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FLAME-RESISTANT FABRIC COMPOSITION

William John Myles, Summit, N.J., assignor to Celanese Corporation, New York, N.Y.

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ABSTRACT OF THE DISCLOSURE

The flammability of sewn textile structures is reduced by using meltable sewing thread in all manufacturing operations requiring a sewing process step.

BACKGROUND OF THE INVENTION

This invention relates to fire resistant textile structures. More particularly, the invention relates to stitched, fabricated textile products, e.g., sewn and decoratively stitched textile articles for use in building interiors and the like, which are self-extinguishing following ignition.

The textile and related industries, in cooperation with governmental bodies and fire protection associations, have developed numerous flame resistant fabric and yarn materials. In general, this research and development work has resulted in the disclosure of textile finish formulations which, when associated e.g. impregnated, coated and the like, with textile fabrics and yarns, impart self-extinguishing characteristics thereto. The term "self-extinguishing" as used in the art and therein in connection with a textile structure refers to a textile article which is fire resistant to the extent that once the igniting flame has ceased to contact unburned parts of the texile structure, the article has the inherent ability to resist further propagation of the flame along its unburned portions, thereby effectively stopping the internal burning process and extinguishing flames in contact therewith which are not arising from an external flame source. Thus a self-extinguishing textile structure will continue to burn if its unburned portions remain in continuous contact with an external flame source or if fabricated in a structural manner allowing continuous, autogenic sustenance of an internal flame source preventing the material from demonstrating its flame quenching properties. The art has developed around fire retardant compositions of a "self-extinguishing" character in large part because of the inability of the textile and related industries to develop true fire-proofing additives capable of converting flammable fabrics into fabrics characterized by a complete resistance to fire, such as demonstrated by asbestos, without impairment of desirable textile properties such as hand, abrasion resistance, wrinkle resistance, lustre, resistance to pilling and the like.

Although textile structures treated with fire retardant compositions imparting a self-extinguishing character thereto will fully conform to present industry and government standards in an unmanufactured state, it has been observed that such treated fabric and yarn materials in many instances do not retain their desirable fire resistant properties when fabricated into certain types of enduse textile products. More specifically, it has been determined that textile products manufactured from self-extinguishing yarn and fabric materials, and further characterized by the inclusion of at least one continuous sewing thread in the end product, have a high degree of flammability approaching in many instances that of comparable products formed from untreated material. The above is true regardless of whether the sewing threads have been stitched into the article for structural or decorative purposes or if the threads have themselves been subjected to a fire-resistant treatment.

Accordingly, it is an object of the present invention to provide sewn, self-extinguishing, fire resistant textile products. It is another object of the invention to provide stitched textile manufactures which retain the highly desirable self-extinguishing properties of raw flame retardant textile structures in manufactured form. It is still another object of the invention to provide a method for fabricating sewn, fire resistant textile articles. A further object of the invention is to provide self-extinguishing, sewn textile articles such as draperies, floor coverings, furniture coverings and the like for use on the inside of buildings, especially where all or part of the textile structure is disposed in generally vertical configuration. Other objects will appear obvious to those of ordinary skill in the art from the detailed description of the invention hereinafter.

THE INVENTION

In accordance with the present invention, sewn, self-extinguishing textile articles are constructed by an improved process which comprises sewing said textile articles with meltable sewing thread during manufacturing operations requiring a sewing process step. The sewing steps may be required for fabricating unitary textile articles, i.e., sewing sleeves onto shirt bodies, and for decorative or other purposes, i.e., needlework embroidering of linens.

In a preferred embodiment of the present invention, self-extinguishing textile articles for use in building interiors, such as draperies, furniture and floor coverings, window shades and the like are produced by first preparing a self-extinguishing, fire resistant textile fabric, such as knitted, woven and nonwoven fabrics, and then manufacturing said fabric into indoor end-use textile products by means of sewing threads which lose structural integrity, e.g., liquefy prior to ignition upon exposure to elevated temperatures produced as the result of fire, and particularly fire occurring at a distant point along the same textile structure.

DETAILED DESCRIPTION

Surprisingly, it has been found that fire, following ignition, will be sustained in a predictable manner in sewn textile products formed of self-extinguishing, fire resistant textile materials. Once ignited, a self-extinguishing textile product containing one or more continuous sewing threads is not capable of quenching the internal fire because of the existence of a continuous flame ignition source localized along the unbroken sewing threads of the article. That is, as the article begins to burn, burning fabric and yarn material are attracted to the continuous, relatively large diameter, bulky sewing thread forming a flame source circumscribing the sewing thread which propagates the fire to connecting fabric material in a manner similar to the burning of combustible material about an ordinary wick, in this case the continuous thread functioning as a wick although, depending upon specific type of thread construction and fibers present probably not absorbing combustion supporting materials. The only essention characteristic of a sewing thread in order to sustain a flame source is that it is substantially continuous and coextensive with a portion of the fabricated textile structure.

The above is readily apparent with manfactured articles having a significant manmade fiber content because manmade fibers, in general, undergo a distinguishable melting or fusion during decomposition caused by the burning process. As the fibers adjacent to the sewing threads begins to melt, which may occur either before or during ignition depending upon the particular polymeric materials present, individual fiber particles fuse about the central sew-

ing thread forming a burning melt or char which ignites adjacent unburned fabric. The burning process can be sustained as long as the continuous wicklike thread remains in the flame path. Of course, if the fabric has an extremely high fire resistant quotient, the fire may not consume the entire length of fabric coextensive with the thread but will in any event burn a substantially greater portion of material than would be destroyed with comparable unsewn material under comparable environmental conditions. To the observer, the fire appears to creep along the continuous thread consuming surrounding fabric material.

The present invention, by providing textile constructions stitched with meltable sewing threads prevents further transmission of fire throughout the product by destroying continuity of the wick-like thread necessary for maintenance of an internal ignition source. With the employment of a meltable thread, that is a thread liquifiable at or above temperatures generated by fire, e.g., temperatures as low as about 150° C. but generally above about 250° C., the thread is transformed into a flowable, detachable mass which can not act as a focal point for burning fabric material and depending upon the direction of fire's path and position of the sewing threads in relationship to gravitational forces, can accelerate the self-extinguishing process by physically carrying burning fabric portions away from the body of the material. The liquified thread material drips away from the textile structure carrying the thread-focalized point of combustion with it. The above is particularly advantageous with vertically-positioned articles such as drapes, curtains and the like.

The meltable sewing threads of the present invention may be composed of numerous fiber materials which will be obvious to those of skill in the art in view of the present disclosure, i.e., polyester, nylon, acetate, both secondary and triacetate, glass, olefin such as polypropylene, polyurethane such as Spandex, polyvinyl halide, e.g., Vinyon, and the like and blends thereof.

The particular procedure or finish formulation used to impart the flame retardant properties to the textile material is clearly not critical to the present invention. By way of example of chemical classes of compounds which may be employed in flame resistant textile applications, all of which are well known in the art, there may be mentioned phosphorous-containing compounds, such as phosphates, phosphites, phosphinic acids, phosphines, and phosphonium compounds, and nitrogen-containing compounds such as ammonium salts, substituted amines, and anilides. Of particular interest in the art at the present time are the halogenated derivatives of the above-mentioned phosphorous and nitrogen-containing compounds and fire retardants containing both phosphorous and nitrogen atoms either in the same molecule or in synergistic combinations of two or more compounds. As specific examples of fire retardant materials there may be mentioned ammonium phosphate, mixtures of urea and/or thiourea with phosphorous-containing compounds such as tris(1-aziridinyl) phosphine oxide, tris(2 - chloroethyl) phosphate, tris(2,3-dibromopropyl) phosphate, tris(2-ethyl) phosphite, dimethyl hydroxymethylphosphonate, hydrolyzed aminated phosphonitrile chloride, 3-(dimethylphosphono) - propionic acid methylolamide, o-phenylphenyl-bisphenyl phosphate, tricresyl phosphate, triphenyl phosphate and the like. Flame retardant materials may be applied as a coating to textile structures, i.e., fibers such as filaments, multifilaments, stable fibers and spun yarns, woven fabrics, knitted fabrics, nonwoven fabrics and the like; chemically combined with the polymeric fiber-forming materials or associated with textile structures in any manner as long as a flame resistant property is imparted thereto.

The following examples are presented to illustrate the principles and certain of the preferred embodiments of the invention.

EXAMPLE I

This example illustrates the increased flammability of extinguishing fabrics continuously stitched with nonmeltable sewing threads.

Fabric sections 10 inches by 3 inches woven from self-extinguishing acetate yarn containing 4 percent tris(2,3-dibromopropyl) phosphate fire retardant and stitched according to the below "Sample Identification" are secured in three-sided clamps along the top and sides so as to leave a 9½ inch length of fabric vertically held ¾ inch above a bunsen burner positioned under the middle of the width of the lower end of the test fabric. Each fabric section is ignited by means of a 1½ inch flame for 12 seconds after which the bunsen burner flame is extinguished. The fabric is then allowed to continue to burn until self-extinguishment. The char length is determined by measuring perpendicularly from the bottom end of the specimen exposed to the flame to the furthermost point of fabric decomposition, e.g., char or melt.

Sample identification:	(Inches) char length
A	4
B	6.375
C	5
D	7.25
E	6.50

A—unsewn fabric
B—fabric containing 1 vertically sewn thread in approximately center of fabric
C—fabric containing 2 centrally-positioned vertical threads sewn ½ inch apart
D—fabric containing 6 equally-spaced vertical threads sewn ½ inch apart
E—fabric containing 6 equally-spaced horizontal threads sewn ½ inch apart

The thread used in this example is No. 50 white mercerized cotton.

EXAMPLE II

Example I is repeated with one vertical thread of the following materials sewn up the center of the fabric test specimen:

Thread sewn:	Char length (inches)
Acetate 150/40/2Z	3.75
Acetate 150/40/2Z [1]	3.5
Nylon 66 210/102	3.5
Dacron 56 polyester 150/34	3.75
Nomex 100/50 [2]	4.0
Glass 150 denier T/0 1×630	4.0
Polybenzimidazole 280/50—burn entire length.	

[1] 4% tris(2,3-dibromopropyl)phosphate—flame retardant incorporated in thread.
[2] (Polymetaphenylene isophthalamide)—melted under conditions of test.

This example illustrates the decreased flammability of fabrics sewn (in accordance with the invention) with meltable sewing threads. The polybenzimidadole thread did not melt under the test conditions, and, as a result, the flame slowly ascended along the thread line until the entire test fabric material was consumed by the fire. This example also illustrates that the principles of the present invention are equally applicable to sewing threads formed of materials not generally used in the construction of sewing threads as long as the selected thread melts under exposure to elevated temperature produced by fire, i.e., glass.

Considering the selection of the meltable sewing thread in greater detail, the essential determination to be considered is that under fire conditions thread material adjacent the flame fuses into a flowable melt which physically separates from the remainder of the thread material. Many of the manmade fibers, when constructed into sewing threads, demonstrate sufficient fluidity under elevated temperatures either prior or simultaneously with ignition to function satisfactorily as meltable sewing threads.

However, certain of the manmade fibers, exemplified by rayon and modacrylic, either burn without melting or stiffen at elevated temperatures and, therefore are inoperable. The following chart lists certain of the manmade fibers which may be used in the practice of the present invention and their approximate melting temperatures.

Fiber:	Melting range (° F.)
Acetate	500
Triacetate	575
Nylon 66	500
Nylon 6	414 to 428
Olefin (polypropylene)	325 to 335
Polyester	480 to 550
Spandex	446 to 518
Vinyon	260

Other thread materials, as illustrated in the examples, will function satisfactorily in the invention as long as they exhibit the above-described melting property, i.e., glass threads. On the other hand, threads formed from materials such as cotton which do not melt under fire conditions, even if treated with fire resistant formulations, will not arrest the burning process because of the existence of the continuous wicklike thread. This factor is illustrated by the following example.

EXAMPLE III

Example I is repeated with two test specimens, both sewn with a continuous cotton thread, containing 12 percent ammonium bromide up the center of the fabric. Prior to ignition, each stitch of thread sewn in one fabric is cut. The specimen containing the clipped threads does not exhibit increased flammability over test specimen "A" of Example I, but the flame slowly ascends up the other fabric specimen due to the clinging of the burning, molten fabric to the continuous cotton char as illustrated by Example I.

Numerous modifications within the spirit of the invention will appear obvious to those of ordinary skill in the art.

Having thus disclosed the invention, what is claimed is:

1. A process for constructing a sewn, self-extinguishing acetate textile article containing continuous sewing thread which comprises:

(a) producing a plurality of unmanufactured acetate textile structures containing a fire retardant capable of imparting self-extinguishing characteristics thereto; and

(b) constructing said acetate article from said structures by sewing said structures together solely by means of meltable sewing thread in all manufacturing steps involving the use of continuous sewing thread, said thread melting at temperatures produced by the flaming of said article, said thread melting at a temperature above about 150° C.

2. The process of claim 1 wherein said thread melts at a temperature above about 250° C.

3. The process of claim 1 wherein said unmanufactured textile structures are fibers which have been treated with a fire retardant.

4. The process of claim 1 wherein said unmanufactured textile structures are fabrics which have been treated with a fire retardant.

5. The process of claim 1 wherein said fire retardant contains a nitrogen or phosphorous atom.

6. The process as defined in claim 2 wherein the meltable sewing thread is a polyester meltable sewing thread.

7. The process as defined in claim 2 wherein the meltable sewing thread is selected from the group consisting of polyester, nylon, acetate, triacetate, polypropylene, polyurethane and polyvinyl halide meltable sewing threads.

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JAMES R. BOLER, Primary Examiner

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