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E. F. SACHARA

2,720,076

COATED FILAMENT AND ARTICLE THEREFROM

Filed Nov. 26, 1952

FIG-1

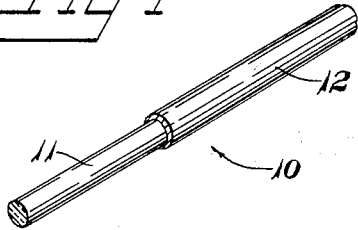


FIG-2

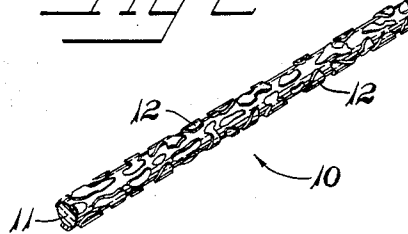


FIG-3

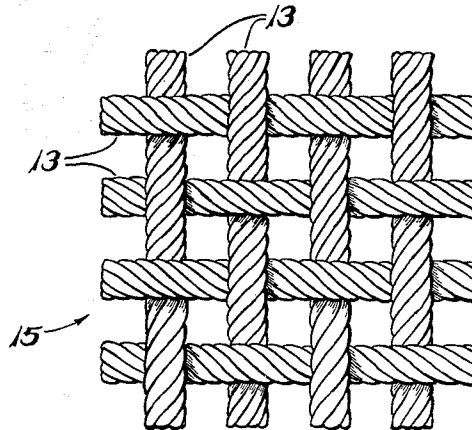
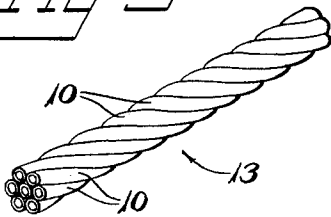


FIG-4

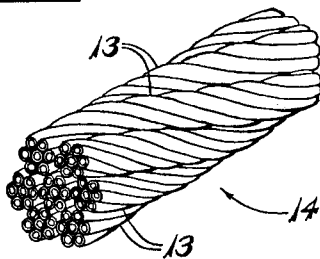


FIG-5

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COATED FILAMENT AND ARTICLE THEREFROM

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20 Claims. (Cl. 57—140)

This invention relates to coated filamentary material and pertains more particularly to flexible coated glass filaments or staple fibers and articles therefrom.

For many years, cotton and wool fibers have been extensively employed in manufactured articles, although it has long been recognized that these materials are not entirely satisfactory for use in numerous manufactured articles because of their inherent low tensile strength and poor durability, particularly at elevated temperatures. As a consequence of the deficiencies inherent in cotton and wool fibers, industry is rapidly substituting artificially made filaments or staple fibers for cotton and wool fibers in many fabricated products. Among those artificially made filaments or staple fibers having physical properties superior to cotton or wool fibers are glass filaments or staple fibers, uncoated glass filaments having been formed which exhibit a tensile strength of over 1,000,000 pounds per square inch, a tensile strength vastly superior to the tensile strength of either cotton or wool fibers. However, even though the physical properties of individual uncoated glass filaments are excellent, it has been found that yarn fabricated from these uncoated glass filaments is relatively weak, it having been observed that upon flexing a yarn of uncoated glass filaments individual filaments of the yarn readily break causing a premature failure of the yarn.

In the copending application of Chester B. Budd, Serial No. 218,108, filed March 29, 1951, it was disclosed that glass filaments or staple fibers having a continuous unitary uninterrupted metal coating over the circumferential face of each filament or staple fiber can be formed into a yarn having properties, particularly flexing properties, vastly superior to those exhibited by a yarn of uncoated glass filaments or staple fibers or of cotton or wool.

It has been observed, however, that certain metals, such as zinc, when in a molten condition, oxidize rapidly in normal atmosphere indicating a desirability to apply the metal coating to the glass filament in an inert medium, such as a nitrogen or helium medium, or in a vacuum substantially free of oxygen. However, many molten metals, for instance zinc, will not satisfactorily adhere to or "wet" a glass surface when applied thereto in a vacuum or in an inert atmosphere, such as a nitrogen or helium medium. It has also been observed that the metal-to-glass adhesion of certain metals to the glass surface of a filament is not as satisfactory as desired for certain applications of metal-coated glass filaments.

I have now found a group of zinc alloys which readily form a coating over the glass surface of a glass filament even when applied in an inert medium, such as a nitrogen or helium medium, an application that is impossible when pure zinc is employed as the coating composition.

Furthermore, the zinc alloys employed in the present invention adhere much more tenaciously to the glass surface of the filament or staple fiber than does pure zinc or other metals and alloys which melt at relatively low temperatures.

Also, the ease with which the zinc alloys of this invention coat a glass filament is much greater as compared to the ease with which other metal compositions coat glass filaments.

To facilitate the teaching of this invention, reference will be made, henceforth, to the specific embodiments hereinafter described; however, it will be understood that I do not intend to limit the scope of this invention to the specific embodiments described since they are intended merely as illustrations of this invention.

In the drawings:

Fig. 1 is an enlarged perspective view partly broken away and in section of a glass fiber embodying this invention;

Fig. 2 is an enlarged perspective view of a second embodiment of this invention;

Fig. 3 is an enlarged perspective view of a glass fiber yarn embodying this invention;

Fig. 4 is an enlarged perspective view of a glass filament cord embodying this invention; and

Fig. 5 is an enlarged plan view of a cloth woven from glass fiber yarn embodying this invention.

Referring to Fig. 1, fiber 10 comprises a flexible elongated glass base member 11 desirably having a diameter small enough to allow several of the glass fibers to be formed into a yarn capable of being fabricated into cloth or cord or the like by processes ordinarily employed in the textile industry. The term "fiber" when used in this specification is intended to include both filaments and staple fibers, a filament being a fiber having a length that exceeds about 16 inches and a staple fiber being a fiber having a length up to about 16 inches. The diameter of base member 11 preferably does not exceed 0.01 inch, since glass fibers having a diameter exceeding 0.01 inch generally are relatively brittle and rigid and, therefore, are not satisfactory for use in yarn or cloth. It is clear that the silicate composition from which base member 11 is formed will vary over a wide range depending upon the chemical and physical properties desired. Glass fibers having desirable characteristics may be obtained from the Owens-Corning Fiberglas Corporation under the name of "Fiberglas."

In accordance with this invention a coating or deposit 12 of an alloy comprising zinc and at least one metal selected from the group of metals consisting of titanium, zirconium, hafnium, vanadium, niobium (columbium) and tantalum is disposed in adherent relationship over the circumferential face of base member 11. As shown in Fig. 1, coating 12 may be a continuous unitary film of the alloy deposited over the entire circumferential face of base member 11 or, as shown in Fig. 2, may consist of a discontinuous or interrupted coating disposed in adherent relationship over the circumferential face of base member 11, such as a coating having a droplet of "bead" formation.

Preferably the zinc alloy from which coating 12 is formed comprises from ½ to 7 per cent by weight of a metal selected from the group consisting of titanium, zirconium, hafnium, vanadium, niobium (columbium) and tantalum, the balance of the alloy composition being zinc, although better results are obtained with alloys of zinc alloyed with from 1 to 2 per cent of titanium, zirconium, hafnium, vanadium, niobium (columbium) or tantalum. Excellent results have been obtained when a zinc-titanium alloy containing from ½ to 7 per cent by weight, preferably from 1 to 2 per cent by weight, titanium is employed in practicing this invention.

When a continuous unitary film of a zinc alloy within the purview of this invention is formed over base member 11, as shown in Fig. 1, it is preferable that the metal coating have a thickness of from two monomolecular layers

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up to 0.01 inch, a thickness of from 0.5×10^{-5} inch to 0.5×10^{-2} inch being even more preferred.

Any method conventionally employed for applying a metal coating to a glass surface may be utilized to form coating 12 over base member 11. However, it is preferable that coating 12 be formed on base member 11 by bringing the glass base member in contact with the zinc alloy from which coating 12 is formed while the alloy composition is in a fluid condition, such as by bringing the base member in contact with the alloy while the alloy is in a molten phase and allowing the coating of molten metal adhering to the glass surface to solidify or by vaporizing the alloy in a vacuum and bringing the base member in contact with the vaporized or gaseous alloy composition to allow condensation of the vaporized metal on the surface of the base member.

The metal coated fibers of this invention may be utilized in several forms. For example, metal coated fibers 10 may be twisted together, employing processes commonly known to the textile industry, to form a yarn 13, as shown in Fig. 3, which may be fabricated into numerous other articles of manufacture, such as cord 14, as shown in Fig. 4, which comprises several strands of yarn 13 twisted together in a conventional manner. Yarn 13 may also be fabricated into a cloth 15, as shown in Fig. 5, by knitting, weaving, braiding or the like, or into a weftless fabric.

The following examples clearly illustrate this invention, however it will be understood that these examples are intended merely as illustrations of this invention and that I do not intend to limit this invention to these specific examples.

Example I

0.000351 inch diameter glass filaments were coated with a zinc-titanium alloy containing 1 per cent by weight titanium. The metal coating was formed over the circumferential faces of the glass filaments by drawing the glass filaments through a molten mass of the zinc-titanium alloy confined in an atmosphere of nitrogen, the filaments being drawn through the molten metal mass at the rate of about 1300 feet/minute. The coating deposited on the surfaces of the glass filaments was a somewhat irregular interrupted deposit having a droplet or beaded formation and adhered so tenaciously to the glass surfaces of the filaments that the coating could not be removed from the glass filaments by mechanical methods without causing portions of glass to be torn from the filaments along with the metallic coating. A pure zinc coating applied to the surface of a glass filament, however, readily can be mechanically removed from the filament with no apparent damage to the glass surface being observed.

Thirty-six of the coated filaments were twisted together to form a thirty-six filament yarn which when flexed through an arc of 150° at a constant rate exhibited a life span vastly superior to that of a yarn comprising thirty-six uncoated glass filaments.

Example II

0.000351 inch diameter glass filaments were coated with a zinc-titanium alloy containing 2 per cent by weight titanium. The alloy was applied to the circumferential faces of the glass filaments by drawing the glass filaments through a molten mass of the alloy confined in a helium atmosphere, the filaments being drawn through the molten mass of metal at the rate of 50 feet/minute. A smooth continuous coating was formed over the entire circumferential face of the filaments which coating adhered tenaciously to the glass surface.

A thirty-six filament yarn formed of these coated filaments when flexed through an arc of 150° at a constant rate exhibited an excellent flex life as compared to a yarn comprising thirty-six uncoated glass filaments.

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Example III

0.000351 inch diameter glass filaments were coated with a zinc-titanium alloy containing 1 per cent by weight titanium by drawing the glass filaments at a rate of 50 feet/minute through a molten mass of the zinc titanium alloy, the coating being applied in an atmosphere of nitrogen. A smooth continuous coating was formed over the entire circumferential faces of the glass filaments. The coating adhered so tenaciously to the glass surface of the filaments that it could not be dislodged mechanically from the glass surface without tearing particles of glass from the surface of the filament.

Thirty-six of these coated filaments were twisted together to form a yarn which when flexed through an arc of 150° at a constant rate exhibited an excellent life span as compared to a thirty-six filament yarn of uncoated glass filaments.

Example IV

0.000351 inch diameter glass filaments were coated with a zinc-titanium alloy containing 1 per cent by weight titanium by drawing the glass filaments at a rate of 50 feet/minute through a molten mass of the zinc-titanium alloy, the coating operation taking place in an atmosphere of air. A smooth continuous layer of the metal alloy was tenaciously formed over the circumferential faces of the filaments.

Thirty-six of these coated filaments were twisted into a yarn which when flexed through an arc of 150° at a constant rate exhibited an excellent life span as compared to a thirty-six filament yarn of uncoated glass filaments.

Coated filaments or staple fibers within the purview of this invention adhere tenaciously to binder materials, such as rubber, and a yarn formed of these filaments has excellent tensile strength and durability enabling the yarn to be formed into cloth or into cord, the cloth or cord being particularly useful as a reinforcing material for articles subjected to severe flexure such as tires or conveyor and transmission belts and the like.

Also, yarns fabricated of filaments or staple fibers within the purview of this invention do not readily absorb moisture, nor will they shrink. The yarns, furthermore, are not susceptible to mildew deterioration.

The alloy coatings employed in practicing this invention adhere so tenaciously to the glass surface of the glass filament that they can not be removed by mechanical means without tearing particles of glass from the coated surface of the glass filament, a metal-to-glass bond not experienced when other metals or metal alloys are employed to coat the glass fiber.

The metal alloys employed in the present invention possess the unusual property of being capable of "wetting" or coating glass in an inert atmosphere, such as an atmosphere of nitrogen or helium, a method of application heretofore unknown.

While I have herein disclosed a few specific embodiments of this invention, it is clear that obvious variations and modifications of this invention may be made without departing from the spirit and scope of this invention as defined in the appended claims.

I claim:

1. A flexible fiber comprising a glass base member and a metal coating of an alloy comprising zinc and a metal selected from the group consisting of titanium, zirconium, hafnium, vanadium, niobium and tantalum disposed in adherent relationship over the circumferential face of said base member, said alloy adhering tenaciously directly to the glass base member so that the alloy can not be removed from the glass base member by mechanical methods without causing damage to the glass base member.

2. A flexible staple fiber comprising a glass base member and a metal coating of an alloy comprising zinc and a metal selected from the group consisting of titanium, zirconium, hafnium, vanadium, niobium and tantalum

9. A flexible filament comprising a glass base member and a discontinuous metal coating of an alloy comprising zinc and a metal selected from the group consisting of titanium, zirconium, hafnium, vanadium, niobium and tantalum disposed in adherent relationship over the entire circumferential face of said base member, said alloy adhering tenaciously directly to the glass base member so that the alloy can not be removed from the glass base

16. A flexible yarn comprising flexible glass fibers individually coated with a metal alloy comprising zinc and titanium, said coating of metal alloy on each individual metalized glass fiber adhering tenaciously directly to the individual glass fiber so that the coating can not

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be removed from the glass fiber by mechanical methods without causing damage to the glass fiber, the metal coating disposed over an individual glass fiber of said yarn maintaining said glass fiber essentially free from glass-to-glass contact with adjacent glass fibers of said yarn.

17. A flexible yarn comprising flexible glass fibers individually coated with a continuous unitary layer of metal alloy disposed in adherent relationship over the entire circumferential face of the glass fiber, said metal alloy comprising zinc and titanium, said coating of metal alloy on each individual metalized glass fiber adhering tenaciously directly to the individual glass fiber so that the coating can not be removed from the glass fiber by mechanical methods without causing damage to the glass fiber, the metal coating disposed over an individual glass fiber of said yarn maintaining said glass fiber essentially free from glass-to-glass contact with adjacent glass fibers of said yarn.

18. A flexible yarn comprising flexible glass fibers individually coated with a discontinuous layer of metal alloy disposed in adherent relationship over the entire circumferential face of the glass fiber, said metal alloy comprising zinc and titanium, said coating of metal alloy on each individual metalized glass fiber adhering tenaciously directly to the individual glass fiber so that the coating can not be removed from the glass fiber by mechanical methods without causing damage to the glass fiber, the metal coating disposed over an individual glass fiber of said yarn maintaining said glass fiber essentially free from glass-to-glass contact with adjacent glass fibers of said yarn.

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19. A flexible cord of yarn comprising flexible glass fibers individually coated with a metal alloy comprising zinc and a metal selected from the group consisting of titanium, zirconium, hafnium, vanadium, niobium and tantalum, said coating of metal alloy on each individual metalized glass fiber adhering tenaciously directly to the individual glass fiber so that the coating can not be removed from the glass fiber by mechanical methods without causing damage to the glass fiber, the metal coating disposed over an individual glass fiber of said yarn maintaining said glass fiber essentially free from glass-to-glass contact with adjacent glass fibers of said yarn.

20. The method of making a flexible fiber comprising providing a flexible glass base member and coating said glass base member in an inert atmosphere with a metal alloy in a fluid phase comprising zinc and a metal selected from the group consisting of titanium, zirconium, hafnium, vanadium, niobium and tantalum.

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