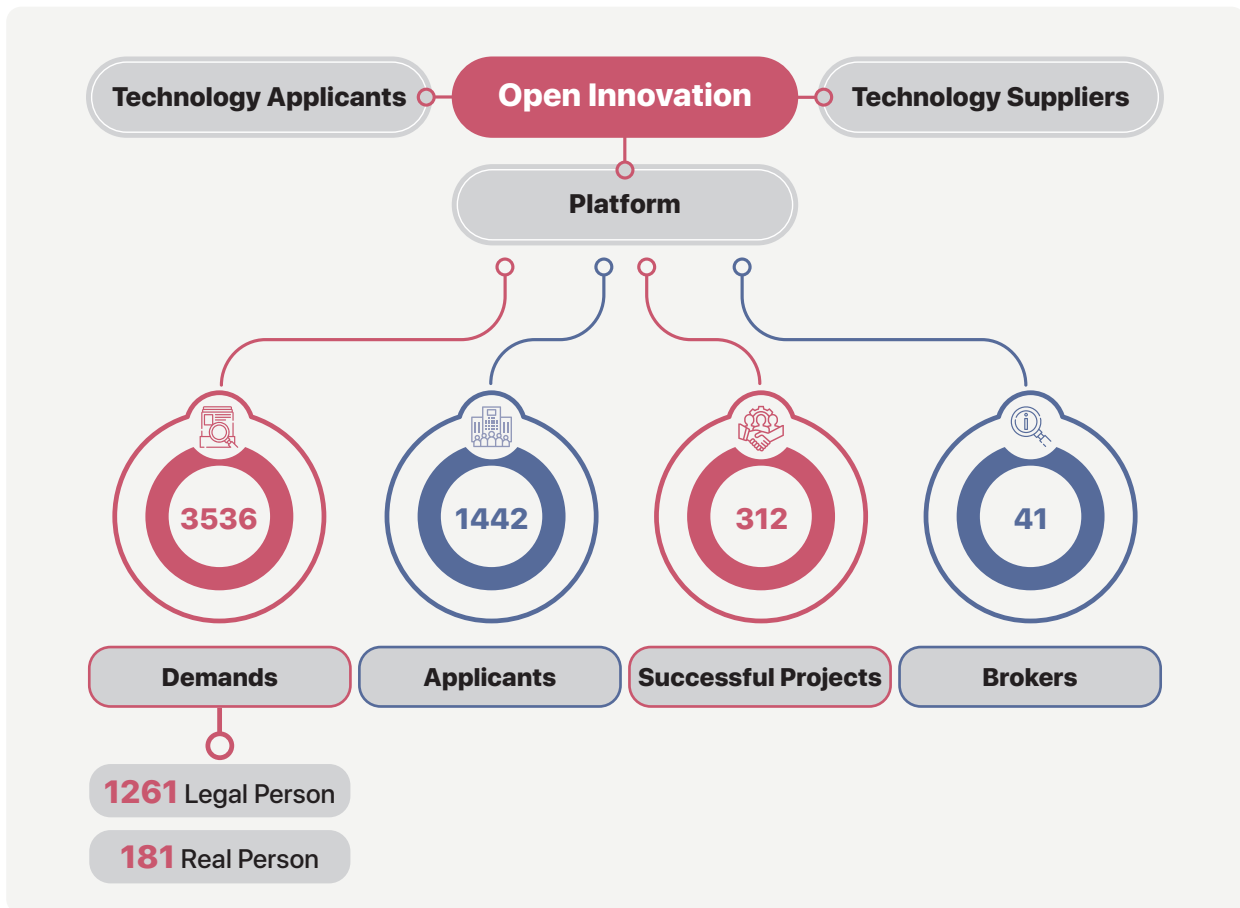
NanoChallenge is a program that started in 2016 as a competition to provide technological solutions to industry problems and expand the scope of nano-related products and services. The participants are primarily students, independent researchers, and small-to-medium innovative companies.





» Nanotechnology Exchange Network

The *Nanotechnology Exchange Network* was established in 2016 to fulfill the demands of industries through the application of nanotechnology solutions. Intermediate brokers have processed industrial needs in this network and facilitated technology cooperation contracts between technology suppliers and applicants. The network holds different training courses such as understanding the requirements of small businesses, monitoring the market, familiarizing with technology transfer contracts to improve brokers' abilities. The network has launched a system for registering and tracking industrial demands to facilitate the technology transfer processes. This network has also started to provide its services to other technology areas since 2020.



» Nanoproducts

Currently, there are 834 nanoproducts in different industrial sectors produced based on nanotechnologies developed in Iran. The rate of growth of nanoproducts is illustrated below.

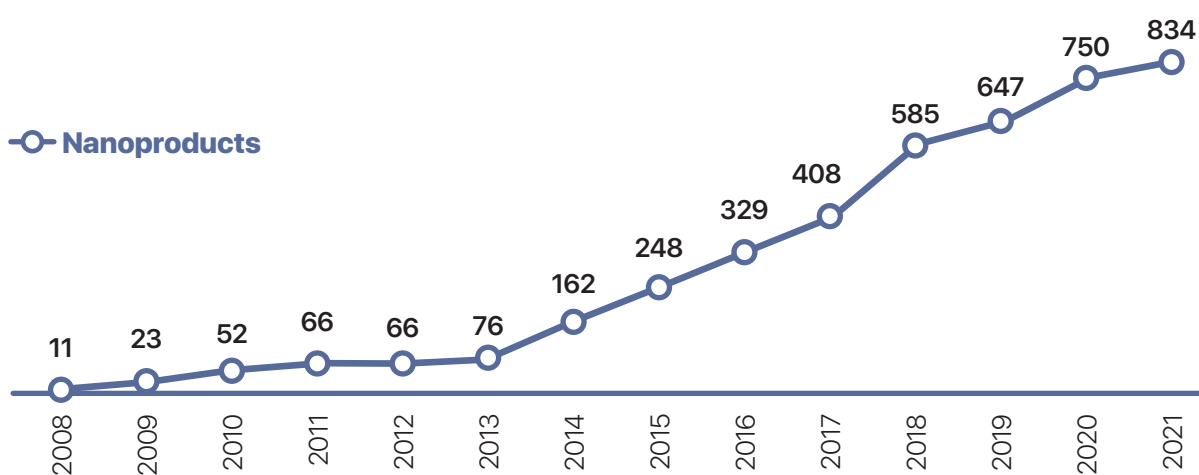


Figure 4. The number of Iran nanoproducts (2008-2021)

INIC has released a list of Iranian Nanotechnology products and equipment in a two-volume book.





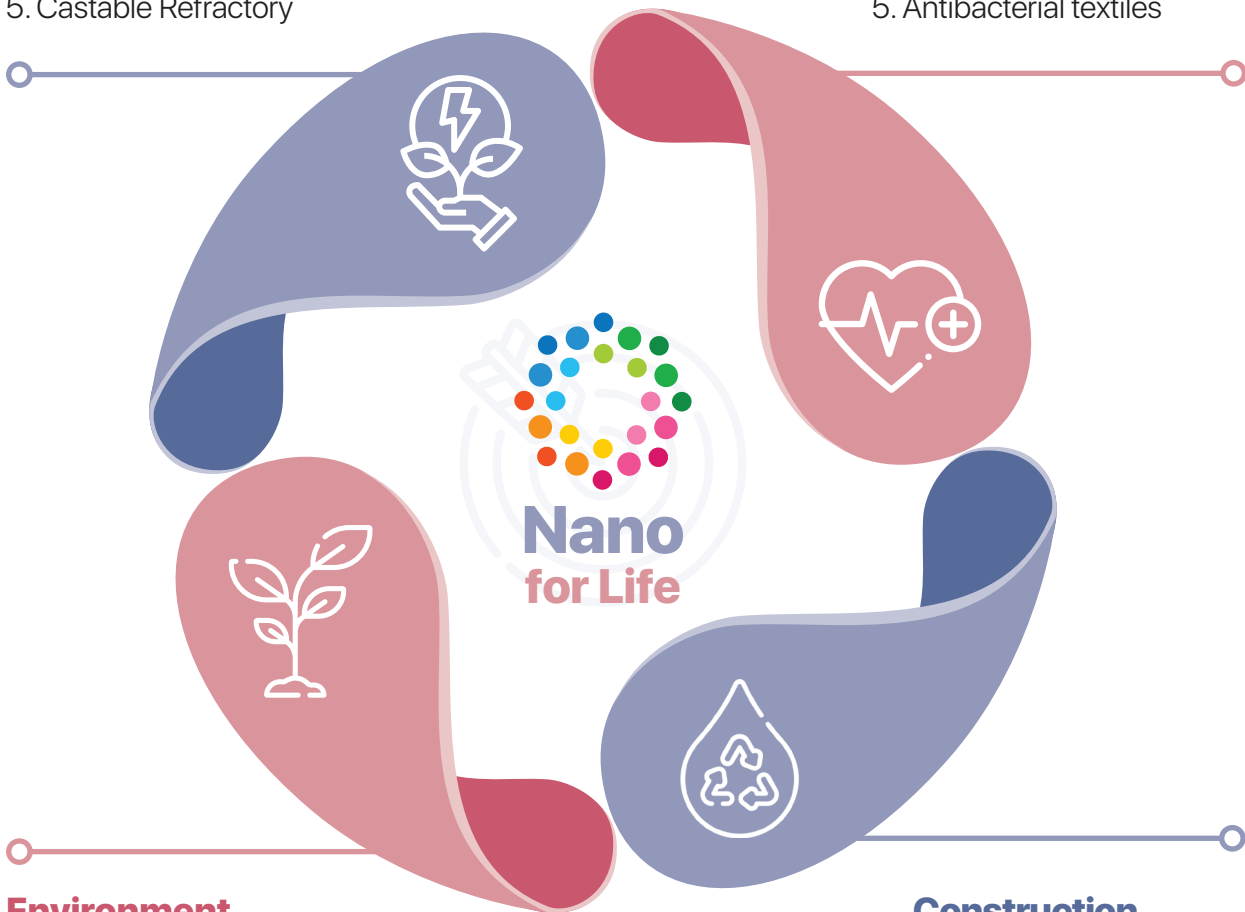
The following figure shows examples of such technologies already developed in Iran.

Energy

- 1. Temperature insulation paints
- 2. Nanofluid coolants
- 3. Power Plants filters
- 4. Oil and Gas Catalysts
- 5. Castable Refractory

Medicine and health

- 1. Anticancer drugs
- 2. Lishmonia treatment gel
- 3. Detection kits
- 4. Respiratory masks
- 5. Antibacterial textiles



Environment

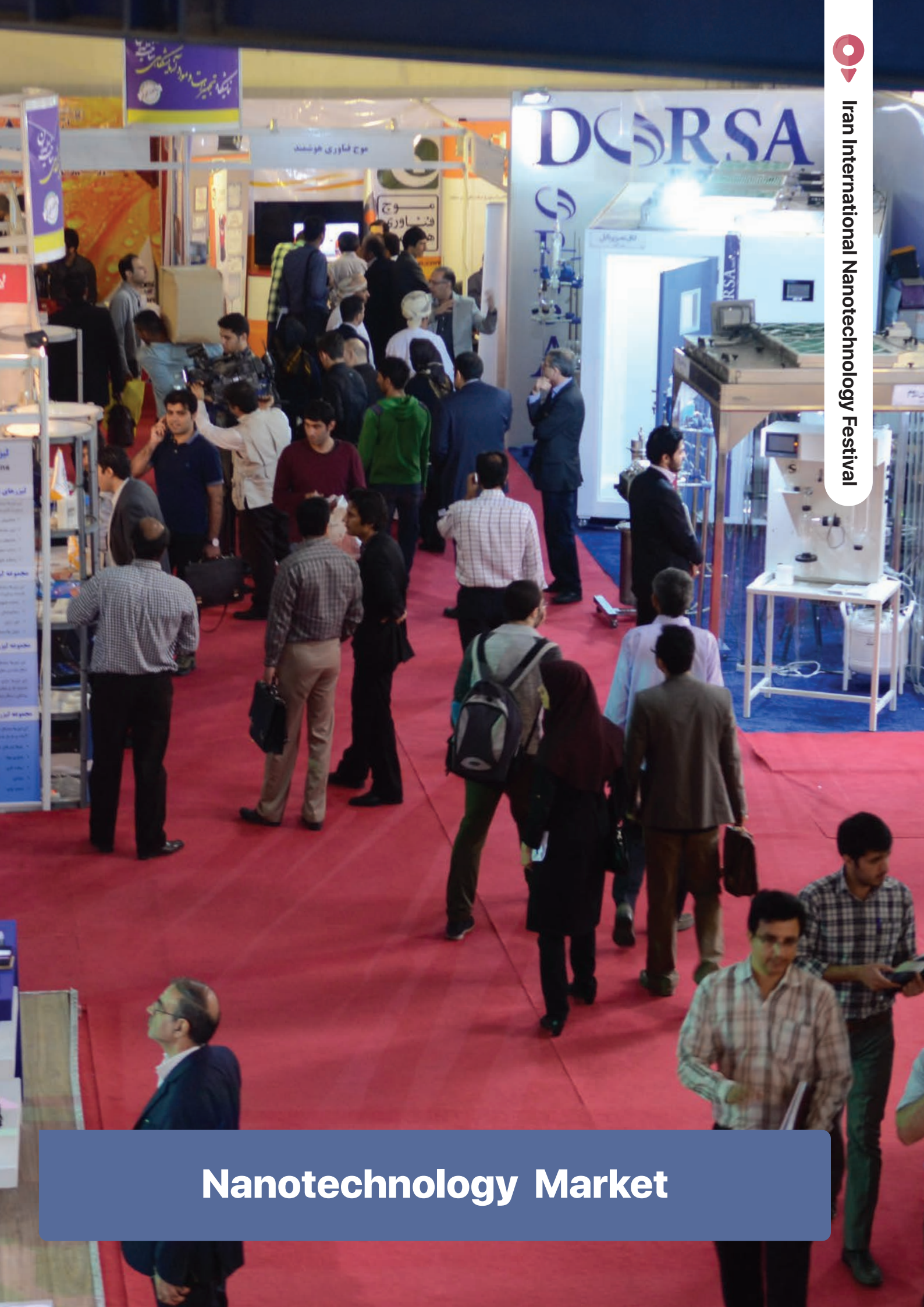
- 1. Biodegradable polymers
- 2. Organic detergents and cleaners
- 3. Arsenic and nitrate removal systems
- 4. Wastewater treatment systems
- 5. Desalination systems

Construction

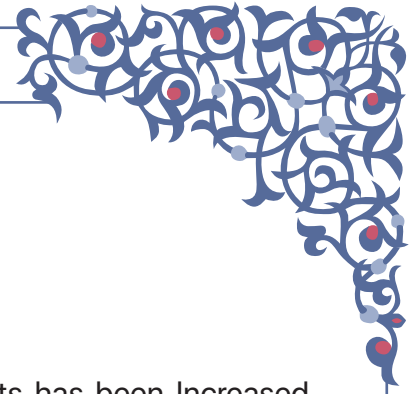
- 1. Low- emissivity glass
- 2. Silent sewage pipes
- 3. UPVC pipes and profiles
- 4. Lightweight concrete

Figure 5. The role of Iranian nanotechnology in improving people's quality of life





Nanotechnology Market



» Nano Market Size

As the following figure shows, the market size of Iran nanoproducts has been Increased annually in the past seven years.

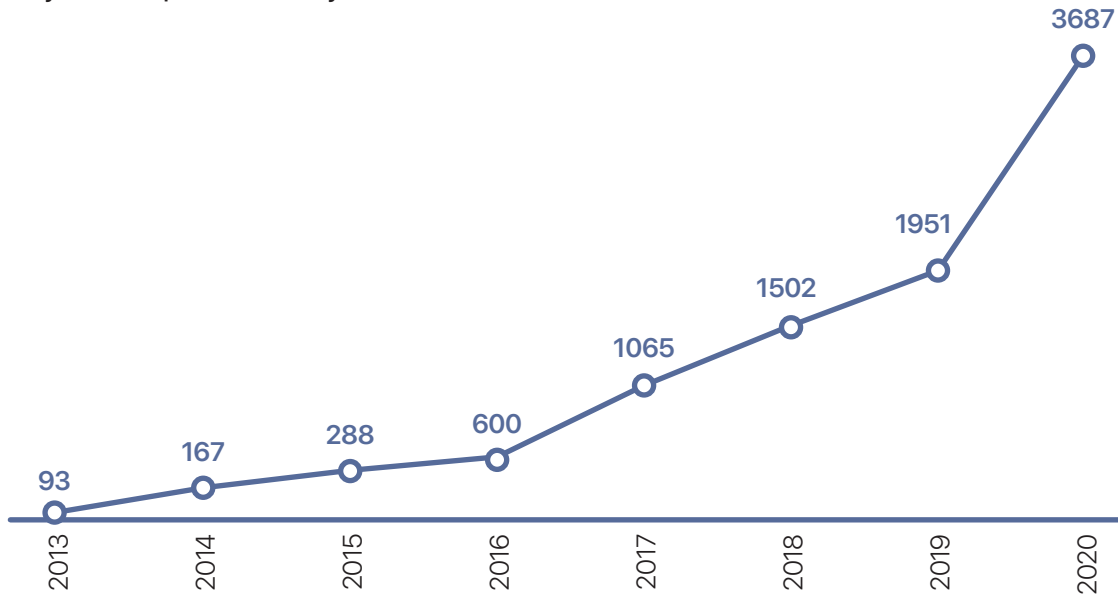


Figure 6. Iran nanoproducts market,PPP¹ (Million \$) (2013-2020)



1. ● Purchasing Power Parity: This metric compares different countries' currencies through a *basket of goods* approach.

● For PPP conversion factor, GDP (LCU per international \$) please visit:
https://data.worldbank.org/indicator/PA.NUS.PPP?most_recent_value_desc=true



Industrial Sectors of Nano Market

The share of each industry from the country's nanotechnology products' market can be seen in the following figure. The construction industry ranks first, and the Gas, oil, and Petrochemical industry occupies second place in market share.

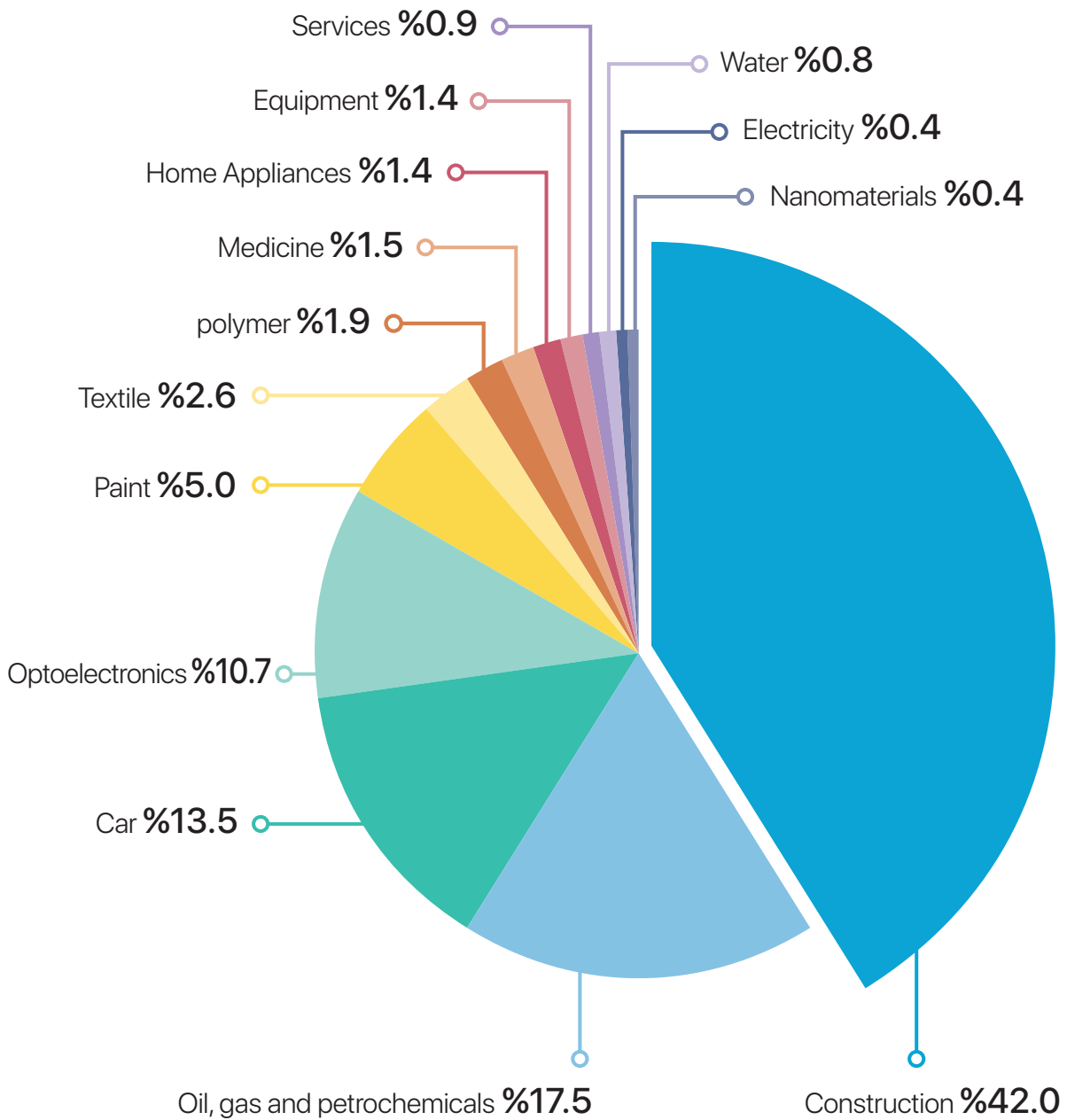
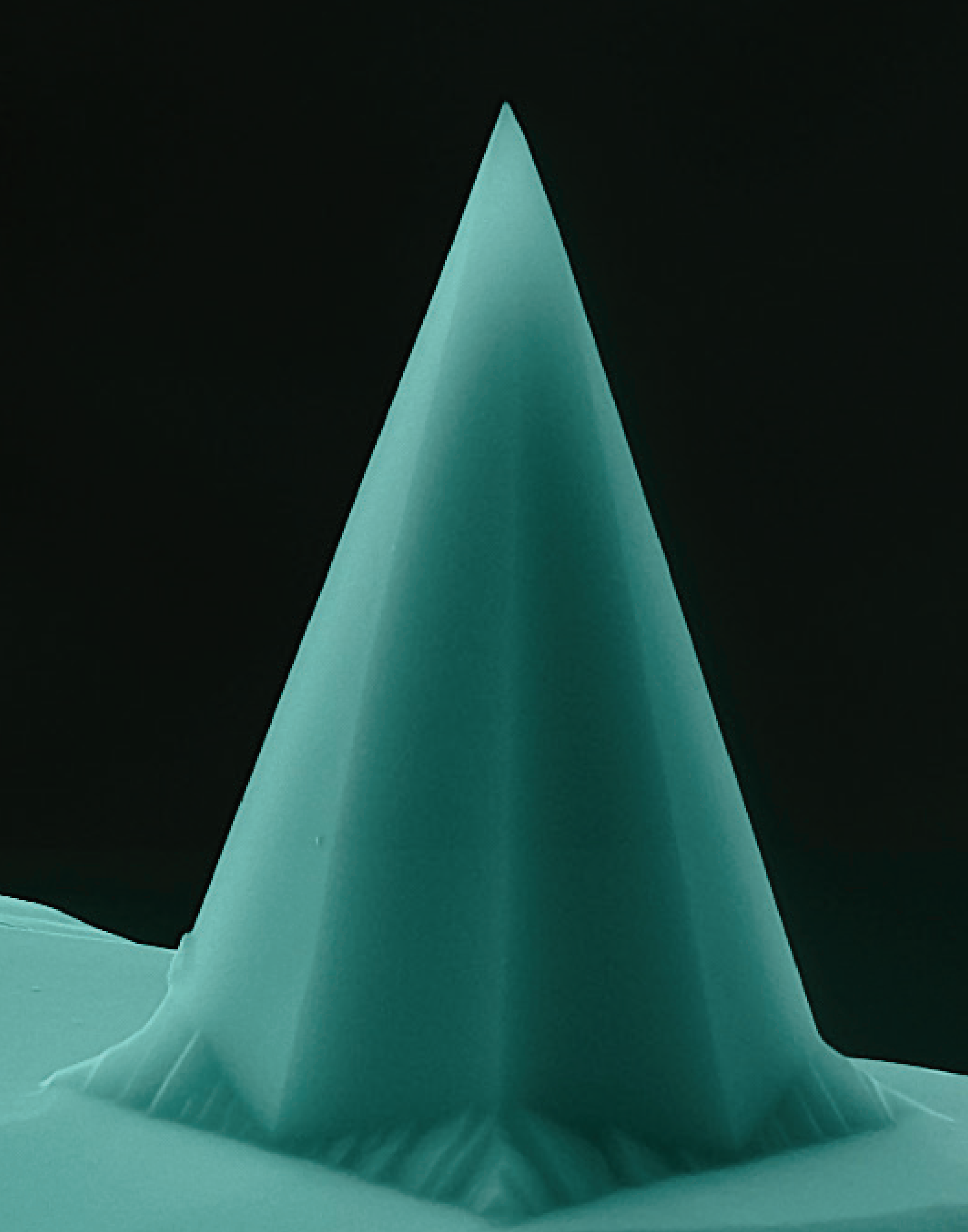
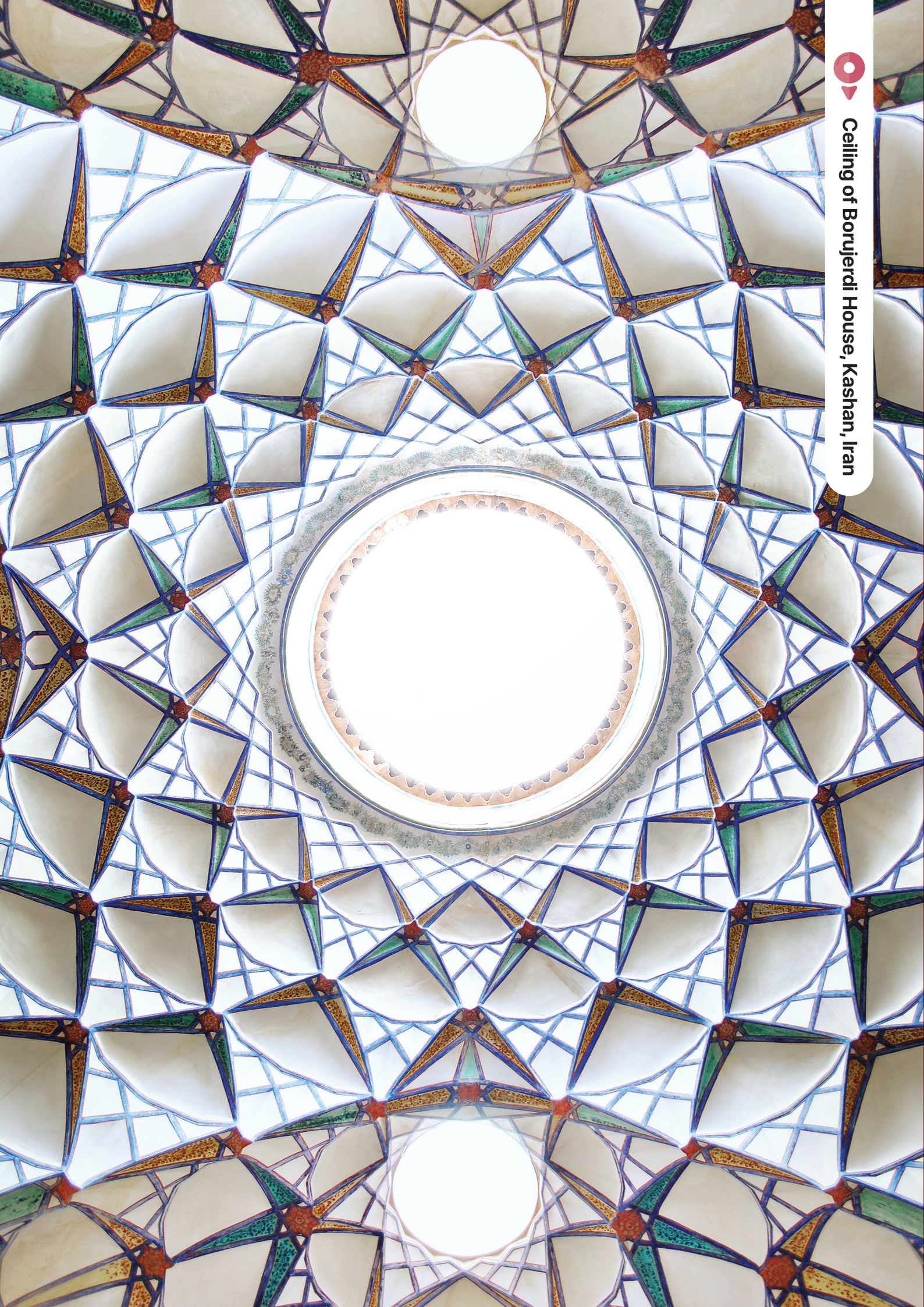


Figure 7. Share of industrial sectors in Iran nanoproducts market (2020)



Atomic Force Microscopy (AFM) Tip Manufactured by Iranian Nanotechnology Company with 9000x Magnification



Ceiling of Borujerdi House, Kashan, Iran



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