DEPOSITION OF METAL – NANOPARTICLES IN TEXTILE STRUCTURE BY CHEMICAL REDUCTION METHOD FOR UV-SHIELDING

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Now mankind is exposed to danger of UV-radiation (UVR) for health and it is very important to create reliable ways for protection against it. For UVR impact reducing, various shielding materials are used. Special place are occupied by textile screens. Their advantages: flexibility, ability to form shields of various shapes, etc. One of main requirements to UV-screens is their electro-conductivity. To-day various methods of textile materials nano-modification are known (such as evaporation of metals in the electric arc, laser and magnetron sputtering of metals; deposition of nano-particles on the surface of textile materials). Each of methods, as a rule, complicates the technology of textile nano-modification; require high energy costs, lead to different environmental problems, and on synthetic textile materials such treatments cause polymer degradation. The purpose of this work: to elaborate the effective method of textiles modification to receive textiles with high level of protection against UV-radiation. We proposed the method of textile modification in Cu-sulfate solution with Cu-ion reduction for receiving of Cu nano-particles directly in porous textile structure. Textiles modified by using of this method have high degree of ultraviolet waves at wavelengths A (315-400nm) and B (315-280nm). The proposed method is simple, accessible and effective (cheap and accessible reagents; processing may be implemented on the equipment for dyeing).

Keywords: UV-shielding; textile modification.

INTRODUCTION

Even the weak energy impact of UV Radiation on the human body affects the resonant processes in various organs and systems of organs of a living organism.

The development of textiles for effective shielding from the action of UV is a task that has attracted attention medics and scientists for many years. All over the world the main requirement to UV-screens is their electro-conductivity (Prue, 2013; Holick, 2016, Juzeniene, 2011; Mikkelsen, 2015; Zaets, 2006).

At first, the textile material serves as a flexible two-dimensional substrate providing an effective surface for harvesting photons of light (Wilson, 2008; Singh, 2013; Vlasenko, 2016).

Secondly, the textile substrate is easier to apply functional nano-substances using different techniques (for example, from solutions, vacuum, laser, printing).

Modern trends in the world economic development of the textile industry and tough competition in the world textile industry market require the creation of innovative textile materials and products from them with a target set of properties. Nano-technologies play especial role in solving this problem. Their use makes it possible to create innovative textile materials with a given set of properties (Абдуллин, 2005; Горберг, 2003; Шаехов, 2006; Красина, 2011).

To-day various methods of textile materials nano-modification are known and used. There are such methods as evaporation of metals in the electric arc, laser and magnetron sputtering of metals and deposition of nano-particles on the surface of textile materials.

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Each of these methods, as a rule, complicate the technology of textile nano-modification, require high energy costs; the special equipment must be used. Then these methods lead to different environmental problems. Besides it, vacuum metallization of textiles worsens its vapor and air permeability. Also, on synthetic textile materials such treatments cause polymer degradation.

In our work we have investigated and propose the method of textile nano-modification from metal salts solutions.

EXPERIMENTAL PART

Modification of the Textile Materials

In our day there is the great growing interest to fabrication and application of nano-materials in textile technologies. Nano-modification provides to textiles new very interesting and necessary properties.

As example, nano-modification with using some metals, provide antistatic, antimicrobial properties, electroconductivity, shielding against EM radiation in wide range of wavelength.

Among nano-articles, metallic cooper particles are interesting with its potential wide application, for example: electrical properties, catalytic activity, low cost, for heat transfer system and its antimicrobial, antiviral, antifungal properties and oth.

The method of modification by the nano-dispersed Cu-powder was performed in accordance with the patent (Vlasenko *et al*., 2018). Transactions copper sulphate recovery process with glucose to form copper nano-powder are carried out in air at atmospheric pressure.

The sequence of stages of copper recovery process of sulfate glucose can be represented by the scheme:

$$CuSO_4 + (C_6H_{12}O_6 + NaOH) \rightarrow Cu_2O \quad (1)$$

$$Cu_2O + NaOH \rightarrow Cu \quad (2)$$

Copper sulfate was dissolved in 30% glucose solution at a temperature about 50-60°C. In this solution of the textile samples were placed. The solution was heated to 70°C. Samples were constantly agitated. To maintain the pH between 8-9 it was added sodium hydroxide – in 10, 20, 30 minutes. Under these conditions the reduction of copper oxide Cu_2O to copper Cu was completed. The reaction was ended after 60-70 minutes. The nano-particles of copper were formed both in the structure of the textile material and on its surface. Then the samples without pressing were dried in air.

We found that the nano-sized copper powder was formed not only in the internal structure of the textile web, but also deposited on both external surfaces of the modified material. To fix the surface deposited copper powder, we fixed a thin PET fabric (thickness of about 15-20 microns) on both outer surfaces of the modified fabric with the help of glue material “Sharnet” (f. Boostic, England).

Determination of UV Absorption by Textiles

To determine the extent of absorption of ultraviolet (UV) radiation was used UV dosimeter-radiometer Tensor-71. UV radiometer-dosimeter designed to measure the intensity of irradiation (radiation).

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Irradiation of samples was carried out on the Fadometer mark LE-1 model KT7035.

The source of UV radiation is a xenon arc lamp, air-cooled with heat and light filters type OSRAM XENON SHORT ARC DISPLAY/OPTIC LAMP. XBOR XTREME LITE; wavelength range is 200-400nm (Vlasenko *et al*., 2017).

Textiles that are modified by metal nano-particles became also antistatic properties. The combination in one textile material of two fundamentally important health factors provide unique protective properties of textile products.

With the choice of soluble metal salts such as copper, iron, nickel and silver makes it possible to produce nano-modified textile materials for various purposes.

RESULTS OF RESEARCH

The results of UV-light absorption testing are summarized in Table 1. As we can see the modification by nano Cu-particles enhanced the protection properties both in A and in B range of UVR.

Table 1. The degree of ultraviolet light absorption by nano-Cu modified textile at wavelengths A (315-400nm) and B (315-280nm)

Characteristics of the sample	The degree of absorption in the range A,%	The degree of absorption in the range B,%
AS 703*, unmodified	91,8	94,4
AS 703*, modified by Cu	99,6	96,7
Cotton fabric bleached, unmodified	85,3	42,7
Cotton fabric bleached, modified by Cu	93,3	92,1

Note: * - AS 703 PET fabric includes conductive carbon fibers.

Advantage of the chemical method of textile nano-modification from salt solutions:

- simplicity of technology implementation;
- availability of initial reagents;
- low energy intensity of the process;
- the process of formation of nano-particles in micropores of textile material;
- the controlled size of the nano-particles of the metal (with a change of the solution concentration).

CONCLUSION

It was investigated the method of textiles nano-modification from metal-salt solution. It was established that nano-metal particles have deposited in porous textile structure and on its surface.

The developed method is simple, accessible and effective method of nano-sized copper particles obtaining directly in the textile structures. Insoluble nano-particles of copper are formed directly in the porous structure of the PET fibers.

This technique may be recommended for textile nano-modification with metals such as Cu, Ni, and Fe using their soluble salts.

Textiles that are modified by metal nano-particles became also antistatic properties. The combination in one textile material of two fundamentally important health factors provide unique protective properties of textile products.

The solving the problem of protection against UV radiation is the key for solving the problem of protection from electromagnetic radiation in a wide range of wavelengths.

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Those innovative materials with multifunctional protective effects may have a wide range of applications (usual clothing, medical protective gown, hospital drapes, protective personal equipment for electricians, farmers, outdoor fabrics, etc.).

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