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3,097,962

GAS PLATING METAL ON FIBERS FOR ANTISTATIC PURPOSES

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2 Claims. (Cl. 117-107)

This application is a division of our application Serial No. 450,539, filed August 17, 1954, and now abandoned.

This invention relates to the treatment of materials such as fabrics, filaments and the like made from organic or inorganic fibers to render the same antistatic. More particularly, the invention is concerned with a method of conditioning a shaped article, for example fiber, film or the like in nonwoven condition or as a fabric, such as clothing, canvas, draperies, paper, etc., to produce a material which does not tend to accumulate electrostatic charges.

It is an object of this invention to treat materials which tend to accumulate electrostatic charges during processing or use to provide the same with a coating or surface layer which prevents the accumulation of electrostatic charges on the material. Such coatings may be either permanent or temporary.

Another object of the invention is to provide a method of treating materials, for example, natural fibers such as cotton, wool, etc., as well as synthetic fibers such as nylon, Dacron, Saran, Vinyon, Velon, Dynel, Orlon and Acrilan in woven or unwoven condition, and products made therefrom, e.g., clothing, drapes and woven or felted industrial articles such as to provide a product which has little or no tendency to accumulate static charges of electricity. The material treated as hereinafter described, can be used in various types of fabricating processes without encountering electrostatic sparking and the hazards and disadvantages ordinarily attending such materials which have not been treated to overcome the tendency to accumulate charges of static electricity.

It is a further object of the invention to provide a treatment whereby an antistatic coating is applied to the material either in a dry or wet state, and wherein the coating eliminates the tendency for the material to build up or accumulate static charges of electricity. The invention is applicable for the treatment of one or more strands of fibers in a roving or woven or felted fabric to provide a product which prevents the accumulation of electrostatic charges on the surfaces of such materials.

These and other objects and advantages will become apparent as the description proceeds.

In accordance with the invention, the fiber, filament, fabric or material to be rendered antistatic is coated uniformly with a very thin film of metal. The coating forms a continuous molecular film of metal. The thickness of the metal film may be on the order of 0.0000001 inch. Such thin metal films not only function to render the filament or fiber thus treated antistatic but such molecular metal films do not change the physical characteristics properties, e.g., flexibility and weaveability of the fibers or filaments. It has also the added advantage that where subsequent removal of the metal film is desired, only a small amount of a reagent is needed.

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The following examples are given as illustrative of the method and product of the present invention, the same being merely exemplary of the invention and not limitative thereof.

Example I

Dynel fibers are subjected to gas plating at reduced atmospheric pressures, utilizing nickel carbonyl $[\text{Ni}(\text{CO})_4]$, to produce a fiber uniformly coated with a thin molecular layer of nickel metal. The resultant metallized fibers are electrically conductive and the fibers can be woven, belted or processed in any desired manner without having a tendency to accumulate static electrical charges.

To restrict the coating metal film to an atomic or molecular thickness, the gaseous plating will be carried out under strict control so that the material will be subjected to gas plating for a time just sufficient to deposit a very thin film of electrically conducting metal on the surface of the material. This is easily accomplished by pre-warming a roving of the fibers and running the same through the plating chamber at high speed. For some fibers, it is not even necessary that the coating or metal film be continuous to secure good antistatic properties.

When using carbonyls in general, and where the fiber or fabric or belting is drawn through the gaseous metal plating chamber, the speed of drawing the material through the gaseous metal plating chamber will be regulated so as to limit the time in which the material is exposed to gaseous metal plating to thus control the thickness of the coating. Ordinarily sufficient metal is deposited on the material to give the material the desired antistatic properties by plating the material so as to deposit a coating film of 0.0000001 inch. Of course, this film thickness may be varied upwardly or downwardly somewhat, depending upon the particular metal deposited and the substrate surfaces.

Example II

In this example, nylon fibers are treated similarly as in Example I using nickel carbonyl. The gaseous plating is conducted at relatively low temperature just sufficient to cause heat decomposition of the nickel carbonyl in the presence of the fiber. Temperatures as low as 325° F. at the nylon surface suffice to give antistatic improvement, even though the core of the monofilament remains relatively cold.

The produce in the form of fibers can then be woven, or formed into a desired material without encountering electrostatic charges on the fibers or material.

Example III

In this example chromium triacetylacetonate is heat decomposed in contact with cotton fibers to deposit chromium oxide thereon and render the same antistatic. The metal oxide confers conductivity like that of metal, apparently as a semi-conductor. The fiber is further processed by being woven into a fabric; the residual chromium triacetylacetonate is then washed out with chloroform.

Example IV

Example III is repeated using woolen fibers in the form of rovings which fibers are gas plated with chromium oxide. After washing the thus treated fibers with chloroform and drying, the resultant fibers may be woven into fabric which exhibits antistatic properties.

Example V

In this example glass fibers are treated with nickel carbonyl so as to provide the same with a thin coating of nickel of approximately molecular thickness. This fiber thus coated is then woven into a glass fiber belt which retains its non-static properties in use.

In the treatment of the fibers the antistatic coating need only be applied to selected areas of the fiber and in an amount sufficient to produce conduction at the surface of the fiber and thus prevent the accumulation of static electricity. One or two coated fibers may be thus treated to render them antistatic and these fibers woven into a pack of roving containing a large number of uncoated fibers to render the whole pack conductive to electricity and thus prevent the building up of static charges of electricity. The product or fiber can then be woven or felted into the desired product while obtaining the beneficial results with respect to the antistatic properties of the fibers.

It is not definitely understood how the coating functions to render the fibers non-static, but is believed that the metals prevent the accumulation of electric charges by acting as a conductor to conduct away the electrical charge.

As aforementioned, where it is not desired or applicable for treating a large bunch of fibers such as in a roving or bolt of the fibers, one or more of the fibers may be selectively treated so as to provide it with a metal coating and thus prevent the entire bolt or roving of fibers from accumulating static, etc. A permanent or temporary antistatic coating may be thus applied to one or more strands of the fibers to produce the desired non-static condition and in this way produces no noticeable alteration of the color or physical properties of the rovings or fabric.

The antistatic treatment is applicable, as aforementioned, through the treatment of filaments, fibers, yarns, film woven, knitted, felted, laid and built-up fibers as in the formation of fabrics and mats. Articles made from such fibers or filaments are also amenable for treatment in accordance with this process. The invention is especially useful in the treatment of thermoplastic and synthetic fibers and fabricated articles from synthetic fibers which have a persistent tendency to build up electrostatic charges during their manufacture or processing.

An important advantage of employing gaseous metal depositions for coating and conditioning materials which have a tendency to accumulate static electrical charges to substantially eliminate this tendency is that a very thin coating of the electrical conducting substance can be laid upon the surface of the material. Thus, for example, by gaseous metal deposition, a thinness averagely represented by an atom or molecular thickness may be effected.

This very thin coating is readily removed after the material has been processed or fabricated to a point where it is not necessary or is not desired to leave the antistatic coating on the fiber or material treated. This is an important advantage where fibers such as synthetic fibers are being processed in the dry state and where it is a decided disadvantage to allow the accumulation of static charges of electricity on the fibers. Where it is desired or is beneficial to leave the antistatic coating on the material, this, of course, is done and thus eliminates the extra step of its removal. In general, the removal of the antistatic coating is unnecessary.

The process of gaseous metal plating utilizing carbonyls and the like as described hereinbefore is carried out similarly as described in the United States Patents 2,344,138 and 2,638,423. The process may be effectively and efficiently carried out by moving the material through a chamber or atmosphere containing the desired metal compound and which is heat decomposable by heating the article to be gas plated with metal in the said atmosphere to a temperature high enough to thermally decompose the metal bearing compound.

Other metals or semiconductors which may be deposited are iron, nickel, cobalt, chromium, molybdenum, tungsten, tellurium, tin, zinc, manganese, thallium, scandium, aluminum, magnesium and the like, or suitable mixtures thereof. Suitable compounds of the metals are used in each case which are heat-decomposed to deposit the metal constituent on the surface to be rendered antistatic.

Illustrative compounds of the carbonyl type are nickel, iron, chromium, molybdenum and cobalt.

Illustrative compounds of other groups are, for example, cobalt nitrosyl carbonyl, hydrides, such as tellurium hydride, antimony hydride, tin hydride, and mixed organometallic hydrides such as dimethyl aluminum hydride, metal alkyls such as aluminum tri-isobutyl, and carbonyl halogens, for example, osmium carbonyl bromide, ruthenium carbonyl chloride, and the like. Rhodium acetylacetonate also may be employed to deposit rhodium. Its use has the advantage that rhodium may be deposited in air, obviating the need for vacuum. For fibers that outgas, this is necessary.

When the metal bearing gases are diluted by inert gases such as carbon dioxide, helium, nitrogen, etc., oxidation is avoided so that deposition of metal on the fibers may be achieved without interruption.

Each material from which metals may be plated has a temperature above which the metal in vapor form is free to deposit as a metal coating. When plating, there is an optimum plating range. For ferrous metal carbonyls from about 350° F. to 450° F. is a preferred range. Decomposition takes place outside this range, but when seeking uniform deposits, it is desirable to operate within the above range and even within the range of about 350° F. to 400° F., where it is desired to plate nickel, iron, cobalt and the like. It is only necessary to heat the fiber surface to a temperature sufficient to cause thermal decomposition of the metal bearing gaseous compound brought in contact therewith.

The above-mentioned temperature range of 350 to 450° F. is also useful for decomposition of the branched-chain compounds. For example, aluminum tri-isobutyl plates out on surfaces at temperatures 250° F. lower than the tri-m-butyl. However, since each type of metal and each type of compound differs in plating range, applicant merely offers the above range for specific embodiments of the invention and not as a limitation upon the operating range.

The terms "fibers" and "yarns" as generally referred to in this application and in the appended claims is intended to include and encompass a single filament, a plurality of filaments, drawn or twisted together in the form of a thread, and which may be either made up of single or multiple threads associated together as by twisting, to produce a thread or multiple threads. Also, these terms connote staple fibers produced from filaments or threads which may be spun into yarn or the like.

It will be understood that while the method has been described and specific coating compositions set forth herein as a preferred form of the invention and its manner of using, modifications obviously can be made without departing from the spirit and scope of the disclosure and that such modifications and substitutions which fall within the scope of the appended claims are to be included herein.

What is claimed is:

1. A method of treating natural and organic synthetic fiber material which has a tendency to accumulate static electrical charges to substantially eliminate this tendency, said method comprising gas plating a coating of metal onto the surface of said fiber material and which consists of a continuous film of an electrical conducting metal, said metal being deposited onto the surface of said fiber material by bringing said metal in the form of a heat decomposable metal compound in contact with said fiber material while heated to a temperature to cause decomposition of said metal compound and deposition of

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the metal onto said fiber material, to form a continuous molecular film of the metal of a thickness which is on the order of 0.0000001 of an inch, said metal being selected from the group consisting of nickel and chromium.

2. A fiber material treated as set forth in claim 1, to provide a fiber which does not tend to accumulate static electric charges.

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