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Formation of Fire Retardant Properties in Elastic Silica Coatings for Textile Materials

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Abstract. The influence of the degree of homogeneity of the SiO_2 sol on the duration of the induction period and the quality of fire-resistant coatings on textile materials was studied. The prospects of using IR spectroscopy as an express method for studying the phase composition of a gel coating, the degree of completion of the hydrolysis of an organosilicon component, and adjusting the parameters for obtaining a high-quality fire-resistant binary coating of a sol SiO_2 - flame retardant system are shown.

1. Introduction

Improving the fire resistance of textile materials is one of the most important problems, since they can withstand only the short-term effect of fire, after which partial or complete destruction of the fabric occurs.

It is possible to increase the fire resistance of the fabric by impregnating it with flame retardant solutions, but this does not solve the problem cardinally: water-soluble inorganic compounds used as flame retardants are easily washed out of the fabric during washing. The application of silica coatings to the fabric by impregnation with organosilicon sols solves the problem of washing out the coating. However, it creates additional difficulties at the time the composition is applied to the fabric.

To obtain a stable coating, it is necessary that the organosilicon component has functional groups capable of forming hydrogen bonds with the surface hydroxyl groups of the fabric [1]. For these purposes, tetraethoxysilane alkyl derivatives (TEOS), aqueous and non-aqueous solutions of TEOS and hybrid sols containing, in addition to TEOS, boric acid [2, 3], sodium phytate [1, 4 - 7], urea and other nitrogen-containing components [8] are most often used, as well as organophosphorus compounds [6, 9 - 11] and their various combinations [3, 5, 8].

The main difficulty of the process is the need for preliminary synthesis of a N,P,B-containing organosilicon component with a developed structure. At the same time, the composition of the fabric is important. There are many works devoted to the fire protection of cotton [4, 5, 12], woolen [1, 6, 8] silk [13] and synthetic [10] fabrics. Much effort is devoted to synthesizing compounds that can carbonize under the influence of fire, forming a swollen layer that prevents the spread of flame, reduces the thermal effect of combustion and prevents residual burning of the fabric after removing the source of fire. In any case, the fabric is completely destroyed, which means that such impregnating compositions are not advisable to use for protective cotton suits of firefighters.

In this regard, water–alcohol sol–gel compositions based on TEOS that are capable of forming dense thin films on the surface of tissue fibers appear to be promising [14].

The fire resistance of textile materials is affected, first of all, by the quality of applying a fire-resistant coating to them. The main requirements for flame retardant coatings on fabrics are to maintain the elasticity of the fabric and ensure uniformity in phase composition and coating thickness.