

# CREATION OF SMART ELEMENTS OF CLOTHING USING MAGNETIC TEXTILES

RIABCHYKOV Mykola, NAZARCHUK Liudmyla  
*Lutsk National Technical University, Lutsk, Ukraine*

\*Corresponding author: RIABCHYKOV Mykola: e-mail [mykola.riabchikov@lntu.edu.ua](mailto:mykola.riabchikov@lntu.edu.ua)

**Abstract:** *The article substantiates the use of magnetic textiles for creating smart clothing elements. The main properties of textiles based on nanocomponents of divalent and trivalent iron are described. Bacterial, magnetic, barrier properties are noted. The main directions of the implementation of textile magnetic materials in the processes of creating smart clothes and smart products, especially in the direction of creating medical and protective products, are substantiated. The requirements for the creation of a magnetic field, special compression properties with the possibility of pressure control are specified. The possibility of creating movable elements of clothing, creating a fit, regulating the removal of sweat and waste products, and the possibility of regulating protective functions using the methods of smart textiles are proven.*

**Key words:** *magnetic textiles, protective products, smart clothing*

## 1. INTRODUCTION

One of the trends of modern textile materials science is to provide new properties with elements of intelligent features, opportunities to manage individual life processes. In many cases, this is associated with nanotechnologies and nanomaterials used to change the properties of textiles.

Such tasks are especially relevant in areas related to human health. This includes bacteriostatic, healing, and protective properties.

Separate studies determine the positive effect on the specified factors when textile materials are saturated with metal nanopowders. A promising, but insufficiently researched direction is the use of magnetic nanopowders based on a mixture of divalent and trivalent iron oxides. Magnetic properties create additional properties of textile materials.

Determining the main properties of such materials for use in smart clothing, medical and protective processes is an urgent task.

## 2. BASIC PROPERTIES OF MAGNETIC TEXTILE MATERIALS

The basic principles of creating magnetic textile materials are described in [1]. Pronounced bacteriostatic properties of these materials were noted In this study.

Study [2] claim a positive effect of compression garments in the treatment of translational orthostatic tachycardia. Real studies were conducted on the effect of compression in different places of the human body. Leveling of heart rate and blood pressure was noted. Taking into account the possibility of pressure control in compression magnetic clothing systems, as well as the dynamic possibilities of changing pressure in such systems, it is possible to note the reality of the introduction

of magnetic textiles for the treatment of tachycardia.

Several publications note the positive local effect of magnetic therapy on blood vessels in the process of antiangiogenic actions. In the study [3], the local effect of inhibitors from the inside using magnetic nanoparticles is proposed. The creation of similar procedures from the outside with the help of nanotextile materials can cause additional effects in terms of a complex effect on the human body.

Magnetic therapy according to [4] can be used to treat the gastrointestinal tract. Specified prospects for the development and use of special devices for the therapy of these diseases are noted. Magnetic garments in these conditions are the universal tools that can provide both passive and active effects on the gastric tract from the outside by simply wearing clothes.

Magnetic therapy for seizures [5] involves, in particular, stimulation of the vagus nerve with the help of a magnetic field. The active action of the magnet can reduce or stop the seizure. Patients determined a significant improvement under the influence of the magnetic field. Active magnetic stimulation using magnetic smart clothing can provide additional means of therapy in the event of a seizure.

Details for active garments for athletes are traditionally produced constructively with the use of special accessory elements. Sportswear (especially sports bras) uses different types of applications to create opportunities for active activities [6]. Such clothing should include the ability to support and train individual parts of the body. Similar actions can be provided by using products made of magnetic textile materials.

Separate directions for creating smart garments involve fixing individual elements to the human body. For example, in the article by [7], the problem of electrode fixation during dynamic electrocardiography is considered. The use of magnetic textile materials allows you to create surface pressure on various devices and, accordingly, diversify the methods of their fixation.

### **3. DIRECTIONS FOR THE INTRODUCTION OF MAGNETIC TEXTILES**

It is proposed to use magnetic nanomaterials based on divalent and trivalent iron oxides.

Magnetic and bacteriostatic properties of textile materials make it possible to use them in various areas and directions. Magnetic technologies are used in medicine, in particular, to improve metabolic processes in the human body. These processes improve treatment and recovery. Magnetic procedures relieve inflammation, improve blood flow, and relieve pain. The use of magnetic textile materials as clothing is capable of reproducing medical magnetic procedures in the course of ordinary life, without visiting treatment rooms with special equipment.

An important area of medical use of textiles is the creation of compression clothing intended for the treatment of varicose and trophic diseases [8]. The main principle of operation of such clothes is to create the necessary pressure in a certain place of the human body. In traditional methods, these problems are solved due to the elastic properties of the material of such clothes. The presence of magnetic textile properties creates the possibility of a different approach to the problem. Creating a magnetic field with a given voltage for a magnetic textile material allows you to provide any given pressure in any part of the human body.

The magnetic properties of textiles and, accordingly, the use of magnetic forces make it possible to create conditions for truly smart clothing [9]. At the same time, it is

possible to develop clothing elements with the ability to move, change the geometry and fit the figure.



**Figure 1:** Clothing with moving parts

Bacteriostatic properties of magnetic textile materials provide very high prospects for the use of materials for medical purposes. In particular, the bactericidal properties of textile materials are a necessary condition for the creation of medical dressing materials [10].

The development of bacteriostatic clothing based on the use of such materials can significantly increase the health-preserving properties of the products. Also, similar bacteriostatic clothing can find use when working in dangerous conditions, in particular when working in infectious conditions.

Bacteriostatic properties of textile materials containing nanomagnetite allow to go beyond medical uses. Ecological packaging technologies in some cases involve the use of textile natural materials instead of packaging made of polymer films. Bacteriostatic properties make it possible to create conditions for long-term storage of products.

If we are talking about medical materials for the purposes of wound treatment, then their main task is to remove exudate - the liquid that forms inside the wound. At the same time, the material must have cavities that create negative pressure and contain harmful fluids from the wound.

The creation of foamed materials with the addition of magnetic nanopowders significantly increases the number of cavities, and also equalizes their dimensions. This effect allows not only to increase the quality indicators of materials, but also to determine the regimes of adding magnetic nanomaterials that ensure the formation of cavities of specified sizes, which provide the necessary parameters for liquid removal, which in some cases is required by wound treatment technologies.

The indicated properties of materials with the content of nanomagnetic materials for regulating the removal of liquid allow to significantly expand similar materials in the direction of creating smart clothes for the comfort of consumers. Such clothing is able

to create the necessary level of humidity on the human body, remove sweat or, conversely, supply cooling liquid.

Of course, similar materials can find use in related industries when creating products with specified characteristics of fluid passage.

Textile materials filled with iron nanopowders acquire properties similar to solid metal products. Such properties, in particular, include protection against electromagnetic radiation, which is relevant for a number of industries.

The directions of use of magnetic textile materials are summarized in Table 1.

**Table 1:** Directions of implementation of magnetic textile materials

Properties of magnetic textile materials based on nanopowders	Medical purposes	Creation of smart clothes and smart products	Alignment
Bactericidal properties	Bactericidal dressing materials	Bactericidal clothing	Storage of products
Magnetic properties	Creation of compression clothing	Рухомі елементи одягу	Clothing with protection against metal objects
	Magnetotherapy	Adjusting the fit of clothes	-
Properties for pore formation	Medical materials for exudate suction	Regulation of removal of sweat and waste products	Creation of porous materials with given parameters of heat and mass transfer
Barrier properties	Barrier elements of medical clothing	Ability to adjust protective functions	Protection against electromagnetic radiation

Thus, the main areas of use of magnetic textile materials can be technologies related to the creation of smart clothes, the introduction of medical textile and protective materials.

#### 4. CONCLUSIONS

The main directions of implementation of textile materials with the content of magnetic nanopowders into real practical results are proven. The process of introducing into clothing for medical purposes, into smart clothing and protective clothing for creating magnetic therapy compression clothing, moving elements of clothing, adjusting the fit of clothing, and other purposes is described. The structure of directions for the use of magnetic textile materials for medical and protective products, as well as for promising elements of smart clothing is expanded.

## 5. References

1. RIABCHYKOV M, NAZARCHUK L, TKACHUK O, STYTSYUK V. Creation of smart compression garment using magnetic nanotextiles In: Research Journal of Textile and Apparel, 2023 <https://doi.org/10.1108/RJTA-08-2022-0095>
2. BOURNE K. M., SHELDON R. S., HALL J., LLOYD M., KOGUT K., SHEIKH N., JORGE J., EXNER D.V., TYBERG J.V., RAJ S.R. Compression Garment Reduces Orthostatic Tachycardia and Symptoms in Patients With Postural Orthostatic Tachycardia Syndrome. In: Journal of the American College of Cardiology, 2021, Volume 77, Issue 3, pp. 285-296, <https://doi.org/10.1016/j.jacc.2020.11.040>
3. RIECK S., HEUN Y., HEIDSIECK A., MYKHAYLYK O., PFEIFER A., GLEICH B., MANNELL H., WENZEL D. Local anti-angiogenic therapy by magnet-assisted downregulation of SHP2 phosphatase. In: Journal of Controlled Release, 2019, Volume 305, pp. 155-164, <https://doi.org/10.1016/j.jconrel.2019.05.031>
4. CANTILLON-MURPHY P., CUNDY T.P., PATEL N.K., YANG G.-Z., DARZI A., TEARE J.P. Magnets for therapy in the GI tract: a systematic review, In: Gastrointestinal Endoscopy, 2015, Volume 82, Issue 2, pp. 237-245, <https://doi.org/10.1016/j.gie.2014.11.007>
5. YIP J., FUNG O.H.Y., NG T. Narrow fabric elastics and accessories for activewear. Latest Material and Technological Developments for Activewear. In: The Textile Institute Book Series, 2020, pp. 73-88, <https://doi.org/10.1016/B978-0-12-819492-8.00004-1>
6. AZADEH S., HERNÁNDEZ N., BERGLIN L., NIERSTRASZ V. Electrode placement in electrocardiography smart garments: A review. In: Journal of Electrocardiology, 2019, Volume 57, pp. 27-30, <https://doi.org/10.1016/j.jelectrocard.2019.08.015>
7. MORRIS G.L. A retrospective analysis of the effects of magnet-activated stimulation in conjunction with vagus nerve stimulation therapy. In: Epilepsy & Behavior, 2003, Volume 4, Issue 6, pp. 740-745, <https://doi.org/10.1016/j.yebeh.2003.08.025> LIU, B. *Uncertainty Theory*. Berlin: Springer-Verlag Press, 2010.
8. RIABCHYKOV M, NAZARCHUK L, TKACHUK O, Basic Parameters of Medical Textile Materials for Removal and Retention of Exudate from Wounds *Tekstilec*, 2022, 65(4), pp. 268–277 <https://doi.org/10.14502/tekstilec.65.2022064>
9. RIABCHYKOV M., ALEXANDROV A., SYCHOV Y., POPOVA T., NECHIPOR S. Magnetic nanotechnology in the production of foamed textile materials for medical purposes. In: *Vlákna a textil*, 2021, (3) Vol 28 , pp.66-72
10. RIABCHYKOV M., ALEXANDROV A., TRISHCH R., NIKULINA A., KOROLYOVA N. Prospects for the Development of Smart Clothing with the Use of Textile Materials with Magnetic Properties. In: *Tekstilec*, 2022, Vol. 65(1), pp. 36–43 doi: 10.14502/tekstilec.65.2021050