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## Assessment of Nanotechnology's Role in Textile Industry

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Nanotechnology is one of the leading technologies in the world and its applications cover a wide range of sciences and industries. The main objective of nanotechnology is to produce particles smaller than 100 nm. In fact, nanotechnology is the specific application of new properties of materials and systems at very small scale, which results in new physical characteristics. Nanotechnology has been used in many industrial applications in recent years, including textile industry. This technology has increased the efficiency, and consequently, the value added of products in textile industry. In addition to conservation of normal properties of the fabrics, nanotechnology creates specific properties to the textile products. Anti-static, x-ray resistant and gamma resistant clothes can be produced by using nanotechnology.

### 1. Introduction

Nanotechnology has applications in many industries and sciences as a new technology. Textile industry is one of the industries that has adopted nanotechnology and benefited from its advantages. The application of nanostructures results in increasing the efficiency of the product and it creates unique properties such as self-cleaning, anti-abrasion, antibacterial, fireproof, UV resistant, anti-stain and anti-shrinkage in the fabrics; therefore, sport and domestic clothes with anti-odor, antibacterial, waterproof, anti-stain, and fireproof properties can be produced by using nanotechnology.

Textile industry is very important due to its direct contact with people's lives, and numerous enterprises are active in this field. Textile products can be classified into the following categories:

- Clothes (including clothes with specific applications such as laboratory uniforms)
- Sport clothes (including shorts, diving suit, ...)
- Medical fabrics (including all types of bandages, uniforms, ...)
- Domestic and home fabrics
- Technical fabrics

- Leather and shoes
- Nanocoatings

Home fabrics include items such as carpets, bedroom products, curtain, furniture dressing and towels. Fibers, yarns and fabrics with specific applications are classified in technical fabrics group, among which mention can be made of conductive fabrics, non-woven fabrics, UV resistant thread, antibacterial thread and awnings.

Nanocoatings include solutions and nanoproducts that are used on the fabrics or clothes either as a final product or as an agent during the completion process.

Two strategies were used to search textile nanoproducts:

- Search by using nanotechnology in textile industry keywords
- Search by using data obtained from technologist enterprises and the related companies

## 2. Enterprises Active in the Application of Nanotechnology in Textile Industry

Search results show that 130 enterprises from 28 countries have produced 249 nanoproducts in industry textile. Table 1 lists the international enterprises that are active in the production of nanoproducts.

Rank	Enterprise	No. of Products	Rank	Enterprise	No. of Products
1	Cofra s.r.l.	13	13	Nanolia WorldwideTM	3
2	Greenyarn Ltd.	12	14	UVR Defense Tech, Ltd.	3
3	NanoTrade Ltd.	8	15	Tung Ho Textile Co., Ltd.	3
4	Schoeller Textil AG	4	16	Shaoxing Global Chemical Co., Ltd.	2
5	Sekisui nano coat technology co. Ltd.	4	17	S.E.TECH	2
6	Lealea enterprise co., Ltd. / Li peng enterprise co. Ltd.	4	18	<a href="#">Japan</a> Exlan Company Limited	2
7	Anson Nano-Biotechnology (ZhuHai) Co. Ltd.	4	19	Miyuki Keori Co.,Ltd.	2
8	Jinda nano tech.(xiamen) co., Ltd.	4	20	ICF Mercantile	2
9	Ag Active	3	21	Huvis	2

10	Zhejiang Donghua Fibre Manufacturing Co.,Ltd.	3	22	Everest Textile Co., Ltd.	2
11	Formosa taffetaco.,ltd	3	23	Hyosung	2
12	Zhejiang Donghua Fibre Manufacturing Co.,Ltd.	3	24	Klopman International	2

Table 1: International Enterprises Active in Production of Nanoproducts in Textile Industry

### 3. Products Classification

Figure 1 demonstrates the classification of nanoproducts in textile industry.



Figure 1: Nanotechnology Applications in Textile Nanoproducts

As is seen in Figure 1, nanocoatings have a share of 46% of nanoproducts in textile industry. The share of various enterprises in nanotechnology applications are 24% in technical fabrics, 17% in clothes, 6% in medical fabrics, 3% in sport and domestic fabrics, and 1% in leather and shoes.



Figure 2: Nanotechnology Applications in Clothing

As is seen in Figure 2, the major application of nanotechnology in clothes belongs to pants and socks. Pants and socks have a share of 33% and 29% of nanoproducts in clothes, respectively. Antibacterial, waterproof and anti-stain properties are the most common specifications used in clothes. COFRA S.r.l., Greenyarn LLC., and Nisshinbo Holdings Inc. are among the well-known enterprises active in this field.

Figure 3 demonstrates the share and number of products produced by different enterprises without counting the nanocoatings. Products of the enterprises are in the field of production of fibers, yarns, cloths, home fabrics and clothes. As is seen in Figure 3, COFRA and Greenyard enterprises rank first and second by producing 13 and 12 products, respectively.



Figure 3: Share of Enterprises that Produce Textile Industry Nanoproducts (Without Nanocoatings)

A sum total of 46% of products in the field of nanocoatings is produced by 80 enterprises. The majority of the nanocoatings have antibacterial, waterproof and anti-stain properties.

Table 2: Enterprises Active in the Production of Nanocoatings

Rank	Enterprise	No. of Products	Headquarters
1	Shanghai huzheng nanotechnology Co.,Ltd	12	<a href="#">China</a>
2	Nanoproofed® GmbH	5	<a href="#">Germany</a>
3	Nanolia Worldwide™	3	<a href="#">USA</a>
4	NANOBIZ.PL Ltd.	3	<a href="#">Poland</a>
5	UVR Defense Tech, Ltd.	3	<a href="#">USA</a>

#### 4. Nanostructures Used in Products

The manufacturing enterprises have claimed the nanostructures used in the production of 109 nanoproducts in textile industry. Silver, silicon dioxide, titanium dioxide and carbon (bamboo-charcoal) nanoparticles are among the mostly-used nanostructures in these products. Figure 4 shows nanostructures used in textile industry nanoproducts.



Figure 4: Share of Nanostructures Used in Textile Industry Nanoproducts

Silver nanoparticles possess a share of 45% in this industry. The reason is antibacterial and anti-odor properties of the particles, based on catalytic or ionic mechanisms.

Figure 5 demonstrates the share and number of products made by various countries. As is observed, the [United States](#) possesses the highest number of nanoproducts in textile industry by having 49 individual products.



Figure 5: Number and Share of Countries in Nanoproducts in Textile Industry