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HEAT RESISTANT POLYAMIDE STRUCTURE

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This is a continuation-in-part of my copending application, Serial No. 779,208, filed October 10, 1947, now United States Patent No. 2,653,112, dated September 22, 1953.

This invention relates to organic textile structures. More particularly, it relates to a novel polyamide textile structure which resists deterioration by heat.

It is an object of the present invention to provide a polyamide textile structure which has been treated to improve its resistance to deterioration by heat.

Another object is to provide a process for the treatment of a polyamide textile structure to increase its resistance to deterioration by heat.

A further object is to provide a rubber coated polyamide textile structure which possesses resistance to deterioration by heat.

Other objects of the invention will appear hereinafter.

By the term "textile structure" is meant a filament, fiber, staple, floc, yarn, tow, cord, fabric and the like.

The objects of the invention may be accomplished, in general, by intimately associating the polyamide textile structure with fine particles of a readily oxidizable metal so as to provide a textile bearing a metal coating comprising at least about 0.2% based on textile weight. For purposes of this invention, such a metal is one which at temperatures of about 150° C. reacts with both air and water to form alkaline products. These products are in themselves heat-aging inhibitors. The metals preferred for use in the process of this invention are those which have only one positive valence and those whose hydroxides are no more water-soluble than strontium hydroxide. It has been discovered that both moisture and oxygen hasten heat degradation and that when they are acting simultaneously a synergistic effect results. This invention, then, is based upon the removal of both water and oxygen by reaction with a metal. Advantageously, in the removal of degradative materials, as oxygen and water, by the process of this invention, increased useful life of the structure results. The application of the metal particles is conducted so that the resultant structure contains a maximum amount of the particular metal being used. Other factors being equal, for all practical purposes, the degree of increased resistance to deterioration by heat of the structures thus treated will be directly proportional to the amount of metal with which they are coated.

The example, wherein parts are by weight, is illustrative only and is not to be construed as limitative.

Example

Several samples of tire cord prepared by conventional processes from hexamethylene adipamide are heated at 150° C. for 16 hours in sealed tubes containing air and 3.4% moisture. After this treatment, the cords lose about 60% of their original strength. A similar set of samples are coated with an amount of magnesium powder equal to 1% of the weight of the cord by immersing the cords in an agitated slurry of magnesium powder in water.

After similarly aging, the coated samples are observed to have lost appreciably less than 25% of their original strength. An improvement of comparable magnitude is likewise observed when aluminum powder is substituted for magnesium.

A convenient method of coating as illustrated above consists in simply immersing the structure in a liquid medium containing a concentrated suspension of the metal. In such processes, the structure, such as a yarn, in the form of a single strand or a fabric, may be passed continuously through the bath so that a suitable length of the structure is immersed at any instant. The immersion may also be accomplished by simply dipping an entire structure, lor example, a skein, in the suspension and allowing it to remain there for a suitable period of time and thereafter removing excess liquid by centrifugal wringing or other means. If the continuous process is employed, it is important that undue tension upon the yarn be avoided in order to attain the penetration of and hence the greatest stabilizing activity from a given amount of metal. This may be accomplished by running the yarn over a simple system of freely rotating pulleys so as to give a length of yarn of about 30 inches immersed at any instant and being wound up on a mechanically driven reel. The reel is rotated at such a speed that the rate of traverse of the yarn through the bath is about 105 yards per minute and the period of immersion is, therefore, about 0.5 second. Yarn speeds ranging from 10 to 300 yards per minute have been found suitable. After passage through the bath, the yarn is allowed to remain on the reel until dry. Drying may also be accomplished using ovens, contact driers or air drying means. The temperatures for drying may vary from about 70° C. to about 110° C.

Other coating methods may be employed. For example, the metal may be melted in an arc or a flame and then blown as a fine spray onto the structure in any of the well known methods of applying metals to textiles. A satisfactory coating may be obtained by passing a moistened textile structure, particularly one moistened with an innocuous viscous liquid such as a textile lubricant or a rubber adhesive, through a bed of metal powder. In any of the methods, it is preferred to apply the metal to the finished structure to avoid losses which occur in twisting operations. For example, it has been shown that such losses of metal occur when the metal is applied to yarn which is then twisted. The loss of metal which occurs depends, among other factors, upon the degree of subdivision or the metal used and upon the nature of the finish, size or adhesive employed.

The nature of the liquid employed as a suspension medium for the metal particles is not critical. Water, organic liquids, including textile lubricants and sizes are suitable. For example, cyclohexane, benzene and similar liquids may be employed in the immersion baths providing these liquids permit the formation of the desired dispersion of metal. Likewise, it is possible to use an adhesive for rubber as a dispersing medium. Other liquids may be added to such an adhesive to give desired fluidity. The temperature of the suspension may vary over a wide range. Generally, operation at room temperature is satisfactory.

The medium may also contain a finish. The application of finish is not necessary to the heat aging inhibition effect, but is preferred because inter-filament lubrication is obtained which facilitates the obtaining of proper twisting and the desired mobility of the filaments in the final structures. In general, any of the numerous, well-known finishes and sizes for polyamide textile structures may be employed in the baths to obtain better adhesion of the metal. The compositions must not be reactive toward the metals of this invention. Dispersing agents may also be incorporated in the baths to obtain stable dispersion

of the metal. The particular dispersing agent may be chosen from the multitude of well-known dispersants taking into consideration the nature of the size, finish or adhesive in admixture with which the metal is to be applied. While finishes, sizes and peptizing agents are not essential to the process of this invention, they may be used frequently to obtain better uniformity of impregnation and greater adhesion. Generally, it is preferred to use a bath containing about 1.25 to about 1.75% of a finish, about 0.4 to about 0.6% of a size such as polyvinyl alcohol and about 0.4 to about 0.6% of magnesium flake. A bath of this composition when used in the process of this invention will lead to the penetration of multifilament structures such as yarns, fabrics and the like to an extent which effectively protects it for a considerable length of time at high temperatures without loading it excessively.

As pointed out above, the metal may also be applied either immediately previous to or in conjunction with the application of a rubber adhesive in the preparation of useful rubber articles. Thus, it is not necessary to employ an extra size or finish. The rubber adhesive being used in the particular commercial operation may act as a vehicle for the metal flake such as the magnesium flake. The treatment of the threads with a resin latex adhesive may be in the manner of Charch and Maney, U. S. 2,128,635 and the types of adhesives disclosed therein or any other adhesive treatment may be employed in this invention. While the process of this invention is applicable to uncoated structures, it is used chiefly in the preparation of coated structures. The coatings may be prepared from any of the commercially available polymers. It is preferred to use a coating having a low permeability to air and moisture. For the most part such coatings reduce the amount of air and moisture diffusing into the yarn to an amount less than that which may be taken up by the inhibitors. As pointed out above, the process of this invention is particularly useful in the preparation of rubber articles. For instance, a rubber-coated article prepared by subjecting the metal-coated cord to treatment with a rubber latex, results in a coated article having high resistance to deterioration by heat. The conventional coating processes may be used. In the manufacture of automobile tires, such a process is described in U. S. 2,273,200, employing either natural or synthetic rubbers. Other polymers which may be used, among a large number, are vinyl polymers as polyvinyl chloride, polyvinyl acetate, polyvinyl butyral, polyethylene interpolymers of vinyl chloride-vinyl acetate, vinyl chloride-vinyl cyanide, hydrolyzed ethylene vinyl acetate interpolymers, vinylidene chloride interpolymers, rubber hydrochloride, chlorinated rubber, etc.

Any common metal which becomes oxidized with comparative ease at elevated temperatures, for example, about 150° C., and which reacts with water or steam may be employed providing it or its reaction products will not react with the physical structure to deteriorate it. Among such metals may be mentioned magnesium, aluminum, strontium and calcium. It is preferred to use those metals whose hydroxides are not more water-soluble than strontium hydroxide. The reactiveness of alkali metals and barium and the alkalinity of their hydroxides limits their usefulness in this invention. Certain other metals, such as zinc, cadmium, lead and tin, can form peroxides which tend to degrade. Accordingly, it is preferred to use those metals which do not have a variable valence and which do not form peroxides. Of those metals which have only one valence, it is preferred to use magnesium or aluminum, this preference being based upon their chemical reactivity, upon their availability and upon the relative inertness of the metals, their oxides and salt.

The concentration of the metal in the suspension is determined by the extent to which it is desired to coat the textile. Effective results are obtained using concentrations of metal sufficient to deposit upon the textile from 0.2 to about 2.0% by weight of the textile. For reasons of practicality and economy, the preferred concentration is from about 0.5 to about 1.5%.

The increased resistance to deterioration by heat imparted by the processes of this invention to the polyamide structures defined, makes them particularly useful where they are to be subjected to elevated temperatures. For instance, yarn treated according to this invention may be twisted into cord or other materials for use as reinforcement for rubber articles, including motor vehicle tires and steam hose. Such treated yarn will withstand, far better than untreated yarn, deterioration during the manufacture of rubber products involving such operations as vulcanization at elevated temperatures or in use where the products are subjected to elevated temperatures. Also, yarn so treated may in one form or another be woven into fabrics for uses at elevated temperatures, as for example, coverings for laundry mangles and as zinc oxide fume bags.

Among other uses for treated structures of this invention are automobile top materials; masks and protectors around steel furnaces and the like; fabric tubes for discharge ends of chutes for hot materials as in cement mills; bags for heating pads; strainers for hot oil and other non-aqueous materials; belt driers such as on blueprint machines; and conveyor belts for hot materials. In general, this invention may be applied to the manufacture of coated fabrics or similar articles which are exposed to elevated temperatures.

Whereas a polyamide textile structure is ordinarily deteriorated on exposure to heat, the present invention makes possible its treatment so that it possesses a marked stability under such conditions. The use of metal such as aluminum and magnesium is particularly advantageous in that the protective chemical reactions they induce do not occur extensively at low or room temperatures. That is, the metals are retained for use at the high temperatures at which they are needed, no loss of metal or protective action occurring because of consumption of the protecting agent at lower temperatures. Even if the metal is converted to some extent at low temperatures, to its oxide or a salt, such as its carbonate, no loss is sustained since these alkaline products are effective heat age inhibitors. The metal, heat-aging inhibitors of this invention are further advantageous in that they are relatively inexpensive materials and very readily obtainable.

While the invention has been particularly exemplified relative to the polyamide hexamethylene adipamide, it is to be understood that it is applicable as well to polyamides in general such as tetramethylene adipamide, tetramethylene sebacamide, pentamethylene adipamide, pentamethylene sebacamide, heramethylene sebacamide and the like. Such compounds and their methods of preparation are described in U. S. Patents 2,071,250; 2,071,251; 2,071,253; 2,130,948 and 2,190,770.

Since it is obvious that many changes and modifications may be made in the above described details without departing from the nature and spirit of the invention, it is understood that this invention is not limited except as set forth in the appended claims.

What is claimed is:

1. A structure having a polyamide surface and bearing, in intimate contact with the said surface, fine particles of a metal of the class consisting of magnesium, aluminum, strontium and calcium.

2. The structure of claim 1 wherein the polyamide textile structure is a yarn.

3. The structure of claim 1 wherein the metal is aluminum.

4. The structure of claim 1 wherein the metal is magnesium.

5. A textile structure having a polyamide surface and bearing in intimate contact with the said surface, fine particles of a metal of the class consisting of magnesium, aluminum, strontium and calcium, the said textile structure bearing the said particles in contact with its surface being coated with a rubber.

6. The structure of claim 5 wherein the metal is aluminum.

7. The structure of claim 5 wherein the metal is magnesium.

8. The structure of claim 5 wherein the rubber is a natural rubber.

9. The structure of claim 5 wherein the rubber is a synthetic rubber.

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