THERMOPLASTIC POLYMER YARNS AND FILMS INCLUDING DRY LUBRICANTS AND INDUSTRIAL TEXTILES MADE THEREFROM

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ABSTRACT

An extruded oriented thermo-plastic polymeric element for industrial textiles, and textiles comprising polymeric elements. The polymeric elements are constructed of a material selected from yarn material, fiber material and film, and comprise a thermoplastic polymer, and at least one dry lubricant, selected from molybdenum disulphide, tungsten disulphide, boron nitride, and a soft metal, the dry lubricant comprising particulate matter having an average particle size between about 0.05μ and about 100μ, and present in the polymeric element in an amount from between about 0.1% and about 10% parts by weight, based on a total weight of the polymeric element. The polymeric elements can be used as yarns in woven and non woven textiles, and as seaming elements. The polymeric elements provide increased abrasion resistance in industrial textiles, and reduced co-efficient of friction.
FIGURE 2

Graph showing Tensile Loss (%) vs. No. of Cycles.
THERMOPLASTIC POLYMER YARNS AND FILMS INCLUDING DRY LUBRICANTS AND INDUSTRIAL TEXTILES MADE THEREFROM

FIELD OF THE INVENTION

[0001] The present invention concerns oriented, thermoplastic polymer elements, including yarns, fibers and films which offer increased resistance to abrasion and provide a reduction in the frictional characteristics in industrial textiles into which they are incorporated. Specifically the invention concerns oriented thermoplastic polymer elements into which dry lubricants such as particles of molybdenum disulphide, boron nitride or tungsten disulphide have been incorporated in amounts of from about 0.1% to about 10% by weight based on the total weight of the elements, and woven or nonwoven fabrics made from or incorporating the elements.

BACKGROUND OF THE INVENTION

[0002] Industrial textiles (also referred to as technical textiles) are used in many consumer and industrial applications, either as a component of the end product, or in the manufacture of one or more components. These textiles are typically woven structures made from polymeric yarns comprising a polyester, polypropylene, polamid, polyethylene, glass fibers or other similar materials; they may also be nonwoven structures assembled from films, staple fibers, encapsulated yarn arrays and similar components such as are known in the art. It is also known to assemble industrial textiles from a plurality of helical coils, which are intermeshed and interconnected in a hinged arrangement, by hinge or pintle yarns. The component yarns, fibers or films from which the textile is assembled may be monofilaments, multifilaments, spun yarns, cabled yarns, homolayer or multilayer films and the like. One general class of industrial textiles to which the present invention is particularly relevant is filtration and conveying fabrics and, in particular, papermaking fabrics.

[0003] However, although the present invention is discussed below with particular reference to papermaking fabrics, it is applicable to any type of industrial textile intended for conveying or filtration and which can be constructed from polymeric elements, including, but not limited to, textiles constructed by weaving, helical or spiral coil assembly, pre-crimped yarn assembly, and selectively slit and embossed film, in each case to provide a single layer textile, or one or more outer layers in a multi-layer construction. In addition, as discussed further below, the present invention is applicable to seaming elements for industrial textiles, including such elements formed from films, or as spiral seaming coils, or as seaming luminers.

[0004] In modern high speed papermaking processes, a highly aqueous stock consisting of about 99% water and 1% papermaking solids is ejected at high speed and precision onto an endless moving forming fabric. A nascent web, which will be self coherent and consist of about 25% papermaking solids by the end of the forming section, is formed as the stock is drained through the fabric as it passes over various dewatering elements and drainage boxes. This web is then transferred from the forming fabric into the press section of the papermaking machine where, together with at least one press felt, it passes through one or more nips where additional fluid is removed by mechanical means. The web is then transferred into the dryer section of the papermaking machine where it is supported on one or more dryer fabrics as it passes in serpentine fashion over a series of heated rotating drums where much of the remaining moisture is removed by evaporative means. The finished sheet is then reeled into large rolls at the end of the papermaking machine, and further finishing processes may be applied. Tissue and towel forming processes are similar but employ a so-called through-air dryer (TAD) fabric to convey the sheet through an air drying section of the tissue-making machine where it is dried and various physical properties are created in the final product.

[0005] Forming fabrics, press felts, dryer and TAD fabrics are critical to the quality of the paper product that is ultimately produced on the papermaking machine. In simplest terms, these fabrics are designed to allow fluid from the stock to pass through the fabric in a controlled manner, while providing uniform support to the papermaking solids. They are also intended to provide consistent support for the paper web formed and conveyed by them. Each of these fabrics is uniquely designed for optimal performance in the environment for which it is intended. Forming fabrics should be as thin as is possible, so as to minimize internal void volume and water carrying capacity, while maximizing support for the papermaking fibers and other solids they convey. Press felts provide a void volume into which water that is expressed from the web in a press nip may be carried away so as to dry the sheet. Dryer fabrics are engineered to carry and support the wet web while the remaining water is evaporated from the sheet. Considerable efforts have been made by various manufacturers of papermaking fabrics to provide textiles that are thin yet sufficiently robust and dimensionally stable so as to survive the environmental forces to which they are exposed. These fabrics are routinely exposed to high temperatures and humidity, as well as abrasive wear from their continuous sliding contact with the various stationary components over which they travel at speeds in excess of 1,000 meters per minute.

[0006] Industrial filtration and conveying fabrics, both woven and nonwoven, are employed in various applications, including but not limited to wastewater treatment, water supply, food processing, pharmaceutical processing, chemical processing, and pigment and coating processes. Like papermaking fabrics, these more generic industrial textiles are typically made from thermoplastic polymer yarns or films whose properties are selected and engineered in accordance with end use requirements.

[0007] In an effort to increase the performance characteristics of these textiles, a wide variety of yarn and film materials have been employed in their manufacture, including natural fibers, metals and, more recently, yarns and films formed from thermoplastic polymers. The predominant polymers in use today in the manufacture of papermaking and industrial filtration fabrics include polyesters, in particular polyethylene terephthalate (PET), polybutylene terephthalate (PBT), polytrimethylene terephthalate (PTT), polyethylene naphthalate (PEN) and 1,4 cyclohexanedicarbonitro-terephthalate-co-isophthalate (PCTA), as well as their various known blends and copolymers, and nylons, such as polyamide-6 and polyamide-6/12, and various blends and formulations thereof. Other non-limiting examples of thermoplastic polymers known and used for such applications include blends of polyester and polyurethane (Monafoam®), polyester ether ketone (PEEK), and polyphenylene sulphide (PPS); others are known and used.
Papermaking fabrics, in particular forming and dryer fabrics, are commonly woven using a thermoplastic polyester monofilament warp material which is usually located in the machine direction (MD) of the final fabric, and either polyester or polyamide monofilaments as the weft material which are arranged in the cross-machine direction (CD), on the machine side (MS) of the fabric where the majority of abrasive force is applied transversely to the longitudinal dimension of the monofilament. The preferred polyester for these applications is PET; however, it is known to use PBT, PTT, PCTA and PEN, as well as copolymers and blends containing PET and other polyesters. Polyamides are generally preferred for use at least a portion of the weft material in forming fabrics due to their ability to resist abrasive wear in comparison to polyesters. However, it is well known that the physical properties of polyamides, in particular their hydrophilic nature and crimp behaviour during fabric processing, introduce difficulties in both manufacturing (in particular the weaving, heatsetting and seamming processes) and the end application, where curl may occur in the outer edges of the forming fabric. These difficulties occur due to the differing mechanical and thermal properties of polyamides as compared to polyesters. It is also known that polyamides are generally less inert than polyesters in acidic environments and will deteriorate more quickly.

Polyester, in particular PET, is a stable polymer that moves through fabric manufacturing processes from weaving to heatsetting and seamming with relative ease due to its stable nature. End users of the woven product seldom have difficulties with fabrics made from this material as such fabrics tend to run without significant performance issues (e.g. skewing, creasing, etc.) and can loop through both the paper forming stage and return/cleaning stages with notable difficulties. However, on more demanding applications in the papermaking machine, where the fabrics are exposed to higher than usual abrasive conditions, polyester monofilaments can wear quickly when exposed to high vacuum levels as they pass over multiple dewatering units. Previous attempts to improve the MS wear resistance of these fabrics have focused on adding or substituting monofilaments composed of other polymers that offered better abrasion resistance. Such efforts are described, for example, by Bhatt et al. in U.S. Pat. No. 5,169,711 and U.S. Pat. No. 5,502,120, both of which disclose blends of polyester and thermoplastic polyurethanes for improved abrasion resistance over pure polyesters. Other similar efforts are known. A known advantage of the polyester blend materials described by Bhatt et al. in U.S. Pat. No. 5,169,711 and U.S. Pat. No. 5,502,120, in comparison to polyamides, is their crimp behaviour during weaving and heatsetting, as well as their proven ability to resist abrasive wear. These polyester/polyurethane blends tend to act more like polyester, which results in improved fabric processing.

At the seams areas of industrial textiles, to minimize discontinuity between those areas and the adjacent textile body, various seating elements are known and used which are constructed of polymers either identical to, or closely compatible with, polymers from which the textile body is constructed. Such seating elements include, for example, spiral seating coils, and various constructions designed to engage the respective textile edges and be connected together.

DISCUSSION OF PRIOR ART

Molybdenum disulphide has been utilized for many years as an additive to polyamides so as to improve the abrasion resistance, and lower the overall coefficient of friction of the polyamide material and thereby increase the wear life of components made from this polymer. Such use of molybdenum disulphide as a component material for the manufacture of polyamide monofilament is known. For example, U.S. Pat. No. 4,370,375 (Bond) discloses polyamide monofilaments containing molybdenum disulphide and lithium bromide for use as transverse strands of woven forming fabrics.

GB 2,315,499 (Draper) discloses microencapsulated photochromic dyes incorporated into the polymer matrix of 10-20 denier staple fibers used in a press felt batt. Either the textile yarns or a textile coating may contain the photochromic material. Draper discloses that other additives including molybdenum disulphide may be incorporated into the dye microcapsules to enhance textile properties, e.g. to increase lubricity.

WO 00/55402 (Hinterkeuser) discloses a polyamide based monofilament fiber that allegedly offers improved abrasion resistance properties in comparison to pure polyamide by incorporating into the polyamide of an effective amount of molybdenum sulphide in a manner similar to that disclosed by U.S. Pat. No. 4,370,375 (Bond).

U.S. Pat. No. 5,585,430 (Patel et al.) discloses a pintle wire formed by extrusion from e.g. nylon (polyamide 6/6, 6/10, 6/12), polyesters or copolyesters, PEEK, PPS, and no more than 3 wt % of a schistose lubricant such as graphite, molybdenum sulphide, clays or a silicate. The schistose material allegedly eases insertion of the pintle wire into press and dryer fabrics because of reduced drag or friction, and reduces wear between the pintle and seamming loops.

US 2009/0209695 (Yu et al.) discloses a thermoplastic composition comprising a mixture of from 10 to 98 pbw of a polycarbonate polymer, from 2 to 90 pbw of a polyester polymer, and from 0 to 5 pbw of a polylactic acid polymer. It is stated in the disclosure (see pg. 7, para. 41) that one or more fillers can be added to the composition, including molybdenum sulphide.

It is also known from U.S. Pat. No. 6,949,289 (Lawton et al.) to use molybdenum disulphide as a coating, and known from US 2006/0110597 (Koralek) and U.S. Pat. No. 4,719,066 (Wells et al.), to add molybdenum to polyesters and polyamides.

There is a well known need in the manufacture of industrial textiles, particularly those intended for use in papermaking processes, for polymer elements, including yarns, fibers and films, which offer improvements in wear resistance over polyester, while simultaneously reducing the frictional characteristic of these textiles in comparison to similar fabrics formed from prior art materials, and which are further free of the attendant processing difficulties associated with polyamides. The present invention seeks to provide such polymeric elements, and textiles formed therefrom.

It has now been found that it is possible to provide significant improvements by both increasing the abrasion resistance and reducing the frictional characteristics of industrial textiles, by providing extruded and oriented thermoplastic polymer elements for a wide range of end use applications, such polymeric elements being provided in suitable forms, including as yarns, fibers or films, and containing an appropriate amount of at least one dry lubricant selected from a group of suitable dry lubricants.

SUMMARY OF THE INVENTION

In the following discussion, the term "yarn" refers to a continuous strand. Yarns can include monofilaments formed
from oriented thermoplastic polymers as noted above, and which may or may not have a sheath-core construction, and can also include polymeric multifilaments, and cabled structures comprised of either or both monofilaments and multifilaments. Such yarns can be provided for incorporation into woven or nonwoven textile structures.

As used herein, the term “fibers” can include staple fibers (small diameter fibers of varying lengths typically formed from polyesters or polyamides which may be consolidated such as by needling into a cohesive mat typically used as a batt in processing) and the like which are known and used in the manufacture of industrial textiles.

As used herein, the term “film” refers to a thin, flexible sheet comprised of one or more layers of a thermoplastic polymer which has been uniaxially or biaxially oriented.

As used herein, the term “dry lubricant” refers to any material which can be provided in dry particulate form for incorporation with the selected thermoplastic polymer. For the purposes of the present invention, dry lubricants include molybdenum disulphide, tungsten disulphide, boron nitride, and soft metals including indium (In), lead (Pb), tin (Sn), bismuth (Bi), cadmium (Cd) and silver (Ag).

As used herein, the expression “% pbw” refers to the percentage parts by weight of the entire composition which is comprised of either the dry lubricant or the thermoplastic polymer.

In relation to the particulate matter of the dry lubricants used in the thermoplastic polymers of the invention, their dimensions are expressed in relation to the average particle size, in microns (µ, wherein 1µ = 1x10^-6 m); or nanometers (wherein 1 nanometer = 1x10^-9 m). In the thermoplastic polymeric elements of the invention, the dry lubricant is typically provided as a very small particle having an average particle size from about 0.05µ to about 100µ.

Molybdenum disulphide is an inorganic compound with chemical formula MoS2. Its appearance and feel are similar to graphite and it is used widely as a solid lubricant because of its low frictional properties. It is known to “fill” other polymers, in particular polyamides, with this material. Several non-limiting examples of polymers to which molybdenum disulphide has been added include Nylatron® (trade mark of DSM Plastics), Telion® (trade mark of Du Pont for polytetrafluoroethylene) and Vespe® (trade mark of Du Pont for a polyimide based polymer). Others are known and used.

Tungsten disulphide is also an inorganic chemical compound, having the molecular formula WS2. It occurs naturally as the rare mineral called tungstenite and it has a layered structure similar to that of MoS2; it is one of the most lubricious substances known. Tungsten disulphide was originally developed by NASA as a dry lubricant for spacecraft components operating in a vacuum. It is known to use this material in plastic mouldings, bearings, gearboxes, cutting and forming tools, threaded and splined components to reduce fretting, galling and seizing, and in various other applications where friction reduction is important.

Boron nitride is also an inorganic chemical compound, with formula BN, consisting of equal numbers of boron (B) and nitrogen (N) atoms. BN exists in both a crystalline, diamond-like form as well as a hexagonal form similar to graphite; it is the hexagonal form which is commonly used. Boron nitride is not found in nature and is produced from boric acid or boron trioxide.

Soft metals, such as indium (In), lead (Pb), tin (Sn), bismuth (Bi), cadmium (Cd), silver (Ag), are naturally occurring elements known to possess lubrication properties due to their low shear strength and plasticity.

The present invention concerns oriented, thermoplastic polymeric elements for use in industrial textiles, and into which an effective amount of very small particulates, having an average particle size from about 0.05µ to about 100µ, and comprised of a dry lubricant, has been blended prior to extrusion. The dry lubricant is preferably selected from at least one of molybdenum disulphide, tungsten disulphide, boron nitride, or at least one soft metal such as indium (In), lead (Pb), tin (Sn), bismuth (Bi), cadmium (Cd) and silver (Ag). The present invention also concerns industrial textiles, particularly papermaking and filtration fabrics, including these novel polymeric elements. The dry lubricant may be incorporated into the polymer resin from which the polymeric element is extruded by means of a masterbatch in quantities sufficient to provide an amount of the dry lubricant between about 0.1% parts by weight (pbw) up to about 10% pbw, based on the total weight of the polymeric element. The masterbatch consists of a polymer, preferably a polyester, which is enhanced with from about 15% - 20% pbw of the dry lubricant, such as one of more of the materials listed above. The masterbatch is incorporated into the polymer from which the fibers, yarn or film are extruded in amounts sufficient to provide a final concentration in the extrudate that is from about 0.1% pbw up to about 10% pbw. Alternatively, the dry lubricant can conveniently be added to the extrudate using a gravity feed, or similar apparatus, located near the extruder throat. Concentrations of the dry lubricant below about 0.1% do not appear to provide marked improvements in the abrasion resistance of the resultant fibers, yarn or film, while concentrations in excess of about 10% may not provide further additional effects. Preferably, the concentration of the dry lubricant in the extruded and oriented fibers, yarn or film will be from about 0.5% to about 7% pbw. Most preferably, the concentration of the dry lubricant in the extruded fibers, yarn or film is between 1%-5% pbw.

Where a polyester is used to construct the polymeric element, this can be selected from such as are commonly used in the manufacture of monofilaments and the like which are suitable for use in industrial textiles such as papermaking fabrics. Preferably the polyester is selected from the group consisting of polyethylene terephthalate (PET), polybutylene terphthalate (PBT), polyethylene naphthalate (PEN) and the like. Polyester alloys and polymer mixtures including a polyester, such as a PET-TPU blend as described in U.S. Pat. No. 5,169,711 (Bhatt) and other similar polyesters such as are commonly used in the manufacture of industrial textiles for papermaking and like applications are suitable.

Preferably, the polyester into which the masterbatch is incorporated will have an Intrinsic Viscosity (IV) of at least 0.55; preferably the IV will be from about 0.60 to about 1.0. More preferably, the IV of the polyester will be from about 0.80 to about 0.95 so as to provide a final polymeric element with physical properties suitable for use in papermakers and similar industrial textiles. For these types of fabric applications, the IV of the polyester of the finished polymeric element should be at least 0.7 or higher. Intrinsic Viscosity, where identified herein, is measured on a solution of the polyester in a mixed solvent comprising a 60:40 pbw mixture of phenol and (1,1,2,2)-tetrachloroethane at 30° C. The IV
can also be measured using a 50:50 pbw mixture of trifluoroacetic acid and dichloromethane.

In general, the masterbatch polyester into which the dry lubricant is incorporated will have an IV that is lower than the IV of the polyester into which it is added. However, the IV of the masterbatch polyester can be equal to or greater than that of the polyester into which it is added. Extrusion requires addition of heat to which will normally lower the intrinsic viscosity of the polyester and degrade the final properties of the resultant polymeric element.

The dry lubricant used in the present invention should be of a substantially uniform particulate size and configuration. Preferably, the dry lubricant has an average particle size of from about 0.05 to about 100 μ. Preferably, the dry lubricant is uniformly dispersed within the chosen polymer and in the final polymeric element.

The blending of the chemical constituents from which the yarns, fibers and films of the present invention are extruded can be carried out in any sequence suitable to the manufacturing operation. However, it has been found convenient to dry blend the polymer material with the required quantity of the masterbatch material to obtain the desired concentration of dry lubricant in the final product and to ensure a reasonably uniform dispersion of the dry lubricant. Alternatively, the dry lubricant can be advantageously added by a metered gravity feed in a known manner to the extruder.

For monofilaments, after blending the chemical constituents, the yarns are prepared according to customary techniques. The molten polymer, together with the dry lubricant with which it is blended, as well as any other additives (such as processing aids, colorants, and the like), is extruded through a die into a quench medium, after which it is oriented. The monofilaments can be extruded according to known methods using either a single screw or a twin screw extruder; it is anticipated that twin screw extrusion will provide more uniform blending of the dry lubricant with the chosen polymer and hence is presently preferred. In general, the diameter of circular cross-section monofilaments formed from the polymer blend of the present invention will be from about 0.08 mm to about 1.2 mm, and is preferably from about 0.12 mm to about 0.5 mm. After extrusion, the extruded polymeric material will undergo an orientation step, involving a uniaxial or biaxial stretching and relaxation, as appropriate and as known in the art of polymer extrusion, so as to align the polymer chains of the extrudate, and thus enhance the physical properties of the resulting material.

As noted above, the present invention is applicable to any type of industrial textile intended for conveying or filtration and which can be constructed from polymeric elements, including, but not limited to, textiles constructed by weaving, felting or spiral coil assembly, pre-crimped yarn assembly, and selectively slit and embossed film, in each case to provide a single layer textile, or one or more outer layers in a multi-layer construction. In addition, where it is sought to minimize discontinuity at the seaming areas of such textiles by using seaming elements which are constructed of polymers either identical to, or closely compatible with, polymers from which the textile body is constructed, the use of the polymeric elements of the present invention for such seaming elements can be particularly advantageous in providing improved physical properties, either for industrial textiles of the present invention, or for industrial textiles not of the invention but constructed of polymers with which the polymers of the seaming elements can be selected to be computable. Such seaming elements would include, but not be limited to, spiral seaming coils, and various constructions designed to engage the respective textile edges and be connected together, in particular seaming lumens such as disclosed in WO 2010/121360 (Manninen), and elements formed from films such as disclosed in PCT/CA2010/001955 (Manninen et al.).

The invention therefore seeks to provide an extruded and oriented thermoplastic polymeric element for use in an industrial textile, wherein the polymeric element is constructed of a material selected from yarn material, fiber material and film, and comprises (i) a thermoplastic polymer; and (ii) at least one dry lubricant, selected from the group consisting of molybdenum disulfide (MoS₂), tungsten disulfide (WS₂), boron nitride (BN), and a soft metal, wherein the dry lubricant comprises particulate matter having an average particle size in a range of between about 0.05 μ and about 100 μ (5.0x10⁻⁶ m and about 1.0x10⁻⁵ m), and is present in the polymeric element in an amount from between about 0.1% and about 10% parts by weight (pbw), based on a total weight of the polymeric element.

The invention further seeks to provide an industrial textile comprising at least one extruded and oriented thermoplastic polymeric element, wherein each of the at least one polymeric element is constructed of a material selected from yarn material, fiber material and film, and comprises (i) a thermoplastic polymer; and (ii) at least one dry lubricant, selected from the group consisting of molybdenum disulfide (MoS₂), tungsten disulfide (WS₂), boron nitride (BN) and a soft metal, wherein the dry lubricant comprises particulate matter having an average particle size in a range of between about 0.05 μ and about 100 μ (5.0x10⁻⁶ m and about 1.0x10⁻⁵ m), and is present in the polymeric element in an amount from between about 0.1% and about 10% parts by weight (pbw), based on the total weight of the polymeric element.

The invention further seeks to provide an industrial textile comprising heatset machine direction (MD) and cross-machine direction (CD) elements, wherein at least 25% of the CD elements are extruded and oriented thermoplastic polymeric elements, each polymeric element comprising (i) a thermoplastic polymer; and (ii) at least one dry lubricant, selected from the group consisting of molybdenum disulfide (MoS₂), tungsten disulfide (WS₂), boron nitride (BN) and a soft metal, wherein the dry lubricant comprises particulate matter having an average particle size in the range of between about 0.05 μ and about 100 μ (5.0x10⁻⁶ m and about 1.0x10⁻⁵ m), and is present in the polymeric element in an amount from between about 0.1% and about 10% parts by weight (pbw), based on the total weight of the polymeric element.

The invention further seeks to provide an industrial textile comprising heatset machine direction (MD) and cross-machine direction (CD) elements, wherein at least 25% of the MD elements are extruded and oriented thermoplastic polymeric elements, each polymeric element comprising (i) a thermoplastic polymer; and (ii) at least one dry lubricant, selected from the group consisting of molybdenum disulfide (MoS₂), tungsten disulfide (WS₂), boron nitride (BN) and a soft metal, wherein the dry lubricant comprises particulate matter having an average particle size in the range of between about 0.05 μ and about 100 μ (5.0x10⁻⁶ m and about 1.0x10⁻⁵ m), and is present in the polymeric element in an amount from between
about 0.1% and about 10% parts by weight (pbw), based on the total weight of the polymeric element.

[0049] In the polymeric elements and the industrial textiles of the invention, preferably the thermoplastic polymer is selected from the group consisting of polyethylene terephthalate (PET), polybutylene terephthalate (PBT), polytrimethylene terephthalate (PTT), polyethylene naphthalate (PEN), blends of PET and a thermoplastic polyurethane, polyether ether ketone (PEEK), polyphenylene sulphide (PPS), 1,4-cyclohexanediol-terephthalate-co-isophthalate (PCTA).

[0050] Alternatively, the at least one dry lubricant is selected from the group consisting of tungsten disulphide (WS2), boron nitride (BN), and a soft metal, and the thermoplastic polymer comprises at least one polyamide. Preferably such polyamide is selected from at least one of the following:

[0051] PA-6: polycaprolactam or nylon-6 or polyamide-6

[0052] PA-6/6: polyhexamethylen adipamide or nylon 6/6 or polyamide-6/6

[0053] PA-6/6:10: poly(b-hexamethylene sebacamide or nylon-6/10 or polyamide-6/10

[0054] PA-11: poly(11-aminoundecanoic acid) or nylon-11 or polyamide-11

[0055] PA-6/12: poly(hexamethylene dodecanoamide) or nylon-6/12 or polyamide-6/12

[0056] PA-10: also known as nylon-10 or polyamide-10

[0057] PA-12: also known as nylon-12 or polyamide-12 polyphthalamide (PPA).

[0058] Preferably, the soft metal is selected from indium (In), lead (Pb), tin (Sn), bismuth (Bi), cadmium (Cd), or silver (Ag).

[0059] Preferably, the dry lubricant comprises between about 0.5% and about 7% pbw of the total weight of the polymeric element, and more preferably between about 1% and about 5% pbw of the total weight of the polymeric element.

[0060] Preferably, the average particle size of the particulate matter of the dry lubricant is in a range of between about 0.1μ and 50μ (1.0×10^-6 m and about 5.0×10^-5 m); more preferably between about 0.5μ and about 20μ (5.0×10^-7 m and about 2.0×10^-6 m).

[0061] The polymeric element can be of any suitable form depending on the intended use, including a film comprising at least one layer; a fiber material, which can comprise a staple fiber material; and a yarn material having a construction selected from monofilament yarn, multifilament yarn, spun yarn, cable yarn, and sheathed yarn.

[0062] In one embodiment, the polymeric elements of the invention can be constructed from yarn material or a film for use as weaving elements, which can be used for weaving industrial textiles or many types, in particular industrial textiles of the present invention.

[0063] The industrial textiles of the invention can comprise woven structures including warp yarns and weft yarns, or nonwoven structures including MD and CD yarns. Alternatively, they can comprise one or more layers of film; or nonwoven structures wherein the at least one polymeric element comprises a plurality of interconnected helically coiled yarns. Additionally, the industrial textiles of the invention can comprise a weaving element constructed as a polymeric element according to the invention.

[0064] The industrial textiles of the invention can be constructed and arranged to be used as industrial filtration fabrics or conveying fabrics, and in particular to be used in a section of a papermaking machine selected from a forming section, a press section and a dryer section. For use in a papermaking machine, the fabrics can be forming fabrics, press fabrics, dryer fabrics, particularly through air dryer fabrics.

[0065] Where the polymeric element is a polyester, preferably the polyester has an intrinsic viscosity of at least 0.7, determined using a mixture selected from a 60:40 pbw mixture of phenol and (1,1,2,2)-tetrachloroethane and a 50:50 pbw mixture of trichloroacetic acid and dichloromethane.

BRIEF DESCRIPTION OF THE DRAWINGS

[0066] The invention will now be described with reference to the drawings, in which

[0067] FIG. 1 is a graph showing the results of dry friction testing of monofilament made in accordance with the teachings of the present invention in comparison with three other monofilaments according to the prior art;

[0068] FIG. 2 is a graph showing percent retained tensile loss under dry test conditions of a monofilament prepared in accordance with the teachings of the present invention in comparison to two other monofilaments according to the prior art;

[0069] FIG. 3 is a graph showing the results of dry friction testing of monofilaments prepared in accordance with the teachings of the invention in comparison to one other monofilament according to the prior art; and

[0070] FIG. 4 is a graph providing comparative data for wet friction testing of three monofilaments prepared in accordance with the teachings of the invention in comparison to two other monofilaments.

DETAILED DESCRIPTION OF THE DRAWINGS

[0071] Referring first to FIG. 1, this is a graph demonstrating the amount of force required to move a monofilament which is in contact with a solid friction pin a measured distance according to the capstan friction test method described in ASTM D 3108-95, entitled “Standard Test Method of Coefficient of Friction, Yarn to Solid Material”. The X-axis indicates the distance as measured in inches, and the Y-axis indicates the force as measured in pounds (lb.).

[0072] In FIG. 1, the results of testing four monofilaments, identified as A, B, C and D, according to the test method are presented. Monofilament A was a 0.40 mm diameter, circular cross-section, melt extruded and oriented monofilament comprised of PET which further included 5% pbw (parts by weight) of a dry lubricant, molybdenum disulphide, in particle form uniformly distributed throughout the monofilament. The molybdenum disulphide particles had an average particle size of about 6μ, and were supplied by the manufacturer, Polyvel, Inc. of 100 Ninth Street, Hammonton, N.J. 08037. Monofilament A was prepared in accordance with the invention and had an Intrinsic Viscosity (IV) of about 0.75.

[0073] Comparison monofilaments B, C and D were also prepared in a manner similar to that of monofilament A but did not contain any dry lubricant dispersed in the polymer melt. Monofilament B did not contain a dry lubricant, but was otherwise substantially similar to monofilament A, in that it was a 0.40mm diameter circular cross-section monofilament, was comprised of the same polyester (PET), and was produced to have an Intrinsic Viscosity (IV) of about 0.75. Monofilament C contained a known lubricant which was not a dry lubricant, but was otherwise also substantially similar to monofilament A. Monofilament D was substantially similar...
to monofilament B, but was produced so as to have a lower IV, of less than 0.7. Following their preparation, the monofilaments A, B, C and D were then tested so as to determine and compare the force required to move them in a standard test similar to that described in ASTM D 3108-95, the test being modified from that described in ASTM D 3108-95 only in order to provide a constant and uniform tension to the monofilaments.

In the modified version of the ASTM D 3108-95 test used to obtain the results shown in FIG. 1, the adjustable input tension applied to the monofilaments prior to the friction pin was replaced with a 50 g mass which was found to be appropriate for the size of the strands. In the test, the 50 g mass was first suspended from one end of a yarn; the yarn was then wrapped at a wrap angle of 450° about a capstan friction pin. The opposite end of the yarn was then attached to a constant rate of extension (CRE) type tensile testing machine provided with an appropriate force gauge. The monofilament was then pulled a known distance and the amount of force required to move that distance was measured (in pounds). Each monofilament was exposed to the identical test conditions (applied mass, wrap angle, friction pin) and the tests were repeated under the same conditions a number of times, using the same materials, so as to obtain a statistically significant result.

The results graphed in FIG. 1 show that the average force required to pull the inventive monofilament A through the apparatus was, on average, about 0.30 lb, whereas the force required to pull the prior art monofilaments B, C and D through the same apparatus, under the identical test conditions, was much higher and ranged from about 1.7 lb for monofilaments B and C, to about 1.3 lb for monofilament D which had the lowest IV of the monofilaments tested. The data presented in FIG. 1 thus show that monofilaments prepared in accordance with the teachings of the present invention require much less force to pull through a known distance at a standard wrap angle around a common capstan friction pin, and thus have a much lower coefficient of friction, than comparable monofilaments which do not contain a proportion of the dry lubricant.

The coefficient of friction (μ) can be determined using the formula:

$$\mu = \frac{T_{\text{after wrap}}}{T_{\text{before wrap}}} \times \text{wrap angle}$$

In the above formula, $T_{\text{after wrap}}$ is the average force required to pull the monofilament (i.e. the Y-axis values in FIG. 1), and $T_{\text{before wrap}}$ is the 50 g mass which was suspended from the monofilament before it was wrapped the friction capstan at a wrap angle of 450°, which corresponds to 7.854 radians.

Referring next to FIG. 2, this is a graph showing the percentage tensile loss under dry test conditions of monofilaments (A) prepared in accordance with the teachings of the present invention, in comparison to two similar monofilaments (E and F) of the prior art, which did not include a dry lubricant.

In this test, the tensile strength of the various monofilament samples is first determined using a suitable apparatus and test method. For example, a CRE test apparatus, such as an Instron Tensile Testing machine available from Instron Worldwide of Norwood, Mass. would be appropriate; other tensile testing apparatus may also be satisfactory. A standard procedure, such as that described in ASTM D2256 “Standard Test Method for Tensile Properties of Yarns by the Single-Strand Method” may be used. Any suitable test method can be selected, provided that each sample is tested using the same procedure and test apparatus as all other samples, so that the results obtained are directly comparable and provide a reliable determination of the maximum tensile strength of the strand.

Following determination of the yarn tensile strength prior to testing, a known length of each monofilament sample was fixedly attached to one side of a so-called “squirrel cage” abrasion test apparatus. In the test, the sample was draped over a rotatable, grooved ceramic wheel; the opposite end of the sample was attached to a known mass so that the sample rested in positive contact with the ceramic wheel. The ceramic wheel was then rotated at constant speed under power with the monofilament samples resting in contact with the wheel and the same applied load attached to each, and the number of rotations (cycles) recorded. The monofilament samples were removed from the test apparatus at regular intervals of 100,000 cycles, and the tensile strength of each sample was remeasured using the same test apparatus and method employed to determine its original maximum tensile strength. The tensile strength of each sample at each interval was compared to its original tensile strength prior to abrasion under test, and the results were plotted as a function of their loss in tensile strength (Tensile Loss (%)) in comparison to the number of cycles to which the samples were exposed.

In the data presented graphically in FIG. 2, monofilament A was a 0.35 mm diameter, circular cross-section, melt extruded and oriented monofilament of the invention, comprised of PET and including 1.7% pbw of a dry lubricant, tungsten disulphide, in particle form uniformly distributed throughout the monofilament. The tungsten disulphide was purchased as dry particles from M.K. IMPEX Canada, 6382 Lisgar Drive, Mississauga, Ontario L5N 6X1, Canada and the particle size as provided by the supplier ranged from about 0.1 to 6.0 microns. To prepare the monofilament A, the tungsten disulfide was uniformly dried blended with the PET granules prior to monofilament extrusion; monofilament samples were then extruded according to standard industry practices.

Monofilament E was a 0.35 mm diameter monofilament comprised of a blend of about 60% PET and 40% thermoplastic polyurethane prepared in the manner described in U.S. Pat. No. 5,502,120 (Bhatt et al.) and which did not contain any dry lubricant. Monofilament F was a 0.35 mm diameter polyamide monofilament such as would be used in the manufacture of industrial textiles and which was prepared in accordance with the teachings of U.S. Pat. No. 6,828,681. Monofilament F was comprised of a blend of approximately 95% pbw polyamide 6/10 & 5% pbw polyamide 11 and did not contain any dry lubricant.

As shown in the graph of FIG. 2, monofilament A, comprised of PET and 1.7% pbw tungsten disulphide particles, lost less than 10% of its original tensile strength following exposure to 600,000 rotation cycles on the test apparatus. In comparison, monofilament E, comprised of the blend of PET and thermoplastic polyurethane, lost about 30% of its original tensile strength whilst the polyamide sample, monofilament F, lost about 87% of its original tensile strength following exposure to 600,000 cycles.
The test data displayed graphically in FIG. 2 thus show that polymeric monofilaments including about 1.7% pbw of a dry lubricant are more resistant to abrasion, as determined by the percent tensile strength remaining in them following exposure to prolonged dry abrasive effects, than are comparable monofilaments that do not contain a dry lubricant, in this case tungsten disulphide.

Referring now to FIG. 3, this is a graph showing the results of friction testing of a monofilament sample (A) that was prepared in accordance with the teachings of the invention, in comparison to a second monofilament sample (B) which did not contain a dry lubricant. The test was performed according to the methods described in relation to FIG. 1. In this case, monofilament A was a 0.35 mm diameter circular cross-section monofilament comprised of PET into which 1.7% pbw of tungsten disulphide particles having a particle size ranging between 0.1 and 6 microns had been uniformly dry blended prior to extrusion. Monofilament B did not contain any dry lubricant, but was otherwise substantially identical to monofilament A, being also a 0.35 mm diameter circular cross-section PET monofilament. The intrinsic viscosity of the polyester of both monofilaments A and B was the same.

Both monofilaments were tested in accordance with the modified version of test method ASTM D 3108-95 entitled “Standard Test Method of Coefficient of Friction, Yarn to Solid Material” as described above. Both monofilaments were tensioned at a wrap angle of 45° around the friction capstan using the same 50 g weight and were pulled a distance of about 9 inches; the force required to pull the monofilaments around the friction capstan was measured using a CRE type tensile testing machine provided with a suitable force gauge. Measurements of the force required to pull the monofilaments around the capstan were taken continuously as shown in the graph.

The data presented in FIG. 3 show that polyester monofilaments including a dry lubricant according to the invention, specifically 1.7% pbw tungsten disulphide particles whose sizes range between about 0.1 and 6 microns, require significantly less force to move through the measured distance than comparable monofilaments that do not contain the dry lubricant.

Referring now to FIG. 4, this is a graph demonstrating the amount of force required to move a monofilament which is in contact with a solid friction pin a measured distance according to the capstan friction test method described in ASTM D 3108-95 entitled “Standard Test Method of Coefficient of Friction, Yarn to Solid Material”. The test was modified in this instance from that described in ASTM D 3108-95 in that the yarns and capstan friction pin were immersed in a water bath. The intent of this test was to determine the force required to pull the monofilaments the required distance when exposed to water and to further determine whether any of the monofilaments behaved differently in such conditions from the others.

In FIG. 4, the results of testing five monofilaments, identified as G, H, I, J and K, in accordance with the modified wet friction test method are offered. Other than with respect to the addition of a dry lubricant into the polymer melt, all five monofilaments were substantially similar, each being melt extruded from pelletized PPS (polyphenylene sulphide) resin in a manner similar to that described above in relation to the extrusion of PET; all the monofilaments were extruded so as to provide a rectangular cross-section measuring 0.60 mm in width by 0.30 mm in height. The composition of each monofilament with respect to the dry lubricant additive was as follows:

- Monofilament G: 2.0% pbw tungsten disulphide
- Monofilament H: 1.1% pbw tungsten disulphide
- Monofilament I: 1.0% pbw molybdenum disulphide
- Monofilament J: 0.0% pbw dry lubricant
- Monofilament K: 0.0% pbw dry lubricant +1% pbw colorant

In the monofilament samples of FIG. 4, samples G and H contained 2% and 1.1% pbw respectively of tungsten disulphide. This material was obtained as dry particles from M.K. IMPEX Canada, 6382 Lissor Drive, Mississauga, Ontario L5N 6X1, Canada and had a particle size as provided by the supplier of between about 0.1 and 6.0 microns. The tungsten disulphide was added in dry powder form to, and was compounded with, the pelletized PPS. The PPS with which the dry lubricants were blended was Fortron PPS which is a high-temperature linear PPS and was purchased from Ticona Engineering Polymers, a business unit of Celanese Corporation of Dallas, TX. The uniformly blended polymer resin pellets together with the dry lubricant were then melt extruded and drawn as rectangular cross sectional monofilaments.

Sample I was prepared in an identical manner to samples G and H with the exception that 1% pbw of molybdenum disulphide dry lubricant was used in place of the tungsten disulphide. The molybdenum disulphide had an average particle size of about 6 microns. The molybdenum disulphide was supplied by the manufacturer, Polyvel, Inc. of 100 Ninth Street, Hammonton, NJ 08037.

Monofilament J was produced identically to monofilaments G, H and I but did not contain any dry lubricant additive; and monofilament K was also produced similarly, without a dry lubricant, but 1% pbw of a commercially available colorant was added to the polymer melt.

In the modified version of the ASTM D 3108-95 test used to obtain the results shown in FIG. 4, the apparatus was modified to include a water bath in which the capstan friction pin, and hence the yarns, were immersed. The arrangement was otherwise essentially identical to that described in relation to the test method used to obtain the data in FIG. 1. Each yarn was attached at one end to a 50 g mass, and was attached at the other to a CRE type tensile testing machine provided with an appropriate force gauge. Each yarn was then wrapped at a wrap angle of 45° about the capstan friction pin, which was under water. The monofilament was then pulled a known distance and the amount of force required to move that distance was measured, in pounds. Each monofilament was exposed to the identical test conditions (applied mass, wrap angle, friction pin) and the tests were repeated under the same conditions a number of times, using the same materials, so as to obtain a statistically reliable and significant result.

The results graphed in FIG. 4 show that the average force required to pull the inventive monofilaments G, H and I through the apparatus was, on average, about 0.40 lb while the force required to pull the prior art monofilament J, and the monofilament K which contained the colorant was at least twice as great, at about 0.80 lb. The data presented in FIG. 4 thus shows that monofilaments comprised of a blend of PPS and dry lubricant, and prepared in accordance with the teachings of the present invention, require much less force to pull through a known distance at a standard wrap angle around a common capstan friction pin while immersed.
in water, and thus have a much lower coefficient of friction, than comparable monofilaments which do not contain a dry lubricant.

[0101] The experimental information presented in FIGS. 1 to 4 thus shows that monofilaments prepared in accordance with the teachings of the present invention possess a lower coefficient of friction (as expressed in terms of the amount of force required to move them a known distance according to standard test methods), and exhibit a greater resistance to abrasion (as measured by percent tensile loss following exposure to dry abrasion conditions) in comparison to comparable monofilaments which do not contain a dry lubricant such as molybdenum disulphide or tungsten disulphide in amounts ranging from about 1.1% to 5% pbw. Alternatively, as noted above, it is expected that many other dry lubricants will provide similar results in monofilaments and films prepared in accordance with the teachings of the present invention, for example boron nitride, or a soft metal such as one or more of indium, lead, tin, bismuth, cadmium or silver.

[0102] The yarns of the invention, constructed as monofilaments, multifilaments or otherwise, can be woven or arranged into industrial textiles, particularly papermaking fabrics, according to known and conventional techniques. The fabrics may be woven using conventional equipment, or they may be assembled from multiple yarn arrays according to methods described elsewhere (see e.g., U.S. Pat. No. 6491794 (Davenport) and WO 05/056920 (Eagles)). The chosen weave construction or yarn arrangement will depend on the intended end use application for which the fabric is desired.

[0103] Where the polymeric elements of the present invention are provided as yarns, such as monofilaments, they may be found particularly satisfactory and effective when used in combination with other polymeric yarn materials which do not contain dry lubricants. For example, the yarn materials of the invention may be used in woven constructions where they form the CD elements located on the MS of the fabric. In such a case, they may comprise from as few as 25% to as much as 100% of the MS CD yarns. The yarn materials of the invention may also be used as at least a portion of the MD elements of the textiles, or as much as 100% of the MD elements on the wear side of the textiles. As a further alternative, the entire fabric may be assembled from monofilaments according to the present invention.

[0104] After weaving or other fabric assembly processes, textiles constructed of yarn materials are heatset according to conventional techniques to stabilize the fabric structure. Heatsetting conditions will vary with the chosen polymers, yarn materials, their size and the weave construction, but will typically involve heating the fabric under tension while it is mounted on a heatsetting frame such as is normally used for this purpose.

[0105] Where the polymeric element is provided as a film, this can be as a homolayer or one or more outer layers in a multilayer textile, as noted above. In particular, the industrial textiles of the invention can advantageously be provided as one or more layers of slit and profiled films such as are described in PCT/CA2010/001956 (Manninen).

[0106] Further, as noted above, the polymeric elements of the present invention can be used for various types of seaming elements for industrial textiles, by incorporating the dry lubricant into the polymer from which the seaming element, such as a spiral coil, seaming lumen or film is constructed.

[0107] As discussed above, the dry lubricants act to improve the abrasion resistance of the polymeric element while simultaneously lowering the coefficient of friction of the resultant yarns and textiles made therefrom. In addition to these benefits, the present invention also provides the ability to take advantage of the physical properties of polyester based materials over polyamide monofilaments of the prior art, including moisture stability and dimensional stability, in that polyester yarns do not expand or contract following wet-to-dry cycling in water and air. The physical and chemical properties of the polymeric elements of the present invention, other than the increased abrasion resistance and reduced coefficient of friction as discussed herein, are substantially similar to those already incorporated into known industrial textiles, thus reducing or eliminating any issues of any need to modify fabric design to accommodate the use of the polymeric elements of the invention. In particular, it is now possible to manufacture fabrics entirely from polyester based materials while reducing the overall coefficient of friction of the fabric and improving its resistance to wear in comparison to prior art fabrics which include a portion of polyamide based materials.

1. An extruded and oriented thermoplastic polymeric element for use in an industrial textile, wherein the polymeric element is constructed of a material selected from yarn material, fiber material and film, and comprises
   (i) a thermoplastic polymer; and
   (ii) at least one dry lubricant, selected from the group consisting of molybdenum disulphide (MoS₂), tungsten disulphide (WS₂), boron nitride (BN), and a soft metal, wherein the dry lubricant comprises particulate matter having an average particle size in a range of between about 0.05 μm and about 100 μm (5.0 × 10⁻⁸ m and about 1.0 × 10⁻⁶ m), and is present in the polymeric element in an amount from between about 0.1% and about 10% parts by weight (pbw), based on a total weight of the polymeric element.

2. A polymeric element according to claim 1, wherein the thermoplastic polymer is selected from the group consisting of polyethylene terephthalate (PET), polyethylene terephthalate (PET), polytrimethylene terephthalate (PTT), polyethylene naphthalate (PEN), blends of PET and a thermoplastic polyurethane, polyether ether ketone (PEEK), polyphenylene sulphide (PPS), 1,4-cyclohexanediol-terephthalate-co-isophthalate (PCTA).

3. A polymeric element according to claim 1, wherein the at least one dry lubricant is selected from the group consisting of tungsten disulphide (WS₂), boron nitride (BN), and a soft metal, and the thermoplastic polymer comprises at least one polyamide.

4. A polymeric element according to claim 3, wherein the at least one polyamide is selected from at least one of PA-6, PA-6/6, PA-6/10, PA-6/12, PA-11, PA-10, PA-12 and polyphthalamide (PPA).

5. A polymeric element according to claim 1, wherein the soft metal is selected from indium (In), lead (Pb), tin (Sn), bismuth (Bi), cadmium (Cd), and silver (Ag).

6. A polymeric element according to claim 1, wherein the dry lubricant comprises between about 0.5% and about 7% pbw of the total weight of the polymeric element.

7. A polymeric element according to claim 6, wherein the dry lubricant comprises between about 1% and about 5% pbw of the total weight of the polymeric element.
8. A polymeric element according to claim 1, wherein the average particle size of the particulate matter of the dry lubricant is in a range of between about 0.1µ and about 50µ (1.0x10⁻⁷ m and about 5.0x10⁻⁵ m).

9. A polymeric element according to claim 8, wherein the average particle size of the particulate matter of the dry lubricant is in a range of between about 0.5µ and about 20µ (5.0x10⁻⁶ m and about 2.0x10⁻⁵ m).

10. A polymeric element according to claim 1, wherein the polymeric element comprises a film comprising at least one layer.

11. (canceled)

12. (canceled)

13. A polymeric element according to claim 1, wherein the polymeric element comprises a yarn material having a construction selected from monofilament yarn, multifilament yarn, spun yarn, staple fiber material, cabled yarn and sheathed yarn.

14. A polymeric element according to claim 1, wherein the polymeric element comprises a material selected from a yarn material and film, and is a seaming element.

15. An industrial textile comprising at least one extruded and oriented thermoplastic polymeric element, wherein each of the at least one polymeric element is constructed according to claim 1.

16.-27. (canceled)

28. An industrial textile according to claim 15, wherein the textile comprises a woven structure including warp yarns and weft yarns.

29. An industrial textile according to claim 15, wherein the textile comprises a nonwoven structure including MD and CD yarns.

30. An industrial textile according to claim 15, wherein the textile comprises a nonwoven structure and the at least one polymeric element comprises a plurality of interconnected helically coiled yarns.

31. An industrial textile according to claim 15, further comprising a seaming element.

32. An industrial textile comprising machine direction (MD) and cross-machine direction (CD) elements, wherein at least 25% of the elements of a set selected from the MD elements and the CD elements are extruded and oriented thermoplastic polymeric elements, each polymeric element comprising:

(i) a thermoplastic polymer; and
(ii) at least one dry lubricant, selected from the group consisting of molybdenum disulphide (MoS₂), tungsten disulphide (WS₂), boron nitride (BN) and a soft metal, wherein the dry lubricant comprises particulate matter having an average particle size in the range of between about 0.05µ and about 100µ (5.0x10⁻⁶ m and about 1.0x10⁻⁴ m), and is present in the polymeric element in an amount from between about 0.1% and about 10% parts by weight (pbw), based on the total weight of the polymeric element.

33. (canceled)

34. An industrial textile according to claim 32, wherein the soft metal is selected from indium (In), lead (Pb), tin (Sn), bismuth (Bi), cadmium (Cd), and silver (Ag).

35. An industrial textile according to claim 15, constructed and arranged to be used as at least one of an industrial filtration fabric and a conveying fabric.

36. (canceled)

37. An industrial textile according to claim 15, constructed and arranged to be used in a section of a papermaking machine selected from a forming section, a press section and a dryer section, and the fabric is selected from a forming fabric, a press fabric, a dryer fabric and a through air dryer fabric.

38.-41. (canceled)

42. A polymeric element according to claim 1, wherein the thermoplastic polymer is a polyester having an intrinsic viscosity of at least 0.7, determined using a mixture selected from a 60:40 pbw mixture of phenol and (1,1,2,2)-tetrachloroethane and a 50:50 pbw mixture of trifluoroacetic acid and dichloromethane.

43. An industrial textile according to claim 15, wherein the thermoplastic polymer is a polyester having an intrinsic viscosity of at least 0.7, determined using a mixture selected from a 60:40 pbw mixture of phenol and (1,1,2,2)-tetrachloroethane and a 50:50 pbw mixture of trifluoroacetic acid and dichloromethane.

44. An industrial textile according to claim 32, constructed and arranged to be used as at least one of an industrial filtration fabric and a conveying fabric.

45. An industrial textile according to claim 32, constructed and arranged to be used in a section of a papermaking machine selected from a forming section, a press section and a dryer section, and the fabric is selected from a forming fabric, a press fabric, a dryer fabric and a through air dryer fabric.

46. An industrial textile according to claim 32, wherein the thermoplastic polymer is a polyester having an intrinsic viscosity of at least 0.7, determined using a mixture selected from a 60:40 pbw mixture of phenol and (1,1,2,2)-tetrachloroethane and a 50:50 pbw mixture of trifluoroacetic acid and dichloromethane

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