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Article:

Functional Materials as an Innovative Approach to Sportswear Design

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Abstract:

The textile industry has become more interested in the sports sector, as well as many other industrial sectors, as a result of the growing popularity of sport around the world and the rise in the number of participants. The apparel and materials created for this market are intended to satisfy the needs and preferences of the consumer when they are participating in a sporting activity. Consumers benefit from a variety of conveniences in their daily lives, including higher safety, a decreased chance of accidents, and improved athletic performance, thanks to the usage of technical and practical items in sportswear. Modern textile and apparel design and manufacture are centred on functionalization, the creation of cutting-edge features, and the application of cutting-edge technology to improve human performance. Therefore, it is a significant field for innovation. The goal of this paper is to examine specially developed materials and assemblies that go beyond their conventional uses and are intended to give the user a specific performance or capability. A number of research has been done in this area, and production of technological, intelligent, and functional textiles that offer consumers a more pleasant wearing experience and comfort in everyday life, as well as that support better performance for those interested in sport, has started to increase. The research is limited to men's and women's everyday sportswear products created in the last 10 years that are technologically advanced, inventive, and functional. A literature review based on several articles, books, magazines, newspapers, and theses, as well as digital interviews with designers and staff members of the brands that may be reached, make up the research methodology.

Key words: Sportwear, functional materials, innovations on textile, innovation on sportwear, smart textiles, technologic design.

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Introduction

In the Turkish dictionary, sport is defined as "all types of physical activity that people do to keep healthy or for enjoyment" [1]. In the English dictionary, it means "all types of physical activity that people do to keep healthy or for enjoyment" [2].

Sportswear is an integral part of technical textiles and has great potential in terms of technological and design innovations. Sports textiles travel much faster than the ready-to-wear segment. Sportswear is no longer limited to athletes engaged in performance sports or strenuous physical activities, and it is obvious that there is an increase in sportswear and accessories among health-conscious users. Accordingly, the sportswear industry has pioneered the development of different categories of sportswear, such as active clothing, daily clothing, and athletic clothing, to meet the needs of athletes and health-conscious customers. The choice of the right fiber, thread and fabric variables for sportswear is of great importance for designing the desired features in sportswear [3, p.1].

Nowadays, we see that fashion designers are interested in smart clothing. In this context, the triad of function, technology, and design can be said to govern the clothing made with specially created technical and smart textiles. For instance, it is well known that the Samsung brand has a patent for smart

clothing with a light-powered energy collector. Its smart clothing products come with medical applications like heart rate monitors, body temperature monitors, blood pressure monitors, and more [4, pp. 633–652].

Purpose of the Study

This article's objective is to study specially designed components and materials that go above and beyond standard functionality in order to give the user a specific performance or functionality. The goal is to find and showcase cutting-edge products made in the last ten years that can improve sportswear while also explaining to the public the advantages of these products, such as safety provided by GPS systems, self-efficient sports, resistance to impact in the event of an accident, improved performance, and lower risk of injury.

Functional Materials and Clothes

There is a lot of use of functional fabric, particularly in the sports and outdoor clothing sectors. These materials feature qualities including sweat absorption, moisture management, waterproofing, breathability, and even UV protection [5].

All clothing serves a variety of purposes, from fundamental protection to aesthetic purposes. Therefore, the phrase "functional fabric" can be used to refer to a broad category of specially designed clothing or clothing assemblies that serve purposes other than those that are directly related to the consumer [6, pp. 321–326].

Functional clothing can be defined as clothing that safeguards those exposed to life-threatening or harmful circumstances while they are at work or participating in sports. It can also be described as clothing that aids in movement and body balance for those with physical disabilities, boosts endurance in athletes, lessens weariness, or for solely aesthetic purposes like enhancing body contours. To satisfy the needs of the consumer, they are products that combine the domains of medicine, nanotechnology, computer, physics, and biotechnology. They offer benefits in terms of protection or comfort, cater to a variety of customer needs, and meet particular sport requirements. Sportswear, protection gear, and medical gear are some of the most well-known examples of functional apparel.

The global functional apparel market is anticipated to reach USD 372.5 billion by 2026, according to the global functional apparel market report (2022). One of the report's segments, sportswear, is anticipated to develop at a CAGR of 5.6% and reach USD 128.4 billion by the conclusion of the analysis period [7].

The recent major development in information technologies (ICT), wearable technologies, and smart textiles has changed the way we conceive of sport and well-being. New types of performing textiles, especially electronic ones, are now being used in a variety of applications and enhancing functionality with all daily activities in mind. Today, textiles have become a supporting platform for integrating technologies, adding more functions to what we wear, and taking advantage of high-tech innovations. In this way, textiles, including computational technologies, enable textiles to be "smart" and people to be interactive. In this process, which helps to move from a static to a dynamic dimension in textiles and consequently to create new dynamic products, the functionality added to the textile structure also creates new behaviors [8].

Sportswear Products

When it comes to sportswear products; It constitutes products that people prefer to wear in their daily lives at home, outside, even if they do not need to do sports, in any condition, providing comfort, comfort and practicality. Sportswear products include; sweatshirts, tracksuits, t-shirts, leggings, tights, bra, overalls, shorts, capri, body, singlets, inflatable vests, inflatable coats, two-piece suits, short skirts, etc. products.

Ekmekçi; ‘Although the phrase "sportswear" typically conjures up images of clothing worn for athletic endeavours, it actually refers to a broader idea because sport encompasses more than simply physical mobility; it also has societal, economic, and ideological components [9, pp. 23–29]. Sports attire frequently transforms into a tool that depicts the culture, technology, and ideology of the time. There are many different sports textile goods available today. Several examples include athletic clothing, artificial grass, climbing ropes, parachute and sailing textiles, balloon fabrics, athletic shoes and bags, sleeping bags, tent fabrics, swimming fabrics, and fishing nets [10, pp. 533–546].

Sportswear, leisure wear, sporting goods, and tools all fall under the category of sports textiles [6, pp. 321–326]. Uttam; ‘Adaptability to various weather conditions, thermal insulation, waterproofing, comfort, UV protection, flexibility, high strength, air permeability, self-cleaning, antistatic properties, hygiene and antibacterial, dirt repellency, flame retardancy, opacity, and ease of drying are just a few examples of the general qualities expected from sports textiles [11, pp. 34–40].

High performance fibres and fabrics are the main components of sportswear textiles. For instance, polyurethane foam (PUR) fibres known as spandex, lycra, and elastane, which have the capacity to stretch 5 times more than their original length, are used to make swimming trunks, gymnastics, and ski suits. These fibres can be combined with other natural fibres to create blends. Although we typically favour cotton clothing in our daily lives, sweating's effect on the fabric makes cotton clothing heavier. Because they do not retain moisture, synthetic fibres are preferred in sportswear. Today, sportswear must have a certain set of characteristics. These include features that give wind, water, and weather protection, heat insulation, vapour permeability (body sweat should be able to pass through all layers of the garment, and the garment should be flexible to allow for freedom of movement during sports), and heat insulation [12].

Among the well-known brands selling sporting goods are Nike, Puma, Adidas, Under Armour, Reebok, Skechers, New Balance, For Fun, Les Benjamins, Hummel, Asics, Converse, Vans, Gap, Marksandspencer, Kappa, The North Face, Slazanger, Salomon, Lacoste etc.

Functional Materials and Properties in Sportswear

Natural fibres like cotton, wool, and linen are used to make sports apparel, as well as synthetic fibres like polyester, polyamide, polypropylene, acrylic, and elastane. Recent innovations and advancements in technical fibres, textiles, and garment production processes have fueled the growth of performance wear. One of the many and quickly expanding categories of performance apparel is sportswear. The market for functional sportswear items is rising as a result of changing lifestyles, a rapidly ageing population, rising sports participation, and a focus on healthy living. As a result, the market for casual sportswear has a variety of value-added clothing items with attributes including temperature control, moisture management, stretch, odour reduction, and lightweight [6, pp. 321–326]. As science and technology have advanced, functional textiles have also begun to evolve into textile goods with unique qualities like luminescence, colour change, temperature regulation, self-cleaning, self-repair, intelligent sensing, etc [13]. This transition has led to the adoption of functional items and smart, technical textiles coupled with the emergence of increasingly technologically advanced products. Functionally, a product that offers an advantage in terms of perspiration is also supplied to advance technically and technologically. While the product offers comfort, it is intended to increase the effectiveness of sports through heartbeat, pulse measurement, or another clever technique.

However, technical and smart fabrics, as well as smart textiles, are very popular in sportswear. These goods, which are made by sewing various electronic devices to textiles or clothing to enhance athletic performance, have already begun to shape the direction of future innovative sportswear designs.

Smart textiles are goods that can live up to consumer expectations by delivering functionality as a result of user/environment interaction with various parameters (such as temperature, humidity, light, electricity, radiation, pH, chemicals, heat, sound, magnetic field), which trigger transformation into smart textiles by using various techniques in conjunction with woven, knitted, or nonwoven surfaces. If the created item is a truly intelligent textile, it responds to outside stimuli and modifies its behaviour as necessary [14, pp. 1–20].

By sensing signals, processing data, and organising reactions, new clothing features known as "smart clothing" can offer interactive responses [15, pp. 1–18].

Innovative Functional Materials Produced for Sportswear in the Last 10 Years

Nadi X Yoga

Design and technology are combined by the fashion technology company Wearable X to improve quality of life. The Wearable X company's Nadi X smart yoga pants give consumers the option to exercise at home, outside or anywhere else without a teacher while offering the ability to improve posture by vibrating while in yoga positions. Additionally, the fabric used to create these yoga pants has a flat seam and four directions of flexibility.

Nadi X has haptic sensors [1] sewn into nylon layers on the hip, knee and ankle (Fig. 1). The gadget provides both visual and auditory directions and connects through Bluetooth to the current Nadi X application on the phone. For instance, an athlete who neglects to stretch his back or straighten his leg while practising yoga receives a warning from light vibrations at the level of intensity he selects in the programme. People experience yoga in a good and efficient way this way, making fewer errors. The sensors and vibrations in the trousers are picked up by the Pulse power pack, which is attached to the opening behind the left knee (Fig. 2). Bluetooth can be readily connected to the phone and Pulse is simple to charge. These yoga pants also include washable technology and are simple to clean in washing machines. The important thing to keep in mind is that only during this cleaning is it required to remove and clean the Pulse device from the product [16, 17].



Fig. 1. Digital images of haptic sensors in the hip, knee and ankle. https://www.wearablex.com/pages/how-it-works



Fig. 2. Fig. 2. The device called 'Pulse' https://www.wearablex.com/products/nadi-x-pulse

GRDXKN® Technology

Protection is offered with GRDXKN®, a newly created process that produces a relief effect on the fabric, thanks to the prints used on the apparel (Fig. 3).

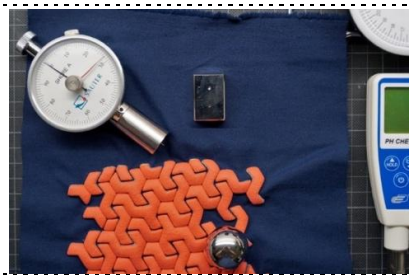





Fig. 3. Product examples of GRDXKN® printing technology https://grdxkn.com/en/#functions, https://www.textiletechnology.net/technical-textiles/news/grdxkn-collaboration-with-q36.5-for-cycling-apparel-33800

[1] Haptic sensor: A system that produces an output that can be perceived by the human sense of touch [18].

This thick material, which can be incorporated into the garment, has shock-absorbing capabilities while also delivering abrasion resistance. With the help of this technology, function and design can now be highlighted equally because it generates a whole new connection between the visual and the material. By converting substrates into smart textiles through the use of GRDXKN® printing technology, the textile industry is introduced to new areas of application. Through the use of specialised printing pastes, this ground-breaking textile printing method allows two-dimensional colours to partially transition into three-dimensional designs by integrating the mechanical material performance of the so-called GRDXKN® into the soft textile itself. When used in this fashion, the technology can be used to blend various materials. In addition, due to the composition of the compression paste (PU), the prints have fire retardant properties. The specific GRDXKN® structure protects certain parts of the body from the cold and protects the body from certain external factors as it is abrasion resistant. The structure is very variable in shape and depth. The thicker the compression layer, the stronger the structure. In addition to all these, GRDXKN® printing technology is solvent-free, obtained with water-based printing pastes, certifiable oekotex, formaldehyde-free and does not generate waste products [19].

We conducted an email interview with Bastian Mueller, the creator of GRDXKN®, and put several questions to him. In answer to our inquiries, he gave us the information below regarding this technique:
Question 1: What does GRDXKN® stand for?
Answer: GRDXKN® as a word is a combination of "grid" and "skin". My graphic designer had used the X as a creative homage to the textile as a print base. GRDXKN® (gridskin) is a technology and a way of thinking to design smart and functional textile solutions. GRDXKN® implements additional technical functions that are printed directly into the textiles. It is a 4D printing technology.

Question 2: What innovations does GRDXKN® 4D printing technology offer to sportswear?
Answer: GRDXKN® controls and adds technical functions through direct printing. The design and technical solution control the function of the fabric product and improve performance in terms of protection, muscle control and aerodynamics. The additional print is lightweight and flexible.

Question 3: What kind of sportswear products can we use GRDXKN® printing technology for?
Answer: The technology could be used for many different sport products. At the moment we developed solution for goalkeeper gloves, race bike wear, aerodynamic race suits and motorbike protective wear.

Question 4: What is the function of this technology in sportswear and how can it be used?
Answer: Right now we have the best combination of benefits for a soft protection solution. We use the technology and unique surface for better aerodynamic performance of textile products, especially for road cyclists. GRDXKN® also uses our product and knowledge to modify textile surfaces. We can add padding zones with abrasion resistant layers and a higher grip.

Question 5: What are the advantages and disadvantages of this technology?
Answer: The advantages are protective performance, abrasion resistance, aerodynamics, light weight and washability. It is an innovative and modern solvent-free water-based printing solution. GRDXKN®'s capabilities are unique and new to the sports market and it takes time to show the full potential and generate interest.

Question 6: When was the company founded by whom and when was this technology launched?
Answer: GRDXKN® was founded by me in 2017. The first idea and development started in 2011. The first small launch was in 2017 in Munich with a micro collection of the fictional bag brand MIMICRI in Germany.

Question 7: Which brands have started using this technology?
Answer: The first big customer was PUMA with the goalkeeper glove collection (Fig. 4) [20].



Fig. 4. Examples of goalkeeper gloves produced for the Puma brand
https://us.puma.com/us/en/pd/ultra-grip-1-hybrid-pro-goalkeeper-gloves/041786?swatch=01

Sensoria® Smart Socks

Sensoria® smart socks have won several awards, including 'Best new wearable technology device' by IDTechEx and 'Wearable Electronics' by Gartner in 2014.

The Sensoria® Run v2.0 app, available for iOS devices, features Mara, an AI coach that provides real-time, actionable biometric feedback to help monitor a training plan, improve form and performance and reduce the risk of injury. Mara synchronises with Sensoria® smart socks and tracks the consumer's progress history, goals, steps, distance covered and total activity time [21].

According to data gathered from the Sensoria firm, the sock is linked to the app through bluetooth, and a wrist-mounted adapter is used to track the user's movements. The consumer will not experience any issues with comfort or convenience because it is machine washable, does not cause discomfort, and is a substance that is easy enough to be incorporated into the textile material (Fig. 5).



Fig. 5. View of the wrist adapter and sock
https://www.sensoriafitness.com/ , https://store.sensoriafitness.com/one-additional-pair-of-smart-sock-v2-0-both-instrumented/

The new web control panel and Sensoria® Run v2.0 enable a graphical analysis to be produced after each session. The findings of the graphs can be compared because the results can be displayed by session, day, week, or month. The application's odometer feature also helps athletes know when to buy new shoes and when to replace their old ones because it can signal when a shoe is no longer functional and when it starts to degrade in performance [22].

Sensoria® provided us with links to the following data and shared a number of resources with us during our email interview. This information was written by Davide Vigano, the general manager and co-founder of the company[2].

The advantages of Sensoria® socks include enhancing athletic performance, enhancing foot health, and lowering injury risk. These socks track foot pressure and movement to identify potential

[2] An email interview with Sharlene (interview date 10.04.2023 and 05.05.2023).

issues like improper foot placement or over-toning, enabling users to alter their stride and lower their risk of injury. By giving athletes insightful information about their performance, Sensoria® smart socks can help them maximise their training and enhance their overall athletic ability.

According to the research in the Journal of Biomechanics, Sensoria® socks can help runners improve their form and lower their risk of injury. According to the study, runners who used Sensoria® Socks had significantly improved running mechanics, including less overpronation and more compliant foot strikes.

A third study examined how football players could use Sensoria® smart socks to lower their risk of injury. It was published in the Journal of Sports Rehabilitation. According to the study, players who wore Sensoria® socks were significantly less likely to sustain injuries, especially ankle sprains.

Another study found that using Sensoria® socks can help diabetic patients avoid developing foot ulcers, and it was published in the Journal of Diabetes Science and Technology. The study demonstrates that patients who wear Sensoria® Socks have significantly lower peak plantar pressure, a critical risk factor for developing foot ulcers [23].

Nike Vaporfly

Nike ZoomX foam and VaporWeave material are two cutting-edge technologies that the Nike company claims to have combined to create the quickest shoe (Fig. 6). The sole of the shoe has a full-length carbon fibre plate that aids with propulsion and speed. Nike ZoomX foam, which is added to the forefoot and is constructed of a hard yet flexible Pebax thermoplastic polymer, offers a high level of energy return. According to the shoe's creators, the new foam provides an energy return of 85% as opposed to 60% for Nike's prior models. This foam produces an extremely sturdy and light-weight construction when paired with the brand-new VaporWeave fabric. Even in severe rain and other weather conditions, the foot won't get wet because to this material's water resistance [23, 24, 25].

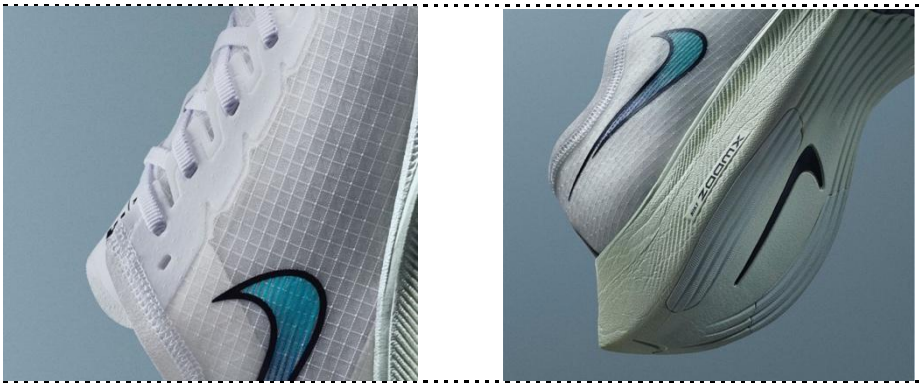

Fig. 6. Nike Vaporfly shoes sample image
https://www.nike.com/tr/kosu/vaporfly

There is a growing consensus that wearing Nike Corporation's latest generation of marathon racing shoes, known as Vaporflys, gives racers a considerable performance edge. The Vaporfly 4%, Vaporfly Next%, Alphafly, and other prototype shoes are only a few of the variations of the shoe that have been used in competitions. However, each design has a carbon fibre plate placed inside a very responsive foam sole.

Highly trained long-distance runners were tested in laboratory tests by Hoogkamer et al. (2018) and Barnes and Kilding (2019); participants wore Vaporflys and various other shoes during test runs on a treadmill. Both trials revealed an average 4% reduction in energy consumption when wearing Vaporflys compared to other shoes. The effects measured varied slightly from athlete to athlete [26, p. 1].

Samsung HumanFit

Since 2015, the Samsung brand has started developing smart apparel. An energy-harvesting shirt has been patented by the company. The shirt contains a processor that gives it a smart structure, sensors that can track data, and specific places that collect energy in response to a person's movements. These technological advancements enable the shirt to both charge smart devices and store the energy required to do so.

Smart clothing generates energy and transforms it into genuinely useful functions using a number of processors and several sensors. The Samsung patent claims that this technique is especially energy-efficient, allowing for the use of a smaller battery than typical. This demonstrates that Samsung produces ecologically responsible and sustainable goods. The patented Smart Clothing technology can be used to produce innovative sportswear products as well as a variety of clothing items like jackets, trousers, caps, gloves, and shoes [27].

Samsung Body Compass

For many years, Samsung C&T and Samsung Electronics have worked together to create and explore a bio-intelligent garment called Body Compass. Body Compass has electrocardiogram (ECG) and electromyogram (EMG) sensors that track the wearer's respiration and heart rate. The sensors also suggest specialised activities based on the wearer's health. The fabric is extremely durable and sticks to the body because it is constructed of sensors and elastic conductive strands (Fig. 7, 8) [28].

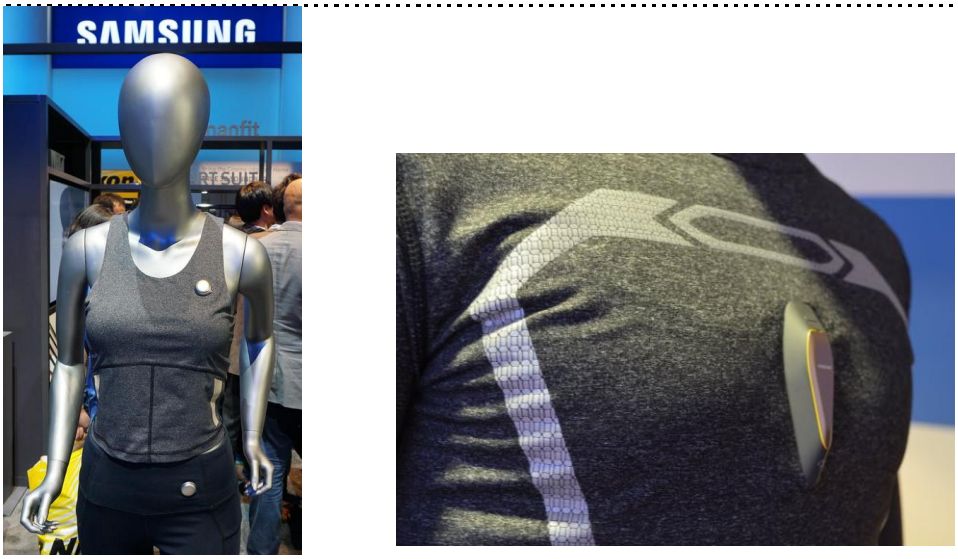

Fig. 7-8. Samsung Body Compass sport athlete
https://pisapapeles.net/samsung-muestra-nuevos-e-ingeniosos-wearables-ces2016/samsung-body-compass-21/ - https://www.youtube.com/watch?v=NfKXbZvMBjA

Speedo LZR Racer Swimsuit

The swimsuit is thought to have a significant impact on a swimmer's performance. The time difference between the victor and the loser in competitive swimming (national, international, and Olympic championships) is typically quite narrow, necessitating the deployment of cutting-edge technology. During the forward stroke, the swimmer expends around 90% of their energy to overcome hydrodynamic resistance. As a result, swimwear can significantly reduce hydrodynamic resistance and the resulting energy waste when swimming, which will benefit the outcome. It is projected that swimsuit performance will keep advancing as more effective swimsuits are developed [29, p. 2505].

Movement is made more challenging by friction, which always moves in the opposite direction. Several techniques have been created to reduce friction in fabrics and garments that are inspired by nature. One of the surfaces in nature with the least amount of friction is shark skin. A extremely thin, sawtooth-like layer that runs parallel to the direction of regional flow covers the skin. The water may move more freely on the surface thanks to this layer, which lessens the rotating movement generated by reverse currents on the skin surface [30, p. 109]. According to scientists, a large part of a shark's ability to float through the water is due to its skin. The skin of sharks is grooved rather than smooth and slippery, which reduces friction between the water and the skin, according to microscopic research (Fig. 9) [31, p. 22].

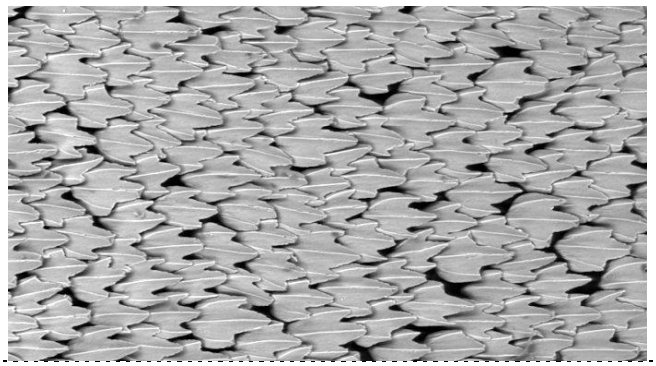

Fig. 9. View of shark skin under a microscope
https://bilimvegelecek.com.tr/index.php/2018/03/27/aerodinamik-icin-kopekbaligi-pullarindan-ilham-aliniyor/

NASA has also researched this shark skin property, which has been put to the test in pipes delivering liquids, boats, and aeroplanes [32, p. 896]. The FastSkin swimwear technology created by Speedo is the most successful commercial example in this field (Fig. 10). The frictional resistance of these swimsuits, which use innovative fibres and weaving techniques, is reduced by 7.5% when compared to conventional swimwear. They wrap around the swimmer's body and have the least water resistance [33, p. 769]. The reduced vibration of the muscles in these form-fitting swimsuits enhanced performance. Many businesses eventually created comparable goods. FINA prohibited all body-conforming swimsuits from competition after 130 world records were set in a single year, including 43 world records broken at the World Swimming Championships [34, p. 7].

Sports Products Functioning as GPS

Activity trackers—also referred to as sports trackers—are frequently worn on the wrist, chest, or ears. They are made to measure sports-related variables and keep track of outdoor exercise. These consist of heart rate, sleep habits, and running distance and speed [35, p. 13].

Most people purchase wearable devices so they can more conveniently track their calorie intake, heart rate, and physical activity. Customers can monitor their activity while performing their regular exercises at the gym, for instance, using fitness bands. Instead of using their cellphones or computers, users can use these devices. They do not need to remove the gadget from their pocket [36].

In Venere Ferraro's 2015 book, "Smart Textiles and Wearable Technologies for Sportswear: A Design Approach," a sweatshirt with LED lights and GPS functionality was created with Italian students for young ice skaters. The glowing sweatshirt was created to inspire kids to skate. The goal was to create the most practical and adaptable training shirt for skating, complete with GPS and LEDs to monitor the child's activities. The rows of LEDs gradually begin to illuminate thanks to an electronic controller coupled to the GPS and LED system (Fig. 10), [37, p. 4].



Fig. 10. Glowing Sweatshirt for little ice skaters [37]

Additionally, the students created a tracking safety kit to keep users safe at night and in hazardous circumstances. The two items in this tracking safety kit (Fig. 11). A pair of shoes that can light the way at night and a wristband that can be used for communication make up the first item. To convert kinetic energy into electrical energy, the shoes have a piezoelectric component, a capacitor and a rectifier connected to a pressure sensor, and an LED strip attached to a rechargeable battery that serves as a GPS [37, p. 4].

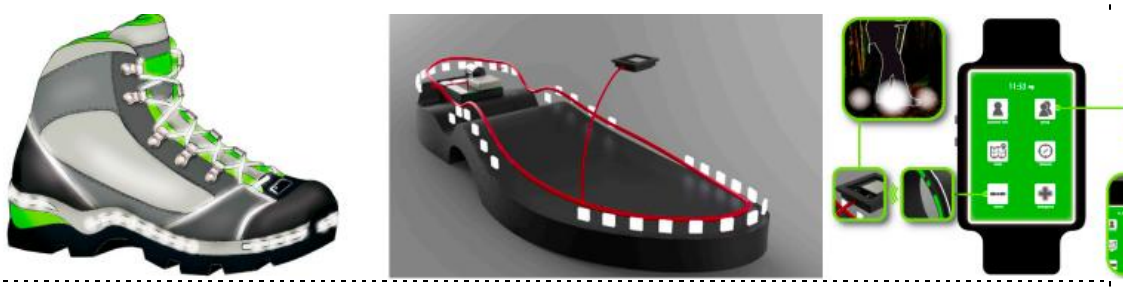

Fig. 11. Tracking safety kit [37].

Conclusion

Wearable technology is advancing daily, and its products are starting to become commonplace. The importance of these changes affects both enterprises and consumers. The existence of a sizable market is crucial for firms when developing and putting new and innovative ideas into practise. Similar items are being introduced to the market as a result of the products of the top businesses that are striving to take advantage of the potential in this industry. The advent of products that simplify life is a positive development from the consumer's point of view. The integration of wearable technology goods in the health, textile, education, entertainment, and tourism sectors is significantly impacted by the scramble for businesses to adapt to the changing and evolving technology.

Consumers can enjoy a healthier, more active lifestyle at a reduced cost thanks to wearable technologies. Wearable technology also gives parents the chance to see their kids succeed in sports in a more relaxed and comfortable manner because it increases the safety element for kids. It has been established that a number of records and accomplishments have been made possible through wearable technology. Numerous victories in a variety of sports will be ensured by staying current with such inventive and technological advances and providing substitute products in this area.

Given the interest people have in technical advancements and their interaction with technology, it is apparent that if more research is done in this area, the textile industry will feature cutting-edge and modern designs.

Highly trained long-distance runners were tested in laboratory tests by Hoogkamer et al. (2018) and Barnes and Kilding (2019); participants wore Vaporflys and various other shoes during test runs on a treadmill. Both trials revealed an average 4% reduction in energy consumption when wearing Vaporflys compared to other shoes. The effects measured varied slightly from athlete to athlete [26, p. 1].

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Functional Materials as an Innovative Approach to Sportswear Design [Функциональные материалы как инновационный подход к дизайну спортивной одежды]

Аннотация:

Текстильная промышленность стала больше интересоваться спортивным сектором, а также многими другими отраслями промышленности в результате растущей популярности спорта во всем мире и увеличения числа участников. Одежда и материалы, созданные для этого рынка, предназначены для удовлетворения потребностей и предпочтений потребителей, когда они участвуют в спортивных мероприятиях. Потребители получают комфорт и удобство в своей повседневной жизни, включая более высокий уровень безопасности, снижение вероятности несчастных случаев и улучшение спортивных результатов благодаря использованию технических и практичных элементов в спортивной одежде. Современный дизайн и производство текстиля и одежды сосредоточены на функционализации, создании передовых функций и применении передовых технологий для повышения производительности человека. Целью этой статьи является изучение специально разработанных материалов и сборок, которые выходят за рамки их обычного использования и предназначены для предоставления пользователю определенных характеристик или возможностей. В этой области был проведен ряд исследований, и начато производство технологичных, интеллектуальных и функциональных тканей, которые предлагают потребителям

более приятные ощущения при ношении и комфорт в повседневной жизни, а также способствуют повышению производительности. Исследование ограничено мужской и женской повседневной спортивной одеждой, созданной за последние 10 лет, которая является технологически продвинутой, инновационной и функциональной. В исследовании привлекаются материалы научных публикаций, диссертаций, а также цифровые интервью с дизайнерами и сотрудниками известных брендов.

Ключевые слова: спортивная одежда; функциональные материалы; инновации в текстильной отрасли; инновации в спортивной одежде; интеллектуальная текстильная отрасль; технология дизайна.

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