

## INNOVATION MATOLAR KELAJAKDAGI KIYIM-KECHAK SANOATINING ASOSIY YO'NALISHI

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### Аннотация

Ushbu maqolada innovatsion matolar tushunchasi, ularning turlari, fizik-kimyoviy xususiyatlari hamda zamonaviy ishlab chiqarish texnologiyalari haqida batafsil ma'lumot berilgan. Aqlli matolar, antibakterial, UV-himoyali, qayta ishlangan va nanotexnologik matolar kabi ilg'or mahsulotlar tahlil qilinib, ularning sport, tibbiyot, harbiy va aviatsiya sohalarida qo'llanilishi yoritilgan.

### Калит so'zlar

Innovatsion matolar, aqlli matolar, nanotexnologiya, antibakterial materiallar, qayta ishlangan tolalar, termoregulyatsiya, UV-himoya, to'qimachilik sanoati, kologik barqarorlik, smart textiles

## ИННОВАЦИОННЫЕ ТКАНИ ОСНОВНОЕ НАПРАВЛЕНИЕ БУДУЩЕЙ ШВЕЙНОЙ ПРОМЫШЛЕННОСТИ

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### Аннотация

В статье подробно рассматривается понятие инновационных тканей, их виды, физико-химические свойства и современные технологии производства. Анализируются такие перспективные продукты, как «умные» ткани, антибактериальные, УФ-защитные, рециклированные и нанотехнологичные ткани, освещается их применение в спорте, медицине, военной и авиационной отраслях.

### **Ключевые слова**

Инновационные ткани, умные ткани, нанотехнологии, антибактериальные материалы, регенерированные волокна, терморегуляция, защита от ультрафиолета, текстильная промышленность, экологическая устойчивость, умный текстиль.

## **INNOVATIVE FABRICS THE MAIN DIRECTION OF THE FUTURE CLOTHING INDUSTRY**

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### **Annatation**

This article provides detailed information on the concept of innovative fabrics, their types, physico-chemical properties, and modern production technologies. Advanced products such as smart fabrics, antibacterial, UV-protective, recycled, and nanotechnology-based fabrics are analyzed, with their applications in sports, medicine, military, and aviation sectors highlighted.

### **Keywords**

Innovative fabrics, smart fabrics, nanotechnology, antibacterial materials, recycled fibers, thermoregulation, UV protection, textile industry, environmental sustainability, smart textiles.

In the modern world, technological advancements are reflected not only in information technology and medicine but also in light industry, particularly in textiles. Innovative fabrics are materials created using advanced technologies, offering more functionality than traditional fabrics. They serve to enhance human comfort, protect health, and promote environmental sustainability. In the context of today's globalization and scientific-technical progress, the modern directions of the textile industry are constantly evolving. Traditional textile methods are giving way to high-tech innovative materials. Innovative fabrics create new opportunities in human health, ecology, energy efficiency, and design. The global demand for such fabrics in the textile industry is increasing year by year. This article provides a scientifically grounded analysis of the types, functional properties, and applications of innovative fabrics.

The following methods were used in the research:

**Analytical Method:** Existing scientific articles, technological analyses, and patent documents were studied.

**Comparative Method:** The functional capabilities of innovative and traditional fabrics were compared.

**Systematic Approach:** The physico-chemical properties, production technologies, and environmental impact of fabrics were systematically analyzed.

The data were primarily compiled from scientific sources published in the USA, the European Union, Japan, South Korea, and China, as well as materials from international exhibitions.

## **Research Results and Analysis.**

### **Types of Innovative Fabrics.**

**Smart Fabrics.** Smart fabrics are materials capable of responding to environmental signals (e.g., heat, light, moisture, pressure, or movement) or adapting their functions accordingly.

**Examples: Sensor-integrated fabrics:** Measure heart rate, breathing rate (for health monitoring).

**Temperature-adaptive fabrics:** Alter their structure based on body temperature (e.g., polymer-based “shape-memory” materials).

These fabrics can respond to external factors like temperature, moisture, or pressure. For instance, sportswear may change color when wet with sweat or regulate body temperature.

**Applications: Medicine:** Real-time monitoring of heart rate, blood pressure, and breathing. Monitoring for Alzheimer’s or Parkinson’s disease. Bandages that monitor wound conditions.

**Sports:** Fabrics that track muscle movement, heart rate, and calorie expenditure. Companies like Nike, Adidas, and Under Armour produce smart sportswear.

**Military:** Monitoring soldiers’ movements. Protection from heat or automatic camouflage adjustment.

**Fashion:** Color-changing, interactive, or LED-lit clothing (e.g., brands like Hussein Chalayan and CuteCircuit).

**Technologies for the Disabled:** Fabrics that transmit signals or aid communication for individuals with mobility impairments.

**Advantages:** Real-time monitoring; Preventive healthcare capabilities; Modern aesthetic appearance; Direct information exchange with the user.

**Disadvantages and Challenges:** High cost; Washing and maintenance issues  
Privacy and data security risks; Not all technologies are fully commercialized.

**Future Prospects:** The global smart textile market is expanding rapidly. According to Research & Markets, the global smart textile market is expected to reach \$15 billion by 2030. The USA, Japan, South Korea, Europe, and China are leading producers.

**Future developments include:** Medical diagnostic clothing; AI-integrated fabrics; Autonomous energy-generating (solar) fabrics; Materials that change shape based on transmitted data.

**Antibacterial Fabrics.** These fabrics contain silver ions, copper, or other antimicrobial substances to prevent bacterial growth. This feature is particularly valuable for healthcare and children's clothing.

**Recycled Fabrics.** Fabrics made from recycled plastic waste or old clothing contribute to environmental sustainability. They require less energy to produce and reduce waste.

**UV-Protective Fabrics.** These fabrics protect against harmful ultraviolet (UV) rays from the sun, making them ideal for outdoor workers or beachwear.

**Nanotechnology-Based Fabrics.** Nanoparticles are embedded in these fabrics, providing water resistance, stain resistance, and self-cleaning capabilities. Such fabrics offer significant advantages in daily life.

#### **Advantages of Innovative Fabrics.**

**Comfort and Functionality:** Fabrics interact with the human body, offering protection and additional features.

**Environmental Benefits:** Using recycled materials helps maintain ecological balance.

**Durability:** Fabrics created with innovative technologies are more durable and have a longer lifespan.

**Modern Designs:** Technological advancements have introduced innovative appearances to the fashion world.

**Antibacterial and Antiviral Fabrics.** These fabrics incorporate antimicrobial ions like silver, copper, or zinc. Demand for such fabrics surged during the pandemic, and they are used in medical gowns, masks, and sportswear.

**Antibacterial Fabrics:** Eliminate bacteria or prevent their proliferation.

**Antiviral Fabrics:** Deactivate virus particles or render them inactive on the fabric surface. These fabrics are crucial for protecting human health, especially in enclosed environments like hospitals, gyms, or public transport.

#### **Mechanism of Action:**

**Surface Contact:** Viruses/bacteria come into contact with the fabric.

**Ion Diffusion:** Silver or copper ions penetrate the microorganism's cell membrane.

**Cell Disruption:** DNA/RNA activity is disrupted, and proteins are denatured.

**Microorganism Elimination:** Bacteria/viruses cannot survive or reproduce on the fabric.

Sector	Applications
<b>Medicine</b>	Hospital gowns, curtains, bedsheets, surgical masks.
<b>Sports</b>	Sweat-resistant, odor-reducing sportswear.
<b>Household</b>	Pillowcases, curtains, bathroom towels.
<b>Transport</b>	Antibacterial bus seats, airplane pillows.
<b>Fashion</b>	Hygienic underwear, face masks.

**Advantages:** Limits the spread of bacteria and viruses; Prevents odor formation Safe for skin contact; Provides long-term protection (up to 10–50 washes); Offers protection against diseases like COVID-19 and influenza.

**Disadvantages:** High cost (especially for silver-based fabrics); Effectiveness may decrease with frequent washing; Antibacterial coatings require maintenance; 100% protection is not guaranteed; used as a precaution.

**Future Prospects:** AI-integrated fabrics that signal bacterial presence; Self-disinfecting fabrics; Biodegradable antibacterial clothing; Use of solid structures (e.g., graphene-based) instead of liquid coatings.

**Nanotechnology-Based Fabrics.** Nanofiber-based fabrics stand out for their ultra-thin yet durable structure. They offer properties like water and stain resistance, high breathability, and oil repellency.

#### **What Are Nanotechnology-Based Fabrics?**

Nanotechnology-based fabrics incorporate nanoparticles (1–100 nanometers) or nanostructures, making them: Hygienic, durable, water-, dust-, bacteria-, and UV-resistant, lightweight, and functional. Nanotechnology involves manipulating the fabric's structure at the atomic or molecular level to achieve advanced properties.

#### **Applications of Nanotechnology in Fabrics:**

**Types of Nanostructures:** Nanoparticles (Ag, ZnO, TiO<sub>2</sub>, SiO<sub>2</sub>); Nanofibers; Nanocapsules (containing odor-releasing or antibacterial substances); Nano-coatings (hydrophobic, UV-filtering layers).

Property	Description
<b>Water and</b>	Nano-coatings cause liquids to “slide off” the fabric



Property	Description
<b>Oil Repellency</b>	surface (lotus effect)
<b>Antibacterial</b>	Silver, copper, or zinc nanoparticles kill bacteria
<b>UV Protection</b>	TiO <sub>2</sub> or ZnO nanoparticles protect against UV rays
<b>Odor Reduction</b>	Limits bacterial growth to prevent bad odors
<b>Lightness and Softness</b>	Nanofibers make fabrics lightweight and comfortable
<b>Self-Cleaning</b>	Nanostructures reduce the adhesion of dust, dirt, or stains

#### Production Technologies:

##### Main Methods:

Method	Description
<b>Sol-gel</b>	Embedding nanoparticles into the fabric via a solution
<b>Electrospinning</b>	Creating microstructures by forming nanofibers
<b>Dip-coating</b>	Coating the fabric surface with nano-solutions
<b>Sputtering</b>	Depositing solid nano-layers in a vacuum environment

##### Applications:

**Medicine:** Antibacterial clothing, masks, bandages, rapid-healing tissues.

**Sports:** Sweat-resistant, lightweight, UV-protective sportswear.

**Fashion:** Self-cleaning or odor-free clothing.

**Military:** Lightweight, bulletproof, or biochemical-protective clothing.

**Household:** Dust- and stain-resistant curtains, upholstery.

**Outdoor:** Weather-adaptive jackets for rain or changing conditions.

**Advantages:** Lightweight and durable. Hygienic, non-allergenic. Requires less washing, saving water. Long lifespan. Modern and aesthetic appearance.

**Disadvantages:** High cost. Complex production technology. Environmental safety of some nanoparticles not fully studied. Recycling processes are complex.

**Eco-nano fabrics:** Biodegradable, eco-friendly nano-elements. **Smart-nano fabrics:** AI and sensor-integrated nanotechnology fabrics. **Energy generation:** Nanofibers generating energy from sunlight or movement. **Medical nano-diagnostics:** Fabrics measuring heart rate or blood sugar via skin contact.

**Thermoregulatory Fabrics.** These fabrics use. Phase Change Materials (PCM) technology, absorbing or releasing energy as temperatures change. Originally developed for space applications, this technology is now widely used in everyday clothing.

**What Are Thermoregulatory Fabrics?** Thermoregulatory fabrics automatically manage heat exchange between the human body and the environment. They retain warmth in cold conditions and provide cooling in hot conditions, ensuring optimal body temperature.

**Working Principle:** These fabrics typically use Phase Change Materials (PCM) that: Absorb heat (when the body is warm). Release heat (when the body cools).

**Examples of PCM:** Paraffin (organic); Gel-based materials; Microencapsulated agents integrated into fabric fibers.

Fabric Type	Description
PCM-filled	Phase-changing materials in microcapsules
Infrared Reflective	Reflects body radiation to reduce heat loss
Hygroscopic Fibers	Regulates temperature via moisture absorption (e.g., bamboo fiber)
Aerogel-based	Used in space technology for excellent thermal insulation

**Key Features:** Retains warmth in cold conditions. Reduces sweating and keeps the body cool in hot conditions. Maintains optimal body temperature during physical activity. Ideal for athletes and military personnel. Durable for multiple washes (in PCM models).

**Advantages:** Maintains body comfort during active movement. Reduces hypothermia risk in cold environments. Safe for direct skin contact. Provides insulation without adding bulk. Eco-friendly (biodegradable PCMs available).

**Disadvantages:** PCM capsules may lose effectiveness after repeated washing. Higher cost compared to regular fabrics. Limited temperature control in extreme conditions. May require special care depending on the product.

**Future Directions:** AI-integrated fabrics adapting to temperature, heart rate, or humidity. Energy-generating fabrics producing power from heat. Eco-friendly PCMs derived from plant-based materials. Clothing + app synchronization for real-time body temperature monitoring.

**UV-Protective Fabrics. What Are UV-Protective Fabrics?** UV-protective fabrics absorb or reflect ultraviolet (UV) rays through special structures or chemical

treatments, protecting the skin from the sun's harmful effects and reducing the risk of skin cancer.

Sector	Examples
Sports	Water sports, mountaineering, running clothing
Children's Clothing	Lightweight, cool, high-UV-barrier clothing
Medicine	Specialized clothing for patients with sensitive skin
Fashion	UV-protective shirts, hats, scarves
Household	UV-filtering curtains, umbrellas, tents, car seat covers

**Advantages:** Reduces sunburn and skin cancer risk Slows skin aging Enhances safety during outdoor activities Often breathable and lightweight Eco-friendly treatment options available.

**Disadvantages:** Many UV coatings lose effectiveness after washing. UV-protective fabrics are slightly more expensive. Some chemical coatings may cause allergic reactions. UV protection depends on weaving method and fabric density; poor design reduces effectiveness.

**Recycled Fabrics.** Recycled fabrics are made from waste materials like plastic bottles, fishing nets, or old clothing, promoting environmental sustainability. For example, PET (polyethylene terephthalate) bottles are processed into fibers for new fabrics.

**What Are Recycled Fabrics?** Recycled fabrics are new textile products made from previously used clothing, industrial waste, or plastic materials (e.g., PET bottles). They conserve natural resources, reduce waste, and support sustainable fashion.

**Sources: Industrial Waste:** Fabric scraps from clothing production; Textile factory waste.

**Recycling Methods: Mechanical Recycling:** Fabrics or fibers are washed, sorted (by color and type), shredded, and spun into new yarn. Used for polyester, cotton, and denim.

**Chemical Recycling:** Materials are broken down into basic molecules through chemical processes and spun into new yarn.

**Advantages:** Reduced environmental impact. Lower raw material consumption. Reduced water use and carbon footprint. Minimizes waste. Promotes sustainable fashion.



**Disadvantages:** Reduced yarn quality in mechanical recycling; Challenges in color separation (difficult to obtain colorless yarn); Chemical recycling requires significant energy; Many recycled fabrics are not 100% natural (contain blends).

**Scientific and Environmental Aspects:** Producing 1 kg of recycled polyester reduces carbon emissions by up to 60%; One T-shirt can recycle five 500 ml plastic bottles; 1 kg of recycled cotton saves 20,000 liters of water.

**Conclusion.** Recycled fabrics are not just a fashion trend but a step toward an environmentally sustainable future. These fabrics play a crucial role in environmental protection, waste reduction, and the development of a green economy. As technology advances, the quality of recycled fabrics continues to improve, making them a viable alternative in various sectors, from everyday clothing to sports.

#### **Scientific and Technological Approaches:**

The production of innovative fabrics relies on the following scientific fields:

**Materials Science:** Development of new fibers, nanocomposites, and superconductors.

**Biotechnology:** Creation of fabrics compatible with living organisms.

**Chemistry:** Chemical modifications for antibacterial or UV-protective fabrics.

**Information Technology:** Sensor systems and programmable fabrics.

**Global Trends in Innovative Fabric Production:** The European Union emphasizes recycled fabrics under its “Circular Economy” program; The USA and Japan widely apply smart fabrics in healthcare; China is developing innovative textiles as a strategic industrial sector.

Innovative fabrics represent not only aesthetic beauty but also functional comfort, environmental sustainability, and health protection. In the future, these fabrics will dominate every aspect of human life—from clothing to medicine, technology, and household goods. Thus, this sector holds significant technological, economic, and social importance.

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