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Investigation of Cellulose-Containing Fabrics Modified with Silicon IV Oxide Nanoparticle Suspensions Using Thermal Methods

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Abstract

The article presents the results of thermal tests of samples of cellulose-containing fabrics treated with stable suspensions obtained on the basis of unmodified and modified particles of silicon IV oxide nanoparticles (aerosil-380). From the obtained results, we can see that these modified processes had a positive effect on the fire-technical properties of the fabrics

Keywords: Silicon IV oxide, nanoparticles, Aerosil-380, modification, cellulosic fabrics, thermal analysis, flammability, level of smoke generation

Analysis and statistics of fires show that the flammability of various materials and the high speed of fire spread lead to less time to evacuate people during fires and, as a result, people die. Therefore, by increasing the fire resistance of substances and materials, including textile materials, it is important to evacuate people in case of fire and, as a result, to increase the time of rescue, as well as to eliminate the fire at the initial stage of its development. [1-8].

It is of great scientific and practical importance to reduce the flammability of textile materials by modifying the fiber composition and structure of textile materials with flame retardant, environmentally friendly (mainly inorganic compounds resistant to high temperatures) components at the stages of certain technological processes of textile production. have

In the research work, nanoparticles of silicon IV oxide (aerosil-380) obtained at the initial stage of scientific research with modified suspensions, under different conditions (from 100 to 400, W), obtained as a result of treatment under the influence of ultrasound [9-10] were applied to cellulose-containing fabrics the changes that occur in them as a result of thermal effects and, as a result, the changes in their flammability properties were studied.

It is known that thermal analysis methods have been widely used in the research of fire safety properties of substances and materials in recent years [11]. At this stage of the research work, as mentioned above, various samples of modified cellulose-containing fabrics [9-10] were tested using the thermal methods of differential-thermal analysis and differential-scanner calorimetry. As a result of the tests, the following results were obtained:

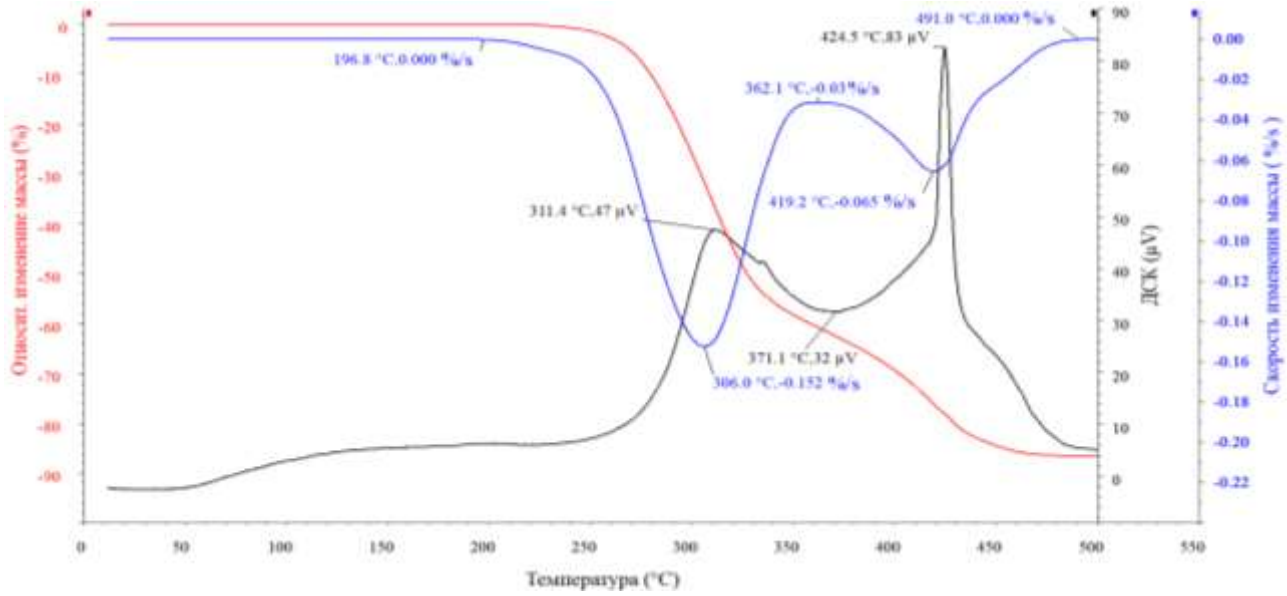

Figure 1. TG, DTG and DSK curves of a fabric sample treated with a mixture of Aerosil-380 and magnesium hydroorthophosphate (0.1:0.1 ratio).

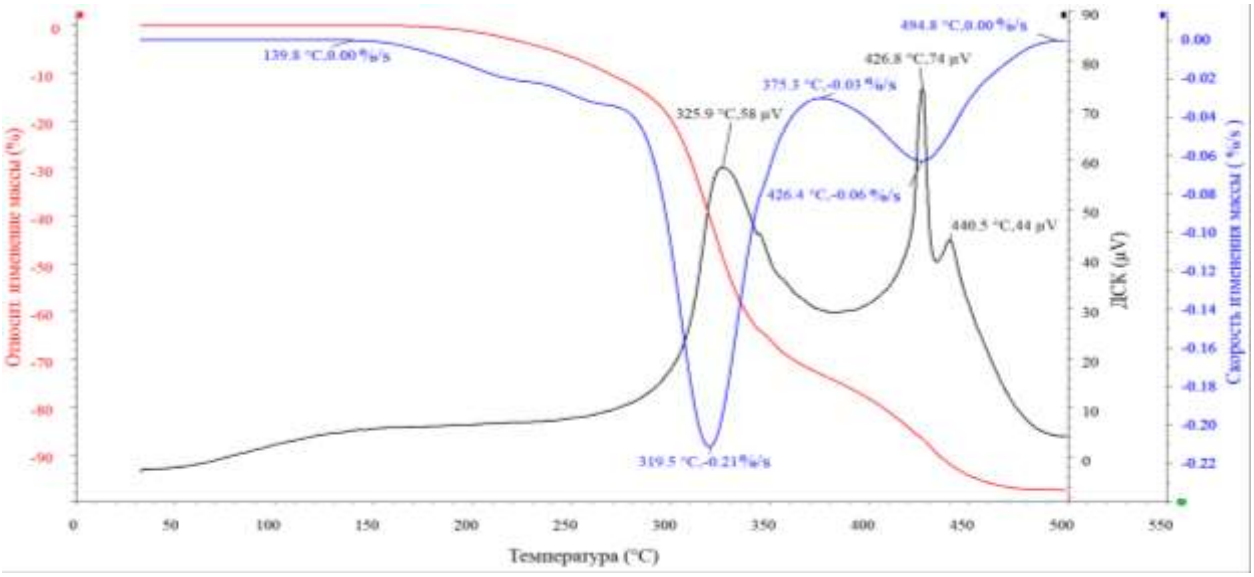

Figure 2. TG, DTG and DSK curves of a fabric sample treated with a mixture of Aerosil-380 and magnesium hydroorthophosphate (ratio 1:0.1).

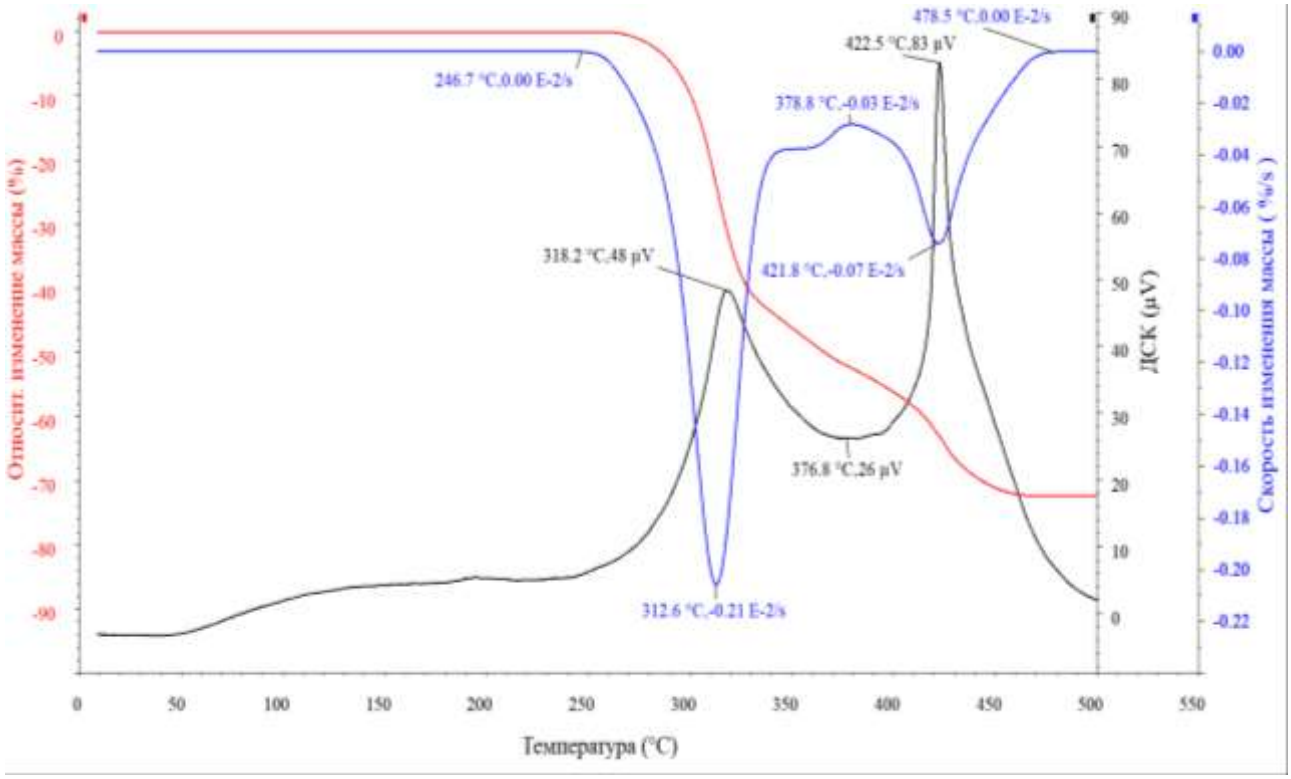

Figure 1. TG, DTG, and DSK curves treated with a 0.1:0.1 mixture of Aerosil-380 and polypropylene glycol.

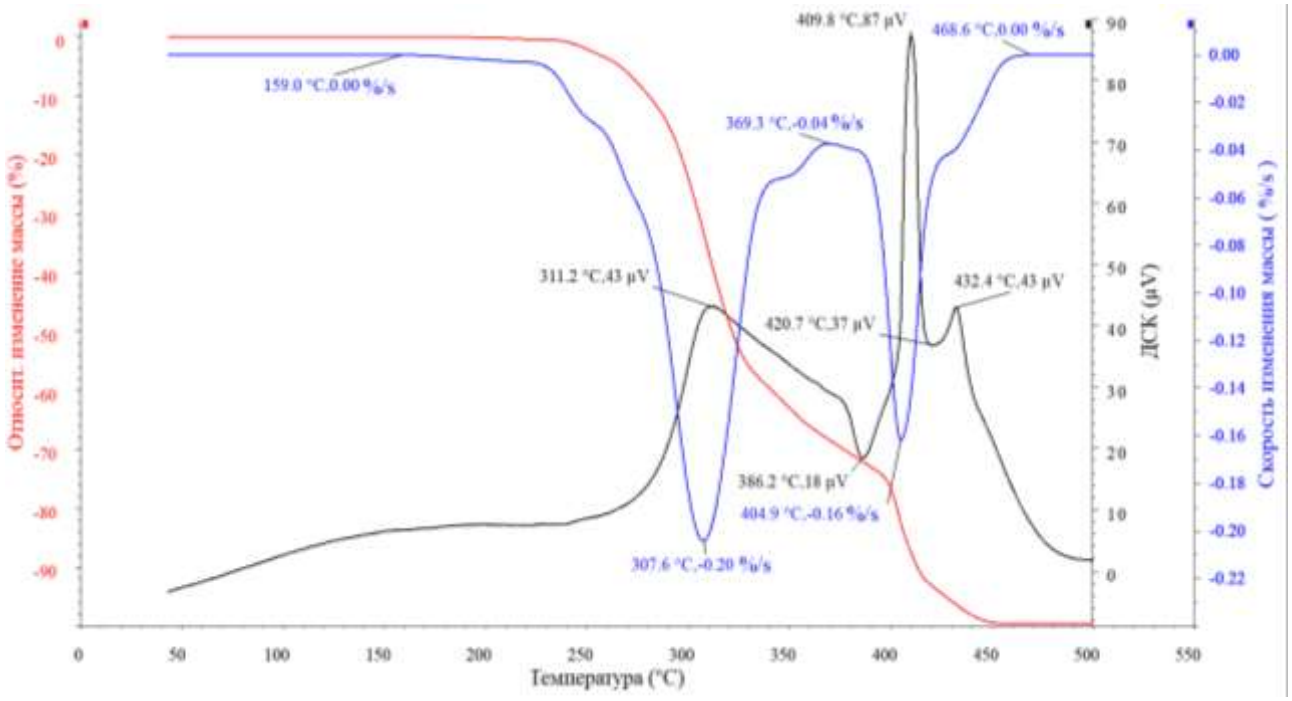

Figure 4. TG, DTG, and DSK curves treated with a 1.0:0.1 mixture of Aerosil-380 and polypropylene glycol.

From the results obtained during the research, it was known that the samples of cellulose fabrics treated with stable suspensions obtained on the basis of unmodified and modified (magnesium hydroorthophosphate, sodium acetate, sodium tetraborate, polypropylene glycols) particles of silicon IV oxide nanoparticles (aerosil-380) and prepared for testing were thermally from the results of the tests, we can see that these modification processes have a positive effect on the fire-technical properties of the fabrics (Tables 1 and 2).

A fabric treated with a mixture of Aerosil-380 and magnesium hydroorthophosphate

№	Fabric treated content	Temperature, ^{0}C	Rate of change of sample mass, %
1.	Aerosil-380 and magnesium hydroorthophosphate (0.1:0.1 ratio)	196,8	0
		306,0	0,152
		362,1	0,030
		419,0	0,065
		491,0	0
2.	Aerosil-380 and magnesium hydroorthophosphate (1:0.1 ratio)	139,8	0
		319,5	0,21
		375,3	0,03
		426,4	0,06
		494,8	0

Table 2

A fabric treated with a mixture of Aerosil-380 and polypropylene glycol

№	Fabric treated content	Temperature, ^{0}C	Rate of change of sample mass, %
1.	Aerosil-380 and polypropylene glycol (0.1:0.1 ratio)	246,7	0
		312,6	0,21
		378,8	0,03
		421,8	0,07
		478,5	0
2.	Aerosil-380 and polypropylene glycol (1:0.1 ratio)	159,0	0
		307,6	0,20
		369,3	0,04
		404,9	0,16
		468,6	0

Based on the results of the tests (Tables 1 and 2), the rate of mass loss due to thermal effects in processed samples of cellulose-containing fabrics is 311.42 0C on average
It was 0.19%, while the rate of mass loss of untreated fabric samples was 0.20% at 100 0C in some samples.
Also, in the tests, it was observed that the burning process continued in the modified fabric samples during exposure to open flame, and the burning process also stopped when the exposure to the flame source was stopped. In the samples of unmodified fabrics, it was observed that ignition and burning processes continued even after the exposure to the open flame source was stopped. We can see that the level of smoke production (according to GOST 12.1.044-89) of these samples has also decreased.
From the results of the conducted researches, it became known that the treated tissues increased their resistance to thermal effects and the effects of open fire. From this it can be concluded that as a result of the conducted researches, as a result of treatment of cellulose-containing tissues in a new way, that is, with the help of ultrasound, an increase in fire resistance was achieved due to the penetration of nanoparticles to the microscopic components of these tissues, as a result of more coverage of the surface.

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