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YARNS OF STAPLE GLASS FIBERS AND COMPOSITIONS AND METHODS FOR MANUFACTURING SAME

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This invention relates to the use of staple glass fibers in the manufacture of fibrous structures, such as reinforced plastics and coated fabrics, and it relates more particularly to the treatment of staple glass fibers, preferably in connection with the forming operation, by the application of the equivalent of a size composition to improve the processing characteristics of the fibers in the formation of yarns of staple glass fibers and which functions, in addition, to improve the bonding relation between the yarn of staple glass fibers with resinous materials combined therewith in the manufacture of coated fabrics and reinforced plastics.

It has been found, in practice, that the characteristics demanded of a size composition applied to glass fiber surfaces differ greatly depending upon the type of fiber and its method of manufacture. Most experience has been secured in the treatment of continuous fibers of the type formed by rapid attenuation of hundreds of molten streams of glass issuing from a single bushing and collected into a bundle to form strands. The size composition applied to the individual filaments as they are gathered together to form the strand is adapted to provide a desired balance between lubricity and bonding sufficient to enable a limited amount of relative movement between the filaments while holding the filaments together in the strand since it is unnecessary to account for any substantial amount of relative movement between the filaments once they have been gathered together in the strand.

On the other hand, the basic concepts in the manufacture of yarns of staple glass fibers, as described in the Tucker et al. Patent No. 2,264,345, issued December 2, 1941, requires substantial movement between the fibers. In the processes which have been developed for the manufacture of yarns of staple glass fibers, the glass fibers in forming are collected in interfelted relation on the peripheral surface of a rotating drum and gathered together for removal from the drum as an endless sliver which is then drafted lengthwise, by as much as 300 percent, with various twisting operations to form a yarn in which the fibrous elements are arranged in substantial lengthwise alignment.

To cause the drafting of the sliver to provide for uniform movement of the fibrous elements throughout the length of the sliver for uniform fiber distribution and to protect the glass fibers against destruction, as by mutual abrasion, it is important to treat the glass fibers with a composition which permits substantial amounts of relative movement between the fibers but in balance with a certain amount of drag which makes drafting possible with glass fibers in the manufacture of yarns.

Size compositions which have been developed for use in the manufacture of strands, yarns, and fabrics of continuous glass fibers have been found, in general, to be incapable of providing the desired processing and performance characteristics for the manufacture of yarns and fabrics of staple glass fibers.

The development of the desired lubricity to permit the fibers to shift lengthwise relative to each other in drafting without destruction of the fibers is not particularly difficult to achieve. However, the development of the desired balance between lubricity and drag presents a fairly difficult problem. Such problems do not exist in the draft-

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ing of slivers formed of cotton fibers, wool fibers, silk fibers or alpha-cellulose fibers and the like, because these fibers tend to cling to one another for development of the desired drag characteristics between themselves for use in the formation of staple yarns having the desired characteristics.

Glass fibers of the staple type, on the other hand, are entirely unlike these natural fibers since they do not embody the fibrillae by which one fiber tends to cling to another. Instead, staple glass fibers exist in the form of round rod-like members of relatively short lengths having perfectly smooth and hard surfaces which do not tend to cling to one another and are, therefore, incapable of developing the desired drag by themselves. Thus, peculiar only to glass fibers of the staple type, as distinguished from continuous glass fibers or natural fibers, it becomes necessary to rely upon a treatment applied to the surfaces of the staple glass fibers to impart such characteristics which enable the sliver to be drafted into yarns and worked into fabrics.

In the past, the treatment of glass fibers of the staple type to provide the desired characteristics for yarn formation has been considered as a problem separate and apart from and completely distinct from the treatment of such staple glass fibers to enhance their performance characteristics with reference particularly to their use in combinations with resinous materials in the manufacture of bonded structures, reinforced plastics, or coated fabrics. Usually the materials applied to the surfaces of the staple glass fibers to enhance yarn formation have been somewhat antagonistic toward the development of a strong bonding relation between the staple glass fibers and the resinous materials used in combinations therewith.

As a result, it has been difficult to achieve full utilization of the strength properties and many of the other desirable properties available from glass fibers. In some applications where strength is of primary importance, it has been necessary to remove the treating composition originally applied to the surfaces of the staple glass fibers subsequent to yarn formation so as to enable the development of improved bonding characteristics between the glass fibers and the resinous materials employed in combinations therewith.

It is conceivable that the development of a size composition capable of being applied to the glass fibers of the staple type and which would provide the desired balance between lubricity and drag for the development of the desired processing characteristics in yarn formation and which would concurrently provide a receptive base for establishing a strong bonding relation between resinous materials and the glass fiber surfaces, would represent a significant advance in the technology of glass fibers. Such development would make glass fibers available for use in combinations with resinous materials for the production of improved and lower cost fibrous structures and with a fuller utilization of the strength properties available from the glass fibers. It is an object of this invention to achieve this ultimate goal.

Another object of this invention is to produce improved yarns of staple glass fibers and to provide a method and a composition for use in the manufacture of same.

More specifically, it is an object of this invention to produce yarns of staple glass fibers in which the fibers are treated in advance of yarn formation with a size composition capable of providing a desired balance between drag and lubricity, which improves the performance characteristics of the glass fibers in the use thereof for the manufacture of fibrous structures, which improves the bonding relationship between the staple glass fibers and resinous materials employed in combinations therewith in the manufacture of reinforced plastics, which

protects the glass fibers against destruction by forces of abrasion, and which generally improves the processing and performance characteristics of the staple glass fibers in the manufacture of yarns, fabrics and the like.

In accordance with the practice of this invention, the desired processing and performance characteristics are made available in staple glass fibers treated with a composition formulated of the following ingredients prior to formation of the staple glass fibers into yarns:

Example 1

5.0-25.0 percent by weight of an ethylene oxide-propylene oxide copolymer

25.0-5.0 percent by weight tricresyl phosphate

0.1-5.0 percent by weight alkylaryl polyether alcohol

0.1-9.0 percent by weight vinyl trichlorosilane

69.8-36.0 percent by weight water

In compounding the size composition, the ethylene oxide polymer is introduced into a mixing vessel. The tricresyl phosphate and the alkylaryl polyether alcohol are added and then the water is introduced slowly with agitation to disperse the materials in the aqueous medium. Instead of adding the water to the mixture of the described ingredients the ingredients can be added slowly to the water with mixing to achieve equivalent results. The vinyl trichlorosilane is added to the aqueous mixture slowly with agitation and it is preferred continuously to agitate the composition in use in order to maintain the desired uniformity in the distribution of the materials.

The size composition may be applied to the staple glass fibers as they are deposited on the periphery of the rotating drum but it is preferred to apply the size composition onto the glass fiber surfaces after the fibers are gathered together into a sliver and stripped from the periphery of the drum for twisting and drafting to form the endless yarn. The size composition applied to the glass fiber surfaces in the formation of the yarns of staple glass fibers may be allowed to air dry while the yarns are wound upon a collecting drum or the like. If desirable, the drying operation to set the size as a coating on the glass fiber surfaces may be accelerated by advancing the yarn through an air circulating oven prior to winding upon a suitable drum for subsequent use in the manufacture of fabrics or reinforced plastics. It is believed that the silane hydrolyzes in the aqueous medium to the corresponding silanol which remains soluble in the aqueous medium when the silane is carefully combined with water sufficient to take up the heat of reaction.

In practice, it is desirable to apply the size composition in amounts to provide coating weights within the range of 0.5 to 10.0 percent by weight. When applied in such amounts, the endless sliver embodies the desired lubricity and drag characteristics which enable the sliver to be drafted by as much as 30 to 150 or 300 percent without deterioration of the fibers. At the same time, the fibers tend to cling to one another through the medium of the coating composition and develop sufficient drag to prevent complete separation. As a result, relative movement between the fibers remains substantially uniform throughout the lengths of the sliver to enable the production of yarns in which the cross section is greatly reduced but which retains a substantially uniform concentration of fibers in cross section.

Upon drying, the applied composition functions as an anchoring agent on the glass fiber surfaces to improve the bonding relation with resinous materials. This is to be distinguished from the tendency for the coatings heretofore employed to repel resinous materials and prevent wetting out of the glass fiber surfaces with a resultant lessening in the bonding relationship and loss in strengths capable of being developed by the presence of the glass fibers.

The exact basis for the development of the described improvements in processing characteristics simultaneous-

ly with the improvement in the performance characteristics by treatment with a single composition is incapable, for the present, of being accurately set forth. It is believed that the desired characteristics result, in part, from a combination of factors including the use of the ethylene oxide polymer as a lubricating material which differs from the oils heretofore employed since the latter are somewhat non-receptive to resinous materials while the ethylene oxide polymers appear to be more resinophilic in character. An additional factor is believed to reside in the use of unsaturated polysiloxane which is capable of strong anchorage through the organo silicon atoms to the glass fiber surfaces and which has unsaturated groups within the organic group attached directly to the silicon atom which are highly receptive to groups existing in most, if not all, of the resinous materials generally used in combinations with glass fibers.

Another factor of possible significance resides in the compatibility which appears to exist between the components of the coating formed by the size composition or the ability of these materials to integrate themselves closely with the applied resinous materials either by solution, or by compatibility, or by molecular orientation. Whatever the reason, it has been established that staple glass fibers treated in the manner described are capable of developing a strong bonding relationship with applied resinous materials, especially such resinous materials as are formed by addition polymerization through ethylenic groups, such as the unsaturated polyesters. This strong bonding relationship which is capable of being developed results in the fuller utilization of the desirable properties of the glass fibers and the development of high strength, resinous bonded materials. The bonding relationship developed appears to be unaffected by high humidity conditions such as is characterized by the tremendous loss in strength in resinous treated fabrics and plastics of the type heretofore produced.

Instead of the ethylene oxide-propylene oxide copolymer, such as marketed under the trade name "Ucon Lubricant LD 65," by the Carbide & Carbon Chemicals Company, use may be made of other water soluble polyether polymers such as the ethylene oxide polymers, polyethylene glycols, polypropylene glycol polymers and mixtures thereof, such as the Carbowax materials marketed by Carbide & Carbon Chemicals Company, fatty acid ester-ethylene oxide condensates and polyvinyl ethers, such as polyvinyl methyl and polyvinyl butyl ethers. Such materials may be substituted in whole or in part for the ethylene oxide-propylene oxide copolymer in the formulation of Example 1.

The vinyl trichlorosilane may be replaced in the above formulation by other water soluble or water dispersible coupling agents such as other organo silicon compounds having organic groups attached directly to the silicon atom containing a highly functional group, such as an unsaturated carbon to carbon linkage of the type capable of addition polymerization or other functional groups of the type described in the Steinman Patent No. 2,552,910. These include organic groups containing amino groups, groups having a high dipole moment, groups having a labile hydrogen atom, groups having a highly negative group adjacent an alpha hydrogen atom and the like, wherein the organic radical wherein such functional groups are present are formed with less than 8 carbon atoms in straight chain arrangement. Representative of organo silicon coupling agents are vinyl triacetoxysilane, vinyl trichloro silane, beta-amino ethyl trichloro silane, or the reaction products of vinyl or allyl trichloro silane with catechol, resorcinol or hydroquinone. Use may also be made of the chromic complex compounds of the Werner type in which the acido group coordinated with the trivalent nuclear chromium atom contains less than 8 carbon atoms in straight chain arrangement and in which the acido group contains a highly functional group of the type previously described. Methacrylate chromic

chloride is representative of a suitable coupling agent of the Werner type.

The tricresyl phosphate may be replaced in whole or in part by other suitable conventional plasticizers, such as glycerol phosphate, glycol phosphate, glycol titanates, such as octalene glycol titanate, and the like.

The function of the alkylaryl polyether alcohol is primarily that of an emulsifying agent for the coating composition. For this purpose, use may be made of many other water soluble non-ionic emulsifying materials, including polyhydric alcohol esters of high molecular weight mineral organic acids (Advanet NA-6—Advance Solvent & Chemical Corporation), amino fatty acid esters, sorbitan sesquioleate, alkyd amido alcohols, mixed fatty acid alkinolamines, sorbitan monolaurate, monostearate, monooleate or trioleate (Span 20, 60, 80 and 85, respectively, of Atlas Powder Company), polyoxyethylene ethers, sorbitan monolaurate polyoxyethylene derivatives and sorbitan monopalmitate polyoxyethylene derivatives, sulfonated mineral oils, sulfonated fatty acid derivatives, and the like.

The following additional examples of treating compositions embodying features of this invention are given by way of illustration, but not by way of limitation:

Example 2

10.0 percent by weight ethylene oxide-propylene oxide copolymer
5.0 percent by weight tricresyl phosphate
0.5 percent by weight alkylaryl polyether alcohol
1.0 percent by weight vinyl triacetoxysilane
83.5 percent by weight water

Example 3

25.0 percent by weight ethylene oxide polymer
5.0 percent by weight tricresyl phosphate
3.0 percent by weight non-ionic emulsifier (polyhydric alcohol ester of high molecular weight mineral organic acids)
3.0 percent by weight vinyl triacetoxysilane
64.0 percent by weight water

Example 4

5.0 percent by weight ethylene oxide-propylene oxide copolymer (Ucon LB-65)
5.0 percent by weight glycol titanate
1.0 percent by weight sorbitan sesquioleate emulsifying agent
2.0 percent by weight allyl trichlorosilane
87.0 percent by weight water

Example 5

5.0 percent by weight polyethylene glycol (Carbowax 1000)
25.0 percent by weight tricresyl phosphate
3.0 percent by weight alkylaryl polyether alcohol
3.0 percent by weight vinyl trichlorosilane
64.0 percent by weight water

Example 6

10.0 percent by weight ethylene oxide-propylene oxide copolymer
5.0 percent by weight glycol phosphate
0.5 percent by weight amino fatty acid ester (emulsifying agent)
0.5 percent by weight methacrylate chromic chloride
84.0 percent by weight water

Example 7

10.0 percent by weight ethylene oxide-propylene oxide copolymer (Ucon LB-65)
5.0 percent by weight tricresyl phosphate (Lindol LH)
0.5 percent by weight alkylaryl polyether alcohol (Triton X100)
9.0 percent by weight methacrylate chromic chloride
75.5 percent by weight water

Example 8

10.0 percent by weight stearic acid-ethylene oxide condensate having more than 8 ethylene oxide molecules per molecule of fatty acid
5.0 percent by weight plasticizer
0.5 percent by weight non-ionic emulsifying agent
0.3 percent by weight vinyl trichlorosilane
84.2 percent by weight water

Example 9

10.0 percent by weight ethylene oxide-propylene oxide copolymer (Ucon LB-65)
5.0 percent by weight tricresyl phosphate
0.5 percent by weight alkylaryl polyether alcohol
1.0 percent by weight beta-amino ethyl trichlorosilane
83.5 percent by weight water

Example 10

5.0 percent by weight ethylene oxide-propylene oxide copolymer
5.0 percent by weight plasticizer
3.0 percent by weight emulsifying agent
3.0 percent by weight of the reaction product of allyl trichlorosilane and catechol
84.0 percent by weight water

Compounding procedures and methods of applications of the above compositions are similar to that described with reference to Example 1. The treated glass fibers are preferably processed into yarns by drafting and twisting the sliver of fibers as soon after the coating composition is applied as possible and preferably before the size composition has had an opportunity to dry substantially on the glass fiber surfaces.

When the coating composition has become set on the glass fiber surfaces, the coating that remains is capable of protecting the glass fibers against destruction by abrasion while sufficient lubricity remains to permit twisting and weaving and the like processing operations into intertwisted yarns and woven fabrics.

The coating formed on the glass fiber surfaces is preferentially received by the glass fiber surfaces so that the coating is not displaced by the usual moisture film that forms when resinous coated glass fibers are exposed to high humidity conditions. When combined with resinous materials in the manufacture of laminates, reinforced plastics or coated fabrics, such as phenol-formaldehyde resins, urea-formaldehyde resins, melamine-formaldehyde resins, and preferably with unsaturated polyester resins, the resinous materials in an intermediate stage of polymeric growth are able substantially completely to wet out the coated glass fibers and to become strongly integrated therewith by physical or by chemical attraction. The bonding relation developed between the treated glass fiber surfaces and the applied resinous materials is sufficient to resist interference by a moisture film under high humidity conditions with the result that the wet strength of the product is not appreciably lower than the strength of the product under dry conditions.

The described relationship is developed most effectively in a system wherein the coupling agent is formed with an unsaturated carbon to carbon linkage in an aliphatic group of short carbon length (less than 8) and when the resinous material combined with the treated glass fibers is formed by polymerization through ethylenic groups, such as represented by the unsaturated polyesters.

It will be understood that changes may be made in the details of formulation, application and treatment of the glass fibers and the manner of their incorporation with resinous materials in the manufacture of reinforced plastics, laminates and coated fabrics, without departing from the spirit of the invention, especially as defined in the following claims.

We claim:

1. Staple glass fibers and a coating on the staple glass fiber surfaces for improving the processing characteristics of the glass fibers when formed into yarns and for improving the bonding relationship of the glass fiber surfaces when combined with resinous materials, consisting essentially of 5-25 parts by weight of a water soluble polyether polymeric lubricant, 25-5 parts by weight of a plasticizer, 0.1-5.0 parts by weight of a non-ionic surface active agent and 0.1-9.0 parts by weight of an anchoring agent selected from the group consisting of an organo silane having an organic group attached directly to the silicon atom containing a functional group within a group formed of less than 8 carbon atoms in straight chain arrangement, its hydrolysis product and its condensation reaction product, and a Werner complex compound in which an acido group coordinated with the trivalent nuclear chromium atom contains a highly functional group within a group formed of less than 8 carbon atoms in straight chain arrangement.

2. Staple glass fibers as claimed in claim 1 in which the anchoring agent is the reaction product of catechol and the silane, its hydrolysis product and condensation reaction product.

3. Staple glass fibers as claimed in claim 1 in which the coating composition is present on the glass fiber surfaces in amounts ranging from 0.5-10 percent by weight.

4. Staple glass fibers as claimed in claim 1 in which the anchoring agent is a compound in which the highly functional group in the organic group of the anchoring agent is represented by an unsaturated carbon to carbon linkage capable of addition polymerization.

5. Staple glass fibers as claimed in claim 4 in which the anchoring agent is vinyl trichlorosilane.

6. Staple glass fibers as claimed in claim 4 in which the anchoring agent is vinyl trialkoxysilane.

7. Staple glass fibers as claimed in claim 4 in which the anchoring agent is methacrylate chromic chloride.

8. Staple glass fibers and a size on the glass fiber surfaces to improve their processing and performance characteristics when formed into yarns and when combined with resinous materials, consisting essentially of 5-25 parts by weight of a water soluble polyethylene oxide polymer, 25-5 parts by weight of a plasticizer, 0.1-5.0 parts by weight of a non-ionic surface active agent and 0.1-9.0 parts by weight of an anchoring agent selected from the group consisting of an organo silicon compound having an organic group attached directly to the silicon atom containing a functional group within a group formed of less than 8 carbon atoms in straight chain arrangement, its hydrolysis product and its condensation reaction product, and a Werner complex compound in which an acido group coordinated with the trivalent nuclear chromium atom contains a highly functional group within a group formed of less than 8 carbon atoms in straight chain arrangement.

9. Staple glass fibers and a size on the glass fiber surfaces to improve their processing and performance characteristics when formed into yarns and when combined with resinous materials, the ingredients of said size consisting essentially of 5-25 parts by weight of a water soluble ethylene oxide-propylene oxide copolymer, 25-5 parts by weight of a plasticizer, 0.1-5.0 parts by weight of a non-ionic surface active agent and 0.1-9.0 parts by weight of an anchoring agent selected from the group consisting of an organo silicon compound having an organic group attached directly to the silicon atom containing a functional group within a group formed of less than 8 carbon atoms in straight chain arrangement and a Werner complex compound in which an acido group coordinated with the trivalent nuclear chromium atom contains a highly functional group within a group formed of less than 8 carbon atoms in straight chain arrangement.

10. Staple glass fibers and a size on the glass fiber

surfaces to improve their processing and performance characteristics when formed into yarns and when combined with resinous materials, said size being formulated of 5-25 parts by weight of a water soluble fatty acid ester-ethylene oxide copolymer, 25-5 parts by weight of a plasticizer, 0.1-5.0 parts by weight of a non-ionic surface active agent and 0.1-9.0 parts by weight of an anchoring agent selected from the group consisting of an organo silicon compound having an organic group attached directly to the silicon atom containing a functional group within a group formed of less than 8 carbon atoms in straight chain arrangement and a Werner complex compound in which an acido group coordinated with the trivalent nuclear chromium atom contains a highly functional group within a group formed of less than 8 carbon atoms in straight chain arrangement.

11. Staple glass fibers and a size on the glass fiber surfaces to improve their processing and performance characteristics when formed into yarns and when combined with resinous materials in which the ingredients of the size consist essentially of 5-25 parts by weight of a water soluble polyvinyl ether lubricant, 25-5 parts by weight of a plasticizer, 0.1-5.0 parts by weight of a non-ionic surface active agent and 0.1-9.0 parts by weight of an anchoring agent selected from the group consisting of an organo silicon compound having an organic group attached directly to the silicon atom containing a functional group within a group formed of less than 8 carbon atoms in straight chain arrangement and a Werner complex compound in which an acido group coordinated with the trivalent nuclear chromium atom contains a highly functional group within a group formed of less than 8 carbon atoms in straight chain arrangement.

12. Yarns of staple glass fibers in which the fibers are oriented lengthwise one with the other in the yarn and in which the fibers in the yarn are coated with a composition the ingredients of which consist essentially of 5-25 parts by weight of a water soluble polyether polymeric lubricant, 25-5 parts by weight of a plasticizer and 0.1-9.0 parts by weight of an anchoring agent selected from the group consisting of an organo silicon compound having an organic group attached directly to the silicon atom containing a functional group within a group formed of less than 8 carbon atoms in straight chain arrangement and a Werner complex compound in which an acido group coordinated with the trivalent nuclear chromium atom contains a highly functional group within a group formed of less than 8 carbon atoms in straight chain arrangement.

13. In a resinous system reinforced with yarns of staple glass fibers, the improvement which comprises a coating on the glass fiber surfaces formulated of ingredients consisting essentially of 5-25 parts by weight of a water soluble polyether polymeric lubricant, 25-5 parts by weight of a plasticizer, 0.1-5.0 parts by weight of a non-ionic surface active agent and 0.1-9.0 parts by weight of an anchoring agent selected from the group consisting of an organo silicon compound having an organic group attached directly to the silicon atom containing a functional group within a group formed of less than 8 carbon atoms in straight chain arrangement and a Werner complex compound in which an acido group coordinated with the trivalent nuclear chromium atom contains a highly functional group within a group formed of less than 8 carbon atoms in straight chain arrangement, and in which the coating is present within the range of 0.5-10 percent by weight of the glass fibers.

14. In the method of treating staple glass fibers to improve their processing and performance characteristics in which the glass fibers are formed into slivers, drafted and twisted into yarns, and combined with resinous materials in the manufacture of coated fabrics and reinforced plastics, the improvement which comprises coating the glass fibers prior to drafting with a composition consisting essentially of 5-25 percent by weight of a

water soluble polyether polymeric lubricant, 25-5 percent by weight of a plasticizer, 0.1-5.0 percent by weight of a non-ionic surface active agent, 0.1-9.0 percent by weight of an anchoring agent selected from the group consisting of an organo silane compound having an organic group attached directly to the silicon atom containing a functional group within a group formed of less than 8 carbon atoms in straight chain arrangement, its hydrolysis product and its condensation reaction product, and a Werner complex compound in which an acido group coordinated with the trivalent nuclear chromium atom contains a highly functional group within a group formed of less than 8 carbon atoms in straight chain arrangement, the remainder being water.

15. The method as claimed in claim 14 in which the water soluble polyether polymeric lubricant comprises an ethylene oxide-propylene oxide copolymer.

16. The method as claimed in claim 14 in which the silane comprises vinyl triacetoxysilane.

17. The method as claimed in claim 14 in which the silane comprises vinyl trichlorosilane.

18. The method as claimed in claim 14 in which the anchoring agent comprises methacrylate chromic chloride.

19. The method as claimed in claim 14 in which the size composition is applied in amounts to provide a coating weight in the range of 0.5-10 percent by weight of the glass fibers.

20. A size composition applied to staple glass fibers for improving the processing characteristics of the fibers

in the formation of yarns thereof and to improve the bonding relation when the glass fibers are combined with resinous materials in which the size composition consists essentially of 5-25 percent by weight of a water soluble polyether polymeric lubricant, 25-5 percent by weight of a plasticizer, 0.1-5.0 percent by weight of a non-ionic surface active agent, and 0.1-9.0 percent by weight of an anchoring agent selected from the group consisting of an organo silicon compound having an organic group attached directly to the silicon atom containing a functional group within a group formed of less than 8 carbon atoms in straight chain arrangement and a Werner complex compound in which an acido group coordinated with the trivalent nuclear chromium atom contains a highly functional group within a group formed of less than 8 carbon atoms in straight chain arrangement, the remainder being water.

References Cited in the file of this patent

UNITED STATES PATENTS

2,258,219	Rochow	Oct. 7, 1941
2,392,805	Biefeld	Jan. 15, 1946
2,513,268	Steinman	June 27, 1950
2,530,635	Sowa	Nov. 21, 1950
2,552,910	Steinman	May 15, 1951
2,729,582	Modigliani	Jan. 3, 1956
2,744,835	Caroselli	May 8, 1956
2,780,909	Biefeld et al.	Feb. 12, 1957
2,801,189	Collier	July 30, 1957
2,846,348	Marzocchi et al.	Aug. 5, 1958