

Title of the invention: Rubbing cloth

TECHNICAL FIELD

[0001] The present invention relates to a rubbing cloth. In more detail, this invention relates to a rubbing cloth used for rubbing the alignment films of liquid crystal displays, to achieve highly precise liquid crystal displaying, which is excellent in alignment performance, unlikely to generate fiber abrasion destined to be a contamination source at the time of rubbing treatment and allowing the resiliency performance to be controlled as desired at the time of rubbing treatment.

BACKGROUND ART

[0002] In recent years, liquid crystal display devices are being widely used as display devices to substitute the conventional CRT monitors, for game computers, television sets, monitors, copiers, cameras, etc., since they are thin and small advantageously in view of installation area. To constitute each liquid crystal display element used in these liquid crystal display devices, a TFT substrate having a thin film transistor (TFT) formed thereon as a drive element and a color filter substrate having color filters formed thereon (hereinafter abbreviated as "CF substrate") are disposed to face each other with a fine clearance formed between them, and the fine clearance is packed with a liquid crystal. On the surfaces of the TFT substrate and the CF substrate, one each alignment film for covering the surface of an ITO electrode is disposed to contact the packed liquid crystal.

[0003] This alignment film is formed of a material selected from SiO₂, polyimide, polyvinyl alcohol-based resin, nylon-epoxy-organic titanium-based material, etc. as appropriate in response to each purpose or structure. The alignment film is treated to be aligned for allowing liquid crystal molecules to be

aligned. This alignment treatment is an important step for achieving uniform alignment of the liquid crystal layer.

[0004] As the alignment treatment method, a rubbing method of rubbing the surface of the alignment film with a rubbing cloth is mainly used. The rubbing cloth is usually stuck around the outer circumferential surface of a roller formed of aluminum or stainless steel, and the roller is rotated to keep the rubbing cloth on the outer circumferential surface thereof in contact with the surface of the alignment film, to rub the surface of the alignment film with the rubbing cloth. Owing to the rubbing treatment of the surface of the alignment film like this, the alignment film is aligned in the rubbed direction, and the liquid crystal molecules are aligned in the aligned direction of the alignment film, to provide uniform display characteristics.

[0005] As the rubbing cloth used for the rubbing method, fibers such as natural fibers, semi-synthetic fibers and synthetic fibers are being used.

[0006] For example, a technique concerning a rubbing material formed of synthetic fibers is proposed (see Patent Document 1). In this technique, a polyester or polyamide is used as synthetic fibers, to form a woven fabric, and the rubbing material obtained certainly allows the liquid crystal to be uniformly aligned by rubbing treatment. However, since the rubbing material formed of a woven fabric only is thin as a woven fabric material per se, it is difficult to control the force of pressing the rubbing cloth required for the rubbing treatment at a constant level. Further, the proposed technique is poor in the technical idea of achieving fine alignment by the proposed rubbing cloth, and as a result, the rubbing material is insufficient in view of the rubbing performance expected for producing more highly precise liquid crystal displays.

[0007] The most popularly used material of rubbing cloths is a fiber material with a pile formed by raising fibers such as velvet (pile cloth). As the pile cloth used for a rubbing cloth, the fineness of the single fibers used as the pile and the number of driven single fibers per area (fibers/cm²) are changed to adjust the pile density, and the pile length of fibers is adjusted by cutting at an appropriate distance from the base cloth. Further, as the fiber material used as the pile, long fibers (filaments) like cellulose fibers such as rayon or triacetate fibers and short fibers like cotton wool are known (see Patent Document 2).

[0008] In relation with said pile cloth, for example, a technique concerning a rubbing cloth obtained as a pile cloth formed of modified cross-section fibers is proposed (see Patent Document 3). This technique has such advantages that precise alignment treatment can be performed using the sharp lateral fiber faces of single fibers and that the alignment force at the time of alignment can be controlled by adjusting the indentation depth of the pile cloth at the time of rubbing treatment owing to the structure particular to the pile cloth. On the other hand, the raised single fibers are likely to generate fiber abrasion at the time of rubbing treatment and to contaminate the liquid crystal alignment film. Further, with regard to the pile cloth per se, the lengths of the raised fibers on the surface of the pile cloth are slightly different from fiber to fiber, that is, the raised fibers are irregular in length without fail, and it is feared that rubbing irregularity occurs at the time of rubbing treatment. Furthermore, it is difficult to avoid the rubbing irregularity.

[0009] Moreover, a technique concerning a rubbing cloth in which a cushioning material is integrated with a raised cloth formed of ultrafine fibers is proposed (see Patent Document 4). With this

technique, finer alignment can be expected owing to the ultrafine fibers, but the technique has such problems as fiber abrasion and alignment irregularity owing to the raised fiber length irregularity as in the aforementioned Patent Document 2. In addition, the raised fibers consisting of ultrafine fibers are not firm and absorb stress. Therefore, the resiliency owing to the cushioning material used is offset by the raised ultrafine fibers, and the alignment regulation force at the time of rubbing treatment tends to be rather poor. Moreover, when the ultrafine fibers contact the alignment film, all the ultrafine fibers are not aligned in the intended direction of alignment, since the fibers per se are not firm. As a result, some ultrafine single fibers not aligned in the alignment direction inhibit the homogeneous alignment of the alignment film, and rubbing irregularity and defects in liquid crystal displaying are likely to occur.

Patent Document 1: JP 1-288827 A (claims, example 1)

Patent Document 2: JP 2003-156746 A (claims, examples)

Patent Document 3: JP 61-46932 A (claims, fig. 1)

Patent Document 4: JP 2005-91899 A (claims, fig. 1)

DISCLOSURE OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0010] The problem to be solved by this invention is to solve the problems of the abovementioned prior art, by providing a rubbing cloth capable of inhibiting the generation of contaminants such as fiber abrasion at the time of rubbing treatment, having fine and homogeneous alignment performance for achieving a higher resolution in the liquid crystal display device and assuring excellent alignment regulation force since the rubbing cloth pressing pressure can be uniformly controlled while the rubbing cloth is kept in contact with the alignment film.

MEANS FOR SOLVING THE PROBLEM

[0011] An embodiment of this invention may employ the following constitutions for solving the abovementioned problem.

- (1) A rubbing cloth comprising a woven or knitted fabric and an elastic material laminated on each other and integrated.
- (2) A rubbing cloth, according to (1), wherein the woven or knitted fabric is a satin weave fabric.
- (3) A rubbing cloth, according to (1) or (2), wherein the number of the ends of the fibers constituting the woven or knitted fabric existing on the surface of the woven or knitted fabric is 30 or less per 1 cm square.
- (4) A rubbing cloth, according to any one of (1) through (3), wherein the number of single fibers of the warp yarns or weft yarns used to form the surface layer of the satin weave fabric is 2000 fibers or more per centimeter.
- (5) A rubbing cloth, according to any one of (1) through (4), wherein an intersection formed by five or more warp yarns and one weft yarn or formed by one warp yarn and five or more weft yarns recurs.
- (6) A rubbing cloth, according to any one of (1) through (5), wherein the single fiber fineness of the warp yarns or weft yarns used to form the surface layer of the satin weave fabric is 2.0 decitexes or less.
- (7) A rubbing cloth, according to any one of (1) through (6), wherein the warp yarns or weft yarns used to form the surface layer of the satin weave fabric is a polyester and/or polyamide.
- (8) A rubbing cloth, according to any one of (1) through (7), wherein the warp yarns or weft yarns used to form the surface layer of the satin weave fabric are formed of non-crimped fibers.
- (9) A rubbing cloth, according to any one of (1) through (8), wherein the elastic material used is such that the ratio R of the stress

at the time of 50% compression (P2) to the stress at the time of 10% compression (P1) in the thickness direction of the rubbing cloth ($R = P2/P1$) is in a range of $0.90 \leq R \leq 2.00$.

(10) Further, according to one aspect of the invention, there is provided a rubbing cloth comprising a woven or knitted fabric, wherein the woven or knitted fabric does not have raised lint and an elastic material laminated on each other and integrated, wherein the thickness of the rubbing cloth is 1.5 mm or more and 10 mm or less.

EFFECTS OF THE INVENTION

[0012] The rubbing cloth of this invention having an elastic material compared with the conventional rubbing cloth formed of a woven fabric only allows the adjustment of the rubbing cloth pressing stress required for rubbing treatment and is excellent in alignment performance (alignment regulation force). Especially in the case where a satin weave fabric is used as the woven or knitted fabric, the fibers are arranged in parallel in the alignment direction of the alignment film, to assure excellent alignment performance. Since the number of fibers arranged in the alignment direction of the alignment film can be selected as appropriate for adaptation to the intended alignment degree of the alignment film, the design of the rubbing cloth is easy, and the rubbing cloth can be employed suitably.

[0013] On the other hand, compared with the conventional pile cloth used as a rubbing cloth, since the rubbing cloth of this invention does not have raised lint, the generation of fiber abrasion at the time of rubbing treatment can be inhibited or prevented, and there is no possibility of alignment film contamination. Further, since there is no pile length irregularity peculiar to a pile cloth, this invention exhibits an excellent effect that the rubbing irregularity resulting in liquid crystal display defects can be inhibited. Moreover, in the case where a satin weave fabric is used as the woven or knitted fabric in the rubbing cloth of this invention, since the fibers used in the woven fabric are constrained, it does not happen that raised fibers are shifted from the alignment direction like a pile cloth, hence that the raised fibers rub at

an angle shifting from the alignment direction. Thus, the rubbing cloth of this invention is excellent in alignment performance. In addition, though a pile cloth is likely to be insufficient in alignment regulation force because of the twisted yarns usually required to be used in the pile cloth, the rubbing cloth of this invention can achieve uniform alignment, since the fibers used in the woven or knitted fabric of this invention can be non-crimped fibers.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] [Fig. 1] is an illustration for explaining a treatment process of rubbing an alignment film on a substrate using an example of the rubbing cloth of this invention.

[Fig. 1] is a cross sectional view of a sheath-core conjugate fiber (before dissolving away a component) as a single fiber for obtaining a modified four-lobed cross-section fiber having sharp projections used as each fiber in the yarns of the woven fabric 10 used in Examples 10 and 19 of this invention.

[Fig. 3] is a measured compression rate-stress curve showing the elastic quality of the elastic material 1 used in the examples of this invention.

[Fig. 4] is a measured compression rate-stress curve showing the elastic quality of the elastic material 2 used in the examples of this invention.

MEANINGS OF SYMBOLS

[0015] 1: rubbing roller

[0016] 2: elastic material

[0017] 3: woven or knitted fabric

4: alignment film

5: substrate

6: sheath component (PEG-copolymerized PET)

7: core component (PET)

THE BEST MODES FOR CARRYING OUT THE INVENTION

[0018] The rubbing cloth of this invention has an elastic material laminated on a woven or knitted fabric. The widely used conventional pile fabrics as rubbing cloths have a problem that the surface properties and the entire compression properties could not be optimized respectively independently. That is, if the fibers constituting the pile of a woven pile fabric are going to be fined in an attempt to achieve more uniform rubbing treatment, the compression properties of the rubbing cloth as a whole are also changed to provide a rubbing cloth poor in cushioning properties. In the rubbing cloth of this invention, a woven or knitted fabric and an elastic material can be respectively separately selected to respond to respectively different properties, so that the surface properties and the cushioning properties of the rubbing cloth can be optimized respectively independently.

[0019] The woven or knitted fabric of this invention is not especially limited. Woven fabrics such as plain weave fabric, satin weave fabric and twill weave fabric and knitted fabrics such as warp knitted fabric, tubular knitted fabric and weft knitted fabric can be used. Among them, a satin weave fabric is especially preferred. In a satin weave fabric, more warp yarns or more weft yarns are exposed on the surface of the woven fabric, and if the direction in which more exposed yarns are arranged is adapted to the direction of rubbing treatment, the uniformity in the contact degree between the fibers of the rubbing cloth and the substrate can be improved to achieve a more uniform rubbing effect.

In this case, a satin weave fabric refers to a woven fabric with a surface having portions in which only warp yarns or weft yarns float as if only warp yarns or weft yarns appear to exist

in those portions.

[0020] In the satin weave fabric, an intersection (structural unit site) formed by warp yarns and a weft yarn or formed by a warp yarn and weft yarns is not close to any adjacent intersection and occurs only once in each recurring structural unit formed by warp yarns and a weft yarn or formed by a warp yarn and weft yarns in the woven fabric, being apart from any adjacent intersection. In the satin weave fabric used in this invention, it is preferred that a structural unit site, namely, an intersection formed by five or more warp yarns and one weft yarn or formed by one warp yarn and five or more weft yarns recurs. A recurring unit of 8 yarns or more is more preferred, and a recurring unit of 10 yarns or more is especially preferred. If the number of yarns in each recurring unit is larger, more warp yarns only or more weft yarns only are exposed, and in the case where the satin weave fabric side of the layered and integrated rubbing cloth of this invention is pressed against the alignment film for rubbing treatment, the rubbing cloth is more excellent in the performance of aligning the alignment film. A satin weave in which a structural unit site (an intersection) formed by five warp yarns and one weft yarn or formed by one warp yarn and five weft yarns recurs is called "5 harness satin," and a satin weave in which a unit of eight yarns recurs similarly is called "8 harness satin," and so on. These are types (modes) of satin weave. A more preferred mode of satin weave is 5 or larger harness satin, and a further more preferred mode is 8 or larger harness satin. An especially preferred mode is 10 or larger harness satin.

[0021] As described before, the rubbing cloth of this invention has a woven or knitted fabric and an elastic material laminated on each other and integrated, and at the time of rubbing treatment, the woven or knitted fabric side is pressed against the alignment

film, for rubbing treatment. In the case where the woven or knitted fabric is a satin weave fabric, it is only required that many fibers are exposed and arranged in the direction parallel to the rubbing direction on the surface of the satin weave fabric to be pressed against the alignment film at the time of rubbing treatment, and in this case, the yarns formed of the many fibers exposed can be either warp yarns or weft yarns. A warp satin weave fabric in which many warp yarns are exposed is preferred since the design for production of the satin weave fabric is easy. If a rubbing cloth in which many exposed fibers are arranged in parallel to the rubbing direction is used to rub the alignment film at the time of rubbing treatment, to achieve alignment, the fine and precise anisotropic alignment of the alignment film can be achieved while the generation of fiber abrasion is inhibited.

[0022] If the number of single yarns of the warp yarns or weft yarns exposed as many fibers on the surface of the satin weave fabric pressed against the alignment film is larger, more precise anisotropic alignment can be achieved. Therefore, it is preferred that the number of the warp yarns or weft yarns in the surface layer is 2000 or more per centimeter. A more preferred number is 3000 or more per centimeter, and an especially preferred number is 5000 or more per centimeter. It is preferred that the upper limit in the number of single fibers is larger. However, in the case where ultrafine fibers with a single fiber fineness of 0.1 decitex or less obtained by conjugate spinning such as fiber splitting or component dissolution as described later are used, a satin weave fabric with up to 250,000 single fibers per centimeter at the largest can be stably produced.

[0023] The fibers used for the woven or knitted fabric constituting the rubbing cloth of this invention can be either long fibers

(filaments) or short fibers (staples), but a woven or knitted fabric formed of long fibers is preferred since a fabric with less lint exposed generates less fiber abrasion at the time of rubbing treatment. As the preferred long fibers, multifilaments are preferred. In this case, as each of the multifilaments, a multifilament consisting of filaments equal in fineness can be used, or a multifilament consisting of filaments different in fineness can also be used. Further, a sheath-core conjugate multifilament with high stiffness and small fineness consisting of one or more filaments respectively with a large fineness arranged as the core and multiple fibers respectively with a small fineness arranged as the sheath can also be used.

[0024] Furthermore, it is preferred that the number of multifilaments as the warp yarns or weft yarns arranged in parallel to the rubbing direction on the surface of the woven or knitted fabric to be pressed against the alignment film is larger, since more precise anisotropic alignment can be achieved at the time of rubbing treatment. Therefore, a preferred number is 70 multifilaments or more per centimeter, and a more preferred number is 80 multifilaments or more per centimeter. An especially preferred number is 90 multifilaments or more per centimeter. Moreover, if the number of multifilaments is 200 or less per centimeter, the woven or knitted fabric can be produced stably. Therefore, a preferred number is 180 multifilaments or less per centimeter. Further, it is preferred that the number of single fibers (filament count) constituting each multifilament is 36 or more. A more preferred number is 48 filaments or more, and a further more preferred number is 96 filaments or more. The most preferred number is 144 filaments or more. It is preferred that the filament count is larger, but the filament count that allows stable

production is 3000 or less.

[0025] If the fineness of each of the single fibers used in the woven or knitted fabric constituting the rubbing cloth of this invention, namely, the single fiber fineness is smaller, finer alignment can be achieved at the time of rubbing treatment. Therefore, it is preferred that the single fiber fineness is 2.0 decitexes (hereinafter abbreviated as dtex) or less, and 1.5 dtex or less is more preferred. Especially preferred is 1.0 dtex or less. A smaller single fiber fineness is preferred, but in the case where the single fiber fineness is too small, the fibers are likely to be cut at the time of rubbing treatment, to generate fiber abrasion. Therefore, a single fiber fineness of 0.005 dtex or more is preferred and 0.01 dtex or more is more preferred. Especially preferred is 0.05 dtex or more. Meanwhile, as a method for obtaining fibers with such a small single fiber fineness, the fibers with a small single fiber fineness can be obtained by direct spinning. As another method, an islands-in-sea type conjugate fiber can be produced, and the sea component can be dissolved away to obtain the island fibers only. As a further other method, a conjugate fiber can be split into fibers with a small single fiber fineness.

[0026] With regard to the sectional form of the single fibers constituting the woven or knitted fabric (the form of each fiber in the cross section perpendicular to the axis of the fiber), a circle or an ellipse is especially preferred since the fiber has uniform properties in the cross section, has isotropic bending stress and is unlikely to generate fiber abrasion. In this case, the ellipse is defined as an ellipse in which the ratio P of the major axis S to the minor axis T ($P = S/T$) is 2.0 or less, and a form with a P value of more than 2.0 is defined as a flat. Further on the other hand, in response to the properties and required alignment

degree of the alignment film, flat form, polygonal form, multi-lobed form, hollow form or special form, etc. can be suitably employed as the sectional form of single fibers. Especially, a polygonal form or multi-lobed form is preferred as the sectional form of single fibers, since the fibers can be made anisotropic in the bending direction, to enhance or lower the stiffness of the single fibers per se at the time of rubbing treatment. Further, a polygonal form in a range from trigonal form to hexagonal form with acute angles or a multi-lobed form having three or more lobes with sharp projections is especially preferred, since fine rubbing treatment capable of achieving more highly precise liquid crystal displaying is possible.

[0027] Further, it is preferred that the warp yarns or weft yarns used to constitute the woven or knitted fabric, namely, to form the surface layer of the woven or knitted fabric are formed of non-crimped fibers. Usually when a textile product such as a woven fabric or knitted fabric is produced, fibers are crimped by circular crimping such as twisting, false-twisting or abrasion or non-circular crimping such as indentation, shaping or multi-component conjugation for increasing the entanglement or friction among fibers to thereby form firmer fabric texture. Also in the woven or knitted fabric constituting the rubbing cloth of this invention, crimped or non-crimped fibers can be used for producing the woven or knitted fabric per se. However, it is preferred as described before that the warp yarns or weft yarns used to form the surface layer of the woven or knitted fabric constituting the rubbing cloth of this invention are formed of non-crimped fibers (flat yarns), since a rubbing cloth with precise and fine alignment performance as intended in this invention can be produced.

[0028] It is preferred that the fibers used in the woven or knitted fabric constituting the rubbing cloth of this invention have an initial tensile modulus of 15 cN/dtex or more, since the rubbing performance suitable for each purpose can be widely obtained. Further, fibers especially high in bending stiffness (having high correlation with the initial tensile modulus) are preferred, since the rubbing cloth formed of such fibers can be strongly indented for allowing such rubbing treatment as to achieve a high alignment degree in the alignment film and can withstand the resilient stress acting at the moment when the rubbing cloth is pressed against the alignment film. An initial tensile modulus of 45 cN/dtex or more is more preferred and 70 cN/dtex or more is especially preferred. Most preferred is 90 cN/dtex or more. Further, it is preferred that the upper limit of the initial tensile modulus is 300 cN/dtex or less, since stable production can be made and 200 cN/dtex or less is more preferred.

[0029] It is preferred that the fibers used in the woven or knitted fabric constituting the rubbing cloth of this invention have such durability that the fibers are not cut even if they are small in single fiber fineness. Therefore, it is preferred that the fibers have a breaking strength of 2.0 cN/dtex or more. More preferred is 2.5 cN/dtex or more, and especially preferred is 3.0 cN/dtex or more. It is preferred that the breaking strength is higher, but considering productivity, fibers with a breaking strength of 7.0 cN/dtex or less can be suitably produced. Furthermore, it is preferred that the fibers have a residual elongation of 5 to 80%, since it is preferred that the deformation of the fibers at the time of rubbing treatment is small. A range of 5 to 50% is especially preferred.

[0030] As the fibers used in the woven or knitted fabric constituting

the rubbing cloth of this invention, at least one selected from natural fibers, semi-synthetic fibers, regenerated fibers and synthetic fibers can be used. However, it is preferred that the fibers have stable physical properties, and filament yarns are preferred as described before. Therefore, semi-synthetic fibers, regenerated fibers and synthetic fibers are preferred, and especially synthetic fibers are preferred.

[0031] The polymers that constitute the semi-synthetic fibers, regenerated fibers and synthetic fibers include, for example, polyesters, polyamides, polyimides, polyolefins, vinyl-based polymers synthesized by addition polymerization of vinyl groups such as polymethacrylate-based polymers and polyacrylonitrile-based polymers, fluorine-based polymers, cellulose-based polymers, silicone-based polymers, aromatic or aliphatic ketones, elastomers such as natural rubbers and synthetic rubbers, and other diverse engineering plastics. However, in view of heat resistance and fiber chipping resistance, polyesters and/or polyamides are preferred.

[0032] Preferred polyamides include polyamides respectively formed by the reaction between a carboxylic acid or carboxylic acid chloride and an amine. Particularly nylon 6, nylon 7, nylon 9, nylon 11, nylon 12, nylon 6,6, nylon 4,6, nylon 6,9, nylon 6,12, nylon 5,7, nylon 5,6, nylon 6T, nylon 9T, MXD6 nylon, etc. can be enumerated. To such an extent that the object of this invention is not impaired, a polyamide copolymerized with another aromatic, aliphatic or alicyclic dicarboxylic acid and another aromatic, aliphatic or alicyclic diamine can be used, or a polyamide copolymerized with only one aromatic, aliphatic, alicyclic aminocarboxylic compound having both a carboxylic acid and an amino group can also be used, or a polyamide further copolymerized with

third and fourth copolymerization components can also be used.

[0033] Further, preferred polyesters include polyesters respectively formed by the esterification reaction between a carboxylic acid and an alcohol. They particularly include polymers respectively formed of the ester linkage between a dicarboxylic acid compound and a diol compound. Such polymers include aromatic polyesters such as polyethylene terephthalate (PET), polytrimethylene terephthalate (also may be called polypropylene terephthalate; PTT), polytetramethylene terephthalate (PBT), polyethylene naphthalate (PEN), polypropylene naphthalate (PPN) and poly(cyclohexanedimethanol terephthalate) (PCMT), liquid crystal polyesters with melt liquid crystal properties containing an aromatic hydroxycarboxylic acid as a main component, etc. Further, a polyester formed of the ester linkage between a dicarboxylic acid compound and a diol compound can also be copolymerized with another component, for example, a dicarboxylic acid compound to such an extent that the object of this invention is not impaired. The dicarboxylic acid compound can be selected from aromatic, aliphatic and alicyclic dicarboxylic acids such as terephthalic acid, isophthalic acid, naphthalenedicarboxylic acid, diphenyldicarboxylic acid, anthracenedicarboxylic acid, phenanthrene dicarboxylic acid, diphenylether dicarboxylic acid, diphenoxyethanedicarboxylic acid, diphenylethanedicarboxylic acid, adipic acid, sebacic acid, 1,4-cyclohexanedicarboxylic acid, 5-sodiumsulfoisophthalic acid, 5-tetrabutylphosphonium isophthalic acid, azelaic acid, dodecanedioic acid and hexahydroterephthalic acid, derivatives thereof such as alkylation, alkoxylation, allylation, arylation, amination, imination and halogenation products, addition products, structural isomers and optical isomers thereof. Any one of these dicarboxylic acid

compounds can be used alone, or two or more of them can also be used in combination to such an extent that the object of this invention is not impaired.

[0034] As preferred copolymerization components of polyesters, diol compounds can be copolymerized. The diol compounds include aromatic, aliphatic and alicyclic diol compounds such as ethylene glycol, propylene glycol, butylene glycol, pentanediol, hexanediol, 1,4-cyclohexanedimethanol, neopentyl glycol, hydroquinone, resorcinol, dihydroxybiphenyl, naphthalenediol, anthracene diol, phenanthrene diol, 2,2-bis(4-hydroxyphenyl)propane, 4,4'-dihydroxydiphenylether, bisphenol S, polyethylene glycol, polypropylene glycol and polybutylene ether, derivatives thereof such as alkylation, alkoxylation, allylation, arylation, amination, imination and halogenation products, addition products, structural isomers and optical isomers thereof. Any one of these diol compounds can be used alone, or two or more of them can also be used in combination to such an extent that the object of this invention is not impaired.

[0035] Further, as preferred copolymerization components of polyesters, there are compounds respectively having a hydroxyl group and a carboxylic acid, namely, hydroxycarboxylic acids. The hydroxycarboxylic acids include aromatic, aliphatic and alicyclic hydroxycarboxylic acids such as lactic acid, 3-hydroxypropionate, 3-hydroxybutylate, 3-hydroxybutyrate valerate, hydroxybenzoic acid, hydroxynaphthoeic acid, hydroxyanthracene carboxylic acid, hydroxyphenanthrene carboxylic acid and (hydroxyphenyl)vinyl carboxylic acid, derivatives thereof such as alkylation, alkoxylation, allylation, arylation, amination, imination and halogenation products, addition products, structural isomers and optical isomers thereof. Any one of these hydroxycarboxylic acids

can be used alone, or two or more of them can also be used in combination to such an extent that the object of this invention is not impaired.

[0036] As preferred polyesters, polyesters in which an aromatic, aliphatic or alicyclic compound having a carboxylic acid and a hydroxyl group, namely, an aromatic, aliphatic or alicyclic hydrocarboxylic acid compound is a main recurring unit, can also be used. Polymers respectively containing such a hydroxycarboxylic acid include polyesters containing a hydroxycarboxylic acid such as polyglycolic acid, polylactic acid, poly(3-hydroxybutyric acid), poly(4-hydroxybutyric acid), poly(4-hydroxyvaleric acid) or poly(6-hydroxycaproic acid), and polyesters such as polyglycolic acid and polylactic acid obtained by polymerizing a single monomer such as glycollide, lactide, butyrolactone or caprolactone, and further, any of these polyhydroxycarboxylic acids may also be copolymerized with an aromatic, aliphatic or alicyclic dicarboxylic acid or an aromatic, aliphatic or alicyclic diol to such an extent that the object of this invention is not impaired, or may also be copolymerized with multiple hydroxycarboxylic acids.

[0037] Among these preferred polyesters, PET-based polymers, PTT-based polymers, PBT-based polymers, PEN-based polymers, PCMT-based polymers and PPN-based polymers are preferred, for such reasons that since they have a high initial tensile modulus, the woven or knitted fabric obtained by using any of the polyesters can have excellent alignment properties at the time of rubbing treatment and that since they have a high melting point, the fibers are unlikely to be deformed even by the friction heat generated at the time of rubbing treatment. Polyesters such as PET-based polymers, PEN-based polymers and PCMT-based polymers are especially

preferred.

[0038] As the material of the fibers used in the woven or knitted fabric constituting the rubbing cloth of this invention, it is preferred to use any of the preferred polyesters and/or polyamides as described above. Any one of the polyesters and/or polyamides may be used alone, or multiple polyesters and/or polyamides may also be used together to such an extent that the object of this invention is not impaired. Further, in the woven or knitted fabric used in this invention, conductive fibers, electrostatic fibers or stretchable fibers may also be used together to such an extent that the object of this invention is not impaired.

[0039] Further, the fibers used in the woven or knitted fabric constituting the rubbing cloth of this invention may contain small amounts of additives such as a delustering agent, flame retarder, lubricant, thinner, antioxidant, ultraviolet light absorber, infrared light absorber, crystal nucleating agent, fluorescent brightener, end-group sealer and conducting agent to such an extent that the object of this invention is not impaired.

[0040] The rubbing cloth of this invention has an elastic material laminated on the aforementioned woven or knitted fabric. The rubbing cloth of this invention in which a woven or knitted fabric and an elastic material are laminated on each other and integrated has the woven or knitted fabric disposed to contact the alignment film when the rubbing cloth is used for rubbing treatment, and the elastic material plays the role of pressing the woven or knitted fabric against the alignment film. Materials suitable as the elastic material layer include a polyurethane foam, polyethylene foam, polypropylene foam, polystyrene foam, polylactic acid foam, non-woven fabric, etc. Further, for the purpose of adjusting mechanical properties such as elastic modulus, a non-woven fabric

or woven or knitted fabric impregnated or coated with such a resin as polyurethane or melamine can also be used. Among them, a polyurethane foam is more preferred since it has moderate elasticity and is well adhesive to the woven or knitted fabric when the elastic material and the woven or knitted fabric are laminated on each other and integrated. The polyurethane foam consists of an isocyanate component, polyol component (high molecular weight polyol component, low molecular weight polyol component) and chain extender. As the isocyanate component, any compound publicly known in the field of polyurethanes can be used without any limitation. Examples of the isocyanate component include aromatic diisocyanates such as 2,4-toluene diisocyanate, 2,6-toluene diisocyanate, 2,2'-diphenylmethane diisocyanate, 2,4'-diphenylmethane diisocyanate, 4,4'-diphenylmethane diisocyanate, 1,5-naphthalene diisocyanate, p-phenylene diisocyanate, m-phenylene diisocyanate, p-xylylene diisocyanate and m-xylylene diisocyanate, aliphatic diisocyanates such as ethylene diisocyanate, 2,2,4-trimethylhexamethylene diisocyanate and 1,6-hexamethylene diisocyanate, and alicyclic diisocyanates such as 1,4-cyclohexane diisocyanate, 4,4'-dicyclohexylmethane diisocyanate, isophorone diisocyanate and norbornene diisocyanate. Any one of them can be used alone, or two or more of them can also be used as a mixture. As the isocyanate compound, in addition to the abovementioned diisocyanate compounds, a trifunctional or higher polyfunctional polyisocyanate compound can also be used. As polyfunctional isocyanate compounds, a series of diisocyanate adduct compounds such as Desmodul-N (produced by Bayer) and trade name Duranate (produced by Asahi Kasei Corp.) are commercially available. Among the abovementioned isocyanate components, it is preferred to use an aromatic diisocyanate and alicyclic diisocyanate together. It

is especially preferred to use toluene diisocyanate and dicyclohexylmethane diisocyanate together. High molecular weight polyol components include polyether polyols typified by polytetramethylene ether glycol, polyester polyols typified by polybutylene adipate, polyester polycarbonate polyols exemplified by the reaction product obtained from a polyester glycol such as polycaprolactone polyol or polycaprolactone and an alkylene carbonate, polyester polycarbonate polyols obtained by letting ethylene carbonate react with a polyhydric alcohol and then letting the obtained reaction mixture react with an organic dicarboxylic acid, polycarbonate polyols obtained by the ester interchange reaction between a polyhydroxyl compound and an aryl carbonate, etc. Any one of them can be used alone or two or more of them can also be used together. The number average molecular weight of the high molecular weight polyol component is not especially limited, but in view of the elastic properties of the obtained polyurethane resin, a number average molecular weight of 500 to 2000 is preferred. If the number average molecular weight is less than 500, the polyurethane resin obtained by using the polyol does not have sufficient elastic properties and becomes a fragile polymer. On the other hand, if the number average molecular weight is more than 2000, the polyurethane resin obtained by using the polyol component is too soft. As the polyol component, in addition to the abovementioned high molecular weight polyol components, it is preferred to use a low molecular weight polyol component such as ethylene glycol, 1,2-propylene glycol, 1,3-propylene glycol, 1,4-butanediol, 1,6-hexanediol, neopentyl glycol, 1,4-cyclohexanedimethanol, 3-methyl-1,5-pentanediol, diethylene glycol, triethylene glycol or 1,4-bis(2-hydroxyethoxy)benzene together. A low molecular weight polyamine component such as

ethylenediamine, tolylenediamine, diphenylmethanediamine or diethylenetriamine can also be used. The (number average) molecular weight of the low molecular weight polyol component or the low molecular weight polyamine component is less than 500, preferably 250 or less. In the case where a polyurethane resin foam is produced by a prepolymer method, a chain extender is used for curing the prepolymer. The chain extender is an organic compound having at least two or more active hydrogen groups, and examples of the active hydrogen groups include hydroxyl groups, primary or secondary amino groups, thiol groups (SH), etc. Examples of the chain extender include polyamines exemplified by 4,4'-methylenebis(o-chloroaniline) (MOCA), 2,6-dichloro-p-phenylenediamine, 4,4'-methylenebis(2,3-dichloroaniline), 3,5-bis(methylthio)-2,4-toluenediamine, 3,5-bis(methylthio)-2,6-toluenediamine, 3,5-diethyltoluene-2,4-diamine, 3,5-diethyltoluene-2,6-diamine, trimethyleneglycol-di-p-aminobenzoate, 1,2-bis(2-aminophenylthio)ethane, 4,4'-diamino-3,3'-diethyl-5,5'-dimethyldiphenylmethane, N,N'-di-sec-butyl-4,4'-diaminodiphenylmethane, 3,3'-diethyl-4,4'-diaminodiphenylmethane, m-xylylenediamine, N,N'-di-sec-butyl-p-phenylenediamine, m-phnylenediamine and p-xylylenediamine, and further, the abovementioned low molecular weight polyol components and low molecular weight polyamine components. Any one of them can be used alone, or two or more of them can also be used as a mixture. The ratio of the isocyanate component, polyol component and chain extender can be changed variously in reference to the molecular weights and desired physical properties of the respective compounds. The polyurethane resin

foam can be produced by either a prepolymer method or one shot method. However, a prepolymer method in which a prepolymer with isocyanate end groups is synthesized beforehand from an isocyanate component and a polyol component, a chain extender being made to react with the prepolymer, is suitable, since the physical properties of the obtained polyurethane resin are excellent. Meanwhile, a prepolymer with isocyanate end groups having a molecular weight of about 800 to about 5000 is suitably excellent in processability, physical properties, etc. A polyurethane resin foam can be produced by a method of adding hollow beads, mechanically foaming method, chemically foaming method, etc.

[0041] As a further other method for producing a polyurethane foam, a method of wet-coagulating a polyurethane can be employed. In this method, a polyurethane resin is dissolved into a water-miscible solvent such as DMF, and the solution is cast on release paper or film, the release paper or film being immersed in water or an aqueous solution of the abovementioned water-miscible solvent. According to this method, the water-miscible solvent is replaced by water, etc., to coagulate the polyurethane, when a microporous structure is formed.

[0042] The elastic material produced as described above and the woven or knitted fabric are laminated on each other and integrated to form a rubbing cloth. As the integration method, a frame lamination method or bonding method is preferred. A bonding method is preferred since no heat treatment is required. That is, for bonding the woven or knitted fabric and the elastic modulus to each other, a method of giving an adhesive to either the woven or knitted fabric or the elastic material and sticking both can be preferably used. As the adhesive, an acrylic, polyurethane-based or polyester-based resin can be selectively used as appropriate. As

the method for applying the adhesive, a method of heating the adhesive to higher than the melting point thereof to melt it for coating, a method of dissolving the adhesive into a solvent or dispersing the adhesive into water for coating can be employed. Further, a method placing a non-woven fabric or film formed of the adhesive between the woven or knitted fabric and the elastic material and hot-pressing the laminate for achieving bonding can also be employed. As said bonding method further, either a method of fixing the woven or knitted fabric and the elastic material at several points of the interface or a method of fixing them on the entire interface can be selected. A method of fixing the woven or knitted fabric and the elastic material on the entire interface is especially preferred for preventing that the woven or knitted fabric and the elastic material shift from each other during rubbing treatment.

[0043] It is preferred that the elastic material used in the rubbing cloth of this invention is such that the ratio R of the stress at the time of 50% compression (P_2) to the stress at the time of 10% compression (P_1) in the thickness direction of the rubbing cloth ($R = P_2/P_1$) is in a range of $0.90 \leq R \leq 2.00$. Usually, in rubbing treatment, a rubbing roller having a rubbing cloth formed around it is rotated and moved straight on the alignment film formed on the surface of a substrate while being kept in contact with the alignment film, to make the alignment film aligned. During the time period from the time when the rubbing roller starts contact with the alignment film till the time when the rubbing roller leaves from the alignment film, the distance between the curved surface of the roller and the alignment film changes gradually with the rotation of the roller. That is, while the roller is rotated, the rubbing cloth is continuously compressively deformed in the

thickness direction of the rubbing cloth. In the rubbing treatment, even during the series of compressive deformation, it is preferred that the alignment performance of the rubbing cloth does not change as far as possible, and that alignment treatment is performed at a constant stress. That is, even during the aforementioned continuous compressive deformation, it is preferred that the stress of the elastic material at the time of compression does not change. Therefore, it is preferred that the elastic material used in the rubbing cloth of this invention is such that the ratio of the stress at the time of 50% compression (P2) to the stress at the time of 10% compression (P1) in the thickness direction of the rubbing cloth is in a range of $0.90 \leq R \leq 2.00$, so that stable alignment performance can be exhibited during rubbing. In view of stable rubbing performance free from alignment irregularity, it is more preferred that said ratio R is in a range of $0.90 \leq R \leq 1.80$. An especially preferred range is $1.00 \leq R \leq 1.50$.

[0044] The thickness of the rubbing cloth of this invention can be decided in reference to the rubbing device used. However, it is preferred that the thickness of the rubbing cloth is 0.5 mm or more, since the resiliency of the elastic material effectively acts. More preferred is 1.0 mm or more, and especially preferred is 1.5 mm or more. It is preferred that the upper limit in the thickness of the rubbing cloth is 20 mm or less, since it is difficult to install a too thick rubbing cloth in the rubbing device. More preferred is 10 mm or less.

[0045] This invention is explained below particularly in more detail based on examples, but is not limited thereto or thereby. Meanwhile, the physical property values in the following examples were measured according to the following methods.

EXAMPLES

[0046] A. Measurement of single fiber fineness [decitexes (dtex)]

Fibers (multifilament) were reeled by a length of 100 m, and the weight (g) of the reeled fibers was measured. The measured value was multiplied by 100. The multifilament was weighed three times like this, and the mean value was obtained as the fineness of the multifilament. The fineness was divided by the number of the single fibers constituting the multifilament, to obtain a single fiber fineness [dtex]. Calculation was made with two significant digits.

[0047] B. Measurement of initial tensile modulus, residual elongation and breaking strength of fibers

A tensile tester produced by Orientec Co., Ltd. (Tensiron UCT-100) was used to measure the initial tensile module (drawn yarns only), breaking strength and residual elongation at an initial sample length of 50 mm and at a stress rate of 400 mm/min for undrawn yarns or at an initial sample length of 200 mm and at a stress rate of 200 mm/min for drawn yarns. The measurement was made five times, and the mean value of five measured values was employed as the value of each property. For the initial tensile modulus, recording on a chart sheet was made at a chart speed of 100 cm/min and with a stress full range of 500 g, and the initial tensile modulus was obtained from the gradient of the curve in the beginning of tension. The initial tensile modulus, residual elongation and breaking strength were calculated with two significant digits.

[0048] C. Calculation of ratio R of the stress at the time of 50% compression (P2) to the stress at the time of 10% compression (P1) of elastic material ($R = P2/P1$)

According to "7. Compression deflection method B" of JIS K 6400-2 (2004), a 50 mm thick, 300 mm long and 300 mm wide specimen was indented by a pressure plate with a diameter of 200 mm at an indentation speed of 100 mm per minute down to 75% thickness of

the specimen in an atmosphere of 23°C temperature and 50% relative humidity, and the pressure plate was returned at the same speed. The series of compression-stress curve was automatically recorded for measurement. The ratio R was calculated from the stress at the time of 10% compression (P1) and the stress at the time of 50% compression, with three significant digits.

[0049] D. Evaluation of alignment performance (alignment regulation force) and evaluation of fiber abrasion

A substrate with an alignment film to be treated with rubbing was prepared and treated with rubbing for evaluation. Particularly, a 10 cm square glass substrate with a polyimide alignment film was prepared, and on the other hand, a rubbing cloth stuck to a rubbing roller made of stainless steel with a diameter of 50 mm using a double-coated adhesive tape was attached to a rubbing device. Meanwhile, the polyimide alignment film was prepared by coating the glass substrate with a polyimide precursor solution (SE-7492 produced by Nissan Chemical Industries, Ltd.) and baking at 250°C. [0050] In the rubbing device, while the rubbing roller was rotated at a rotation speed of 1500 rpm, the rubbing cloth was brought closer to the alignment film and pressed against the surface of the alignment film till the thickness of the rubbing cloth from the surface became 50% (this state is called 50% indentation). In this state, the stage mounted with the substrate was moved in a certain direction at a moving speed of 30 mm/sec, to perform rubbing treatment. This rubbing treatment was performed for two substrates using the same rubbing cloth, and the two substrates were jointed so that the alignment films might face each other with the rubbing treatment directions kept in anti-parallel to each other, to form a cell. The clearance between the two substrates was packed with a liquid crystal. The final liquid crystal cell gap was about 5

μm.

[0051] The prepared liquid crystal cell was held between two polarizing plates, and light was transmitted for visually observing the alignment state of the liquid crystal, in comparison with the intensity of the light transmitted through a place other than the liquid crystal cell. The liquid crystal cell showing good light transmittance and found to be sufficient in alignment performance was evaluated to be excellent (expressed by a double circle), and the liquid crystal cell showing the marks of liquid crystal flow caused when the liquid crystal was packed or found to be weak in liquid crystal alignment performance but showing light transmittance was evaluated to be good (expressed by a single circle). Further, the liquid crystal cell showing no light transmittance at all was evaluated to be poor (expressed by a triangle).

[0052] Further, after completion of rubbing treatment, the surface of the alignment film on the substrate and the ends of the alignment film were observed using Digital Microscope VHX-100 produced by Keyence Corporation. The alignment film showing no fiber abrasion at all or showing a few fiber abrasion on the surface or at the ends thereof was evaluated to be excellent (expressed by a double circle), and the alignment film showing fiber abrasion on the surface or at the ends thereof but less than the fiber abrasion of the rubbing cloth formed of a pile cloth of Comparative Example 2 was evaluated to be good (expressed by a single circle). The alignment film showing fiber abrasion on the surface or at the ends thereof as many as or more than the fiber abrasion of Comparative Example 2 was evaluated to be poor (expressed by a triangle).

[0053] (Method for producing polyethylene terephthalate (PET)):
An oligomer was obtained from 166 parts by weight of terephthalic

acid and 75 parts by weight of ethylene glycol by an ordinary esterification reaction, and 0.03 part by weight of 85% phosphoric acid aqueous solution as a coloration preventive, 0.06 part by weight of antimony trioxide as a polycondensation catalyst and 0.06 part by weight of cobalt acetate tetrahydrate as a toner were added to the oligomer, to perform a polycondensation reaction, for obtaining usually used pellets of polyethylene terephthalate (hereinafter referred to as PET) of IV 0.66.

[0054] (Production of polytrimethylene terephthalate (PTT)): One hundred thirty parts (6.7 mole parts) of dimethyl terephthalate, 114 parts (15 mole parts) of 1,3-propanediol, 0.24 part (0.014 mole part) of calcium acetate monohydrate and 0.1 part (0.01 mole part) of lithium acetate dihydrate were added, and while methanol was distilled away, an ester interchange reaction was performed to obtain an oligomer. To the oligomer, 0.065 part of trimethyl phosphate and 0.134 part of titanium tetrabutoxide were added, and while 1,3-propanediol was distilled away, a polycondensation reaction was performed to obtain a prepolymer as chips. The obtained prepolymer was further polymerized in solid phase in a nitrogen stream at 220°C, to obtain pellets of polytrimethylene terephthalate (PTT) of IV 1.16. Before the PTT pellets were used for melt spinning, they were dried in vacuum at 150°C for 10 hours.

[0055] (Production of warp yarn 1): The PET pellets were dried in vacuum at 150°C for 10 hours and melt-spun using an extruder type melt spinning machine equipped with a double-screw extruder (screw length L/screw diameter D = 35) at a spinning temperature of 280°C, using a die having 144 round holes with a hole diameter of 0.20 mm, and an aqueous treating agent (effective component concentration 20 wt%) was deposited on the filaments to have 1 wt% of the effective component deposited thereon. Then, the filaments

were taken up at a speed of 1500 m/min, to obtain a wound multifilament.

[0056] The wound multifilament was drawn and heat-treated with the yarn feed speed of a yarn feed roller at 320 m/min, with the yarn feed speed of a first roller at 320 m/min at 80°C, with the yarn feed speed of a second roller at 800 m/min at 120°C and with the yarn feed speed of a third roller at 800 m/min at room temperature, and the yarn was cooled by a cold roller to lower than the glass transition temperature (T_g ; 77°C) of the polyester, and wound to obtain a drawn multifilament yarn (warp yarn 1) with a multifilament fineness of 144 dtex, consisting of 144 filaments with a single filament fineness of 1.00 dtex, the cross sectional form of each filament being round. The fiber physical properties of the warp yarn 1 are shown in the column of woven fabric 1 in Table 1.

[0057] (Production of weft yarn 1): Melt spinning, drawing and heat treatment were performed by the same methods as those for producing the warp yarn 1, except that a die with 48 round holes with a hole diameter of 0.30 mm was used, to obtain a drawn multifilament yarn (weft yarn 1) with a multifilament fineness of 56 dtex, consisting of 48 filaments with a single filament fineness of 1.17 dtex, the cross sectional form of each filament being round.

[0058] (Production of woven fabric 1): The warp yarn 1 and the weft yarn 1 (both, non-crimpled flat yarns) were used to prepare a 10-harness warp satin weave fabric with 1000 warp multifilaments per centimeter and 44 weft multifilaments per centimeter.

[0059] [Table 1]

Table 1)

Properties		Unit	Woven fabric 1	Woven fabric 2	Woven fabric 3	Woven fabric 4	Woven fabric 5	Woven fabric 6	Woven fabric 1
Properties of fibers (warp yarns)	Production method (*1)	—	Direct spinning	Dissolving away	Dissolving away	Direct spinning	Direct spinning	Direct spinning	Direct spinning
	Polymer	—	PET	PET	PET	PET	PET	PET	PET
	Cross sectional form of fibers	—	Round	Round	Round	Round	Round	Round	Round
	Multifilament fineness	d tex	1 4 4	1 4 4	1 9 6	5 6	7 2	7 2	5 6
	Filament count (*2)	fibers	1 4 4	2 8 8	2 4 5 0	3 6	4 8	1 4 4	3 6
	Single filament fineness	d tex	1.0	0.5	0.08	1.6	1.5	0.5	1.6
	Initial tensile modulus	cN/dtex	102	96	92	111	112	104	111
	Strength	cN/dtex	4.0	3.5	3.0	4.5	4.5	4.0	4.5
	Elongation	%	38	35	31	38	39	39	38
	Crimping	—	Non-crimped	Non-crimped	Non-crimped	Non-crimped	Non-crimped	Non-crimped	Non-crimped
Properties of woven fabric (warp satin)	Type of satin weave (*3)	—	10-harness satin	10-harness satin	10-harness satin	10-harness satin	10-harness satin	8-harness satin	5-harness satin
	Number of multifilaments (*4)	yarns/cm	100	100	100	70	80	180	100
	Number of single filaments (*5)	fibers/cm	14400	28800	245000	2520	3840	25920	3600

Properties		Unit	Woven fabric 8	Woven fabric 9	Woven fabric	Woven fabric 11	Woven fabric	Woven fabric	Woven fabric
Properties of fibers (warp yarns)	Production method (*1)	—	Direct spinning	Direct spinning	Dissolving away	Direct spinning	Direct spinning	Direct spinning	Direct spinning
	Polymer	—	PET	PET	PET	PEN	PTT	PBT	Ny6
	Cross sectional form of fibers	—	Round	Round	Sharp 15μm leveled	Round	Round	Round	Round
	Multifilament fineness	d tex	1 4 4	7 2	1 4 4	1 4 4	1 4 4	1 4 4	1 1 8
	Filament count (*2)	fibers	1 4 4	3 6	1 4 4	1 4 4	1 4 4	1 4 4	1 4 4
	Single filament fineness	d tex	1.0	2.0	1.0	1.0	1.0	1.0	0.82
	Initial tensile modulus	cN/dtex	102	112	92	138	29	48	24
	Strength	cN/dtex	4.0	4.5	3.8	4.6	3.9	4.0	4.1
	Elongation	%	38	39	34	32	38	36	38
	Crimping	—	Crimped	Non-crimped	Non-crimped	Non-crimped	Non-crimped	Non-crimped	Non-crimped
Properties of woven fabric (warp satin)	Type of satin weave (*3)	—	10-harness satin	10-harness satin	10-harness satin	10-harness satin	10-harness satin	10-harness satin	10-harness satin
	Number of multifilaments (*4)	yarns/cm	100	50	100	100	100	100	100
	Number of single filaments (*5)	fibers/cm	14400	1800	14400	14400	14400	14400	14400

*1 Production method: Fiber production method selected from the following:

Direct spinning: A method for obtaining fibers comprising melt spinning, drawing and heat treatment, without dissolving or splitting

Dissolving away: A method comprising the step of dissolving away the sea component of an islands-in-sea type conjugate yarn using a solvent, to obtain island fibers only

Yarn splitting: Method of splitting a yarn by stressing the yarn, to obtain fibers with a small fineness

*2 Filament count: Number of single filaments constituting a multifilament

*3 Type of satin weave: This refers to the number of warp yarns intersecting each weft yarn or the number of weft yarns intersecting each warp yarn. A satin weave in which five warp yarns intersect each weft yarn or five weft yarns intersect each warp yarn is called "5-harness satin," and if the number is 10 instead of 5, the satin weave is called "10-harness satin."

*4 Number of multifilaments: Number of multifilaments per 1 cm, as the warp yarns in the direction parallel to the rubbing direction on the surface of the satin weave fabric to be pressed against the orientation film

*5 Number of single filaments: Number of single filaments per 1 cm, of the warp yarns exposed more than weft yarns on the surface to be pressed against the orientation film.

PET: Polyethylene terephthalate PEN: Polyethylene naphthalate PTT: Polytetramethylene terephthalate PBT: Polybutylene terephthalate Ny6: Nylon 6

[0060] (Production of warp yarns 2, 3 and 10): Wound multifilaments were obtained by the same method as that of warp yarn 1, except that an extruder type conjugate yarn melt spinning machine equipped with two double-screw extruders (screw length L/screw diameter D = 35) was used to produce an islands-in-sea type conjugate yarn 2 or 3 (warp yarn 2 ... 36 islands x 8 holes; warp yarn 3 ... 70 islands x 35 holes) using PET as the island component and PEG-copolymerized

PET obtained by copolymerizing 15 wt% of polyethylene glycol (PEG) having an average molecular weight of 1000 as the sea component, or to produce a sheath-core conjugate yarn (core ... PET, sheath ... PEG-copolymerized PET; the sheath-core form as shown in Fig. 2; 144 holes in the die), and that the spinning temperature for melt spinning was 275°C. The wound multifilaments were drawn and heat-treated by the same method as that for the warp yarn 1, to obtain drawn multifilament yarns. The obtained yarns were treated with 1% sodium hydroxide aqueous solution, to obtain warp yarn 2, warp yarn 3 and warp yarn 10.

[0061] (Production of warp yarns 4 to 9): Melt spinning, drawing and heat treatment were performed by the same methods as those for producing the warp yarn 1, except that a die with holes as many as the filament count shown in Table 1 (with a hole diameter of 0.30 mm for warp yarn 4, 5, 7 or 9 or 0.20 mm for warp yarn 6 or 8) was used, to obtain drawn multifilament flat yarns (warp yarns 4 to 7 and 9) round in the cross sectional form of each filament shown in Table 1. Meanwhile, the warp yarn 8 was obtained as a crimped yarn twisted by 100 T/m.

[0062] (Production of warp yarns 11 to 14): Melt spinning, drawing and heat treatment were performed by the same methods as those for producing the warp yarn 1, except that the polymer (warp yarn 11 ... polyethylene naphthalate HIPERTUF 90000 produced by M&G Polymers, hereinafter referred as PEN; warp yarn 12 ... PTT; warp yarn 13 ... polybutylene terephthalate type 1100SS produced by Toray Industries, Inc., hereinafter referred to as PBT; warp yarn 14 ... nylon 6 type 300 produced by Toray Industries, Inc.) shown in Table 1 was used, that a die with holes as many as the filament count (with a hole diameter of 0.20 mm) was used, and that the spinning temperature was 310°C for warp yarn 11 or 250°C for warp yarn 12, 13 or 14, to

obtain drawn multifilament flat yarns (warp yarns 11 to 14) round in the cross sectional form of each filament shown in Table 1.

[0063] (Production of woven fabrics 2 to 14): Warp satin weave fabrics (woven fabrics 2 to 14) with 44 weft multifilaments per centimeter, each multifilament being the same weft yarn 1 as that of the woven fabric 1, were prepared using the abovementioned warp yarns 2 to 14. The types of satin, the numbers of warp multifilaments and the numbers of warp single filaments of the respective woven fabrics are shown in Table 1.

[0064] Examples 1 to 25 and Comparative Example 1

Rubbing cloths of Examples 1 to 25, each having the thickness shown in Table 3, using any one of the woven fabrics 1 to 14 shown in Table 1, and having the properties shown in Table 2 and Figs. 3 and 4, were obtained using polyurethane foam type TB-QJH (characteristics as shown in Fig. 3; Examples 1 to 14 and 21 to 24; hereinafter referred as the elastic material 1) or type ZF (characteristics as shown in Fig. 4; Examples 15 to 20 and 25; hereinafter referred to as the elastic material 2) respectively produced by Achilles Corporation, and an acrylic acid ester-based adhesive, DICNAL K-1500 produced by Dainippon Ink and Chemicals, Inc. (2 wt% of DICNAL VS-20 used as a thickener per 100 wt% of K-1500; Examples 1 to 21 and 23 to 25; hereinafter referred as the adhesive) or using a frame lamination method. A rubbing cloth using the woven fabric 1 only without using any elastic material was evaluated as Comparative Example 1. Evaluation results of alignment performance (alignment regulation force) and fiber abrasion are shown in Table 3. It was found that the alignment performance and the degree of fiber abrasion changed in response to the single filament fineness, the polymer used for forming the filaments, the number of warp single filaments and the type of satin weave (Examples

1 to 14) and that the alignment performance and the degree of fiber abrasion changed also in response to the elastic material used, the thickness of the rubbing cloth, and the method of bonding the elastic material and the satin weave fabric (Examples 15 to 25). However, generally good results were obtained. On the other hand, in Comparative Example 1, few fiber abrasion occurred, but since there was no elastic material, it was difficult to uniformly press the rubbing cloth against the alignment film, and alignment irregularity occurred.

[0065] Comparative Example 2

The raised rayon cloth stated as No. 5 in Table 1 among the examples of Patent Document 2 was used to evaluate the alignment performance and fiber abrasion as in Example 1. Like Comparative Example 1, no elastic material was used. The alignment performance was good, but so many fiber abrasion occurred as to be buried also in the alignment film, and even if the cloth was washed with pure water, the fiber abrasion could not be removed to show that the cloth was poor in fiber abrasion.

[0066] [Table 2]

[Table 2]

Properties		Unit	Elastic material 1	Elastic material 2
Properties of elastic material	Material	—	Polyurethane foam	Polyurethane foam
	P1(*5)	N	1 9 1	3 7 0
	P2(*6)	N	2 6 4	7 2 3
	Ratio R (*7)	—	1.3 8	1.9 5

*5 P1: Stress at the time of 10% compression in the thickness direction of rubbing cloth

*6 P2: Stress at the time of 50% compression in the thickness direction of rubbing cloth

*7 Ratio R: Ratio of P2 to P1 ($R = P2/P1$)

[0067] [Table 3]

Table 3]

Properties	Unit	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Example 7	Example 8	Example 9
Woven fabric used	—	Woven fabric 1	Woven fabric 2	Woven fabric 3	Woven fabric 4	Woven fabric 5	Woven fabric 6	Woven fabric 7	Woven fabric 8	Woven fabric 9
Elastic material used	—	Elastic material 1	Elastic material 1	Elastic material 1	Elastic material 1	Elastic material 1	Elastic material 1	Elastic material 1	Elastic material 1	Elastic material 1
Bonding method	—	Adhesive	Adhesive	Adhesive	Adhesive	Adhesive	Adhesive	Adhesive	Adhesive	Adhesive
Bonding site	—	Entire interface	Entire interface	Entire interface	Entire interface	Entire interface	Entire interface	Entire interface	Entire interface	Entire interface
Thickness of rubbing cloth	mm	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Orientation performance	—	⊙	⊙	⊙	○	⊙	⊙	○	○	○
Fiber chips	—	⊙	⊙	○	⊙	⊙	⊙	⊙	⊙	⊙

Properties	Unit	Example 10	Example 11	Example 12	Example 13	Example 14	Example 15	Example 16	Example 17	Example 18
Woven fabric used	—	Woven fabric 10	Woven fabric 11	Woven fabric 12	Woven fabric 13	Woven fabric 14	Woven fabric 1	Woven fabric 3	Woven fabric 7	Woven fabric 9
Elastic material used	—	Elastic material 1	Elastic material 1	Elastic material 1	Elastic material 1	Elastic material 1	Elastic material 2	Elastic material 2	Elastic material 2	Elastic material 2
Bonding method	—	Adhesive	Adhesive	Adhesive	Adhesive	Adhesive	Adhesive	Adhesive	Adhesive	Adhesive
Bonding site	—	Entire interface	Entire interface	Entire interface	Entire interface	Entire interface	Entire interface	Entire interface	Entire interface	Entire interface
Thickness of rubbing cloth	mm	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Orientation performance	—	⊙	⊙	○	○	○	⊙	⊙	○	○
Fiber chips	—	⊙	⊙	⊙	○	⊙	⊙	○	⊙	⊙

Properties	Unit	Example 19	Example 20	Example 21	Example 22	Example 23	Example 24	Example 25	Comparative Example 1	Comparative Example 2
Woven fabric used	—	Woven fabric 10	Woven fabric 14	Woven fabric 1	Woven fabric 1	Woven fabric 1	Woven fabric 1	Woven fabric 2	Woven fabric 1	Raised rayon cloth
Elastic material used	—	Elastic material 2	Elastic material 2	Elastic material 1	Elastic material 1	Elastic material 1	Elastic material 1	Elastic material 2	Nil	Nil
Bonding method	—	Adhesive	Adhesive	Adhesive	Frame (*9)	Adhesive	Adhesive	Adhesive	—	—
Bonding site	—	Entire interface	Entire interface	Dotted (*8)	Entire interface	Entire interface	Entire interface	Entire interface	—	—
Thickness of rubbing cloth	mm	3.0	3.0	3.0	3.0	1.0	5.0	10.0	0.3	1.8
Orientation performance	—	⊙	○	○	⊙	○	⊙	○	△	○
Fiber chips	—	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	△

*8 Dotted: The adhesive was applied as 5 mm dots with the distance between the centers of the respectively adjacent dots kept at 10 mm.

*9 Frame: Frame lamination method

CLAIMS

- [1] A rubbing cloth comprising a woven or knitted fabric, wherein the woven or knitted fabric does not have raised lint and an elastic material laminated on each other and integrated, wherein the thickness of the rubbing cloth is 1.5 mm or more and 10 mm or less.
- [2] A rubbing cloth, according to claim 1, wherein the woven or knitted fabric is a satin weave fabric.
- [3] A rubbing cloth, according to claim 1 or 2, wherein the fibers constituting the woven or knitted fabric are long fibers.
- [4] A rubbing cloth, according to claim 2 or 3, wherein the number of single fibers of the warp yarns or weft yarns used to form the surface layer of the satin weave fabric is 2000 fibers or more per centimeter.
- [5] A rubbing cloth, according to any one of claims 2 through 4, wherein an intersection formed by five or more warp yarns and one weft yarn or formed by one warp yarn and five or more weft yarns recurs.
- [6] A rubbing cloth, according to any one of claims 2 through 5, wherein the single fiber fineness of the warp yarns or weft yarns used to form the surface layer of the satin weave fabric is 2.0 decitexes or less.
- [7] A rubbing cloth, according to any one of claims 2 through 6, wherein the warp yarns or weft yarns used to form the surface layer of the satin weave fabric is a polyester and/or polyamide.
- [8] A rubbing cloth, according to any one of claims 2 through 7, wherein the warp yarns or weft yarns used to form the surface layer of the satin weave fabric are formed of non-crimped fibers.
- [9] A rubbing cloth, according to any one of claims 1 through 8, wherein the elastic material used is such that the ratio R of the stress at the time of 50% compression (P_2) to the stress at the time of 10% compression (P_1) in the thickness direction of the rubbing cloth ($R = P_2/P_1$) is in a range of $0.90 \leq R \leq 2.00$.