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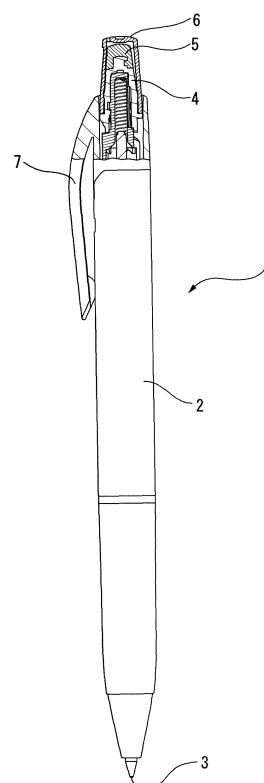
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(54) **FRICTION BODY, WRITING IMPLEMENT, AND WRITING IMPLEMENT SET**

(57) Provided are a friction body capable of reducing paper soiling caused by a strong force and/or repeated rubbing motion, and a writing instrument and writing instrument set provided with that friction body. Provided are a friction body that allows an image having thermochromicity to change color with frictional heat, the friction body containing a styrene-based elastomer, and having compression set at 120°C of 80% or less, and Shore A hardness of 60 to 98, and a writing instrument and writing instrument set provided therewith. The styrene-based elastomer is preferably crosslinked.

FIG. 1



Description

FIELD

5 **[0001]** The present invention relates to a friction body, a writing instrument and a writing instrument set.

BACKGROUND

10 **[0002]** Writing instruments have conventionally been known that are provided with thermochromic ink and a friction body and are configured so as to rub an image formed using the thermochromic ink with the friction body and allow the image to change color by frictional heat. Known examples of friction bodies include those composed of an elastomer.

[0003] PTL1 describes a friction body having elasticity that allows an image formed using a reversible thermochromic ink to change color from a first state to a second state by frictional heat, wherein the friction body is composed of silicone rubber.

15 **[0004]** PTL2 describes a friction body that allows an image formed using a reversible thermochromic ink to change color from a first state to a second state by frictional heat, wherein the friction body is composed of a styrene-butylene-styrene copolymer or styrene-ethylenebutylene-styrene copolymer. According to the invention described in PTL2, PTL2 describes to the effect that a friction body is obtained which, in addition to being able to allow a thermochromic image to easily change color without peeling off, is capable of reforming the thermochromic image on a rubbed portion without
20 repelling the ink.

[CITATION LIST]

[PATENT LITERATURE]

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[0005]

[PTL1] JP-A-2004-148744

[PTL2] JP-A-2006-123324

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SUMMARY

[TECHNICAL PROBLEM]

35 **[0006]** The inventors of the present invention noticed that, when an image having thermochromicity (and typically, an image formed on paper using a thermochromic ink) is allowed to change color by rubbing with a friction body composed of a styrene-based copolymer as described in PTL2, for example, the problem occurs in which a state results in which the paper becomes soiled due in particular to a strong load or repeated rubbing motion and the like (also simply referred to as "paper soiling" below). An object of the present invention is to solve the aforementioned problem by providing a
40 friction body, which in addition to being capable of favorably allowing an image having thermochromicity to change color by rubbing (namely, impart a favorable color change), is capable of reducing soiling of paper caused by a strong force and/or repeated rubbing motion, and to provide a writing instrument and writing instrument set provided with this friction body.

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SOLUTION TO PROBLEM

[0007] The present invention at least includes the aspects indicated below.

50 [1] A friction body that allows an image having thermochromicity to change color with frictional heat, the friction body containing a styrene-based elastomer, and having compression set at 120°C of 80% or less, and Shore A hardness of 60 to 98.

[2] The friction body described in Aspect 1 above, which is crosslinked with a styrene-based elastomer.

55 [3] The friction body described in Aspect 1 or Aspect 2 above, wherein the styrene-based elastomer is selected from the group consisting of styrene-ethylene-propylene-styrene (SEPS), styrene-ethylene-ethylene-propylene-styrene (SEEPS) and styrene-ethylene-butadiene-styrene (SEBS).

[4] The friction body described in any of Aspects 1 to 3 above, containing 0.1% by weight to 3.0% by weight of a lubricant.

[5] A writing instrument having a thermochromic ink and a friction body that allows handwriting written with the thermochromic ink to change color with frictional heat; wherein, the friction body is the friction body described in any of Aspects 1 to 4 above.

[6] A writing instrument set provided with a writing instrument having a thermochromic ink and a friction body that allows handwriting written with the thermochromic ink to change color with frictional heat; wherein, the friction body is the friction body described in any of Aspects 1 to 4 above.

ADVANTAGEOUS EFFECTS OF INVENTION

[0008] According to the present invention, a friction body capable of favorably allowing an image having thermochromicity to change color (namely, imparting a favorable color change) by rubbing in addition to reducing paper soiling caused by strong force and/or repeated rubbing motion, along with a writing instrument and writing instrument set provided with such a friction body, can be provided.

BRIEF DESCRIPTION OF DRAWINGS

[0009]

FIG. 1 is a partial cross-sectional view of a writing instrument according to one embodiment of the present invention.

FIG. 2 is a perspective view of a friction body according to one embodiment of the present invention.

FIG. 3 is a perspective view of a friction body according to one embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0010] Although the following provides an explanation of exemplary aspects of the present invention, the present invention is not limited to these aspects. Furthermore, various characteristic values described in the present disclosure are intended to be values measured according to methods described in the section on "Examples" of the present disclosure, or methods understood to be equivalent thereto by a person with ordinary skill in the art, unless specifically indicated otherwise.

<Friction Body>

[0011] One aspect of the present invention is a friction body that allows an image having thermochromicity to change color with frictional heat, the friction body containing a styrene-based elastomer and having compression set at 120°C of 80% or less and Shore A hardness of 60 to 98.

[0012] In the present disclosure, an "image having thermochromicity" refers to an image that has the property of maintaining a prescribed color (first color) at normal temperature (such as 25°C), changing to a different color (second color) when the temperature thereof is raised to a prescribed temperature (such as 60°C), and optionally returning to the original color (first color) when subsequently cooled to a prescribed temperature (such as -5°C). An image having thermochromicity can typically be formed using a thermochromic ink to be subsequently described.

[0013] The cause of a paper surface becoming soiled particularly by strong force and/or repeated rubbing motion when changing the color of an image having thermochromicity by rubbing with a friction body is not clear. However, the inventors of the present invention surmised that the cause thereof may be that the physical properties of the friction body change as the surface temperature of the friction body rises during rubbing, and that destruction of the friction body (and more specifically, local separation) occurs causing the friction body to adhere to the paper surface, thereby causing soiling of the paper surface. Alternatively, the inventors of the present invention surmised that the force applied to the paper surface during rubbing becomes uneven due to softening of the elastomer, thereby resulting in a locally strong force being applied to the ink when the color of the ink is attempted to be changed completely, with the resulting destruction of the thermochromic coloring material causing soiling of the paper surface. The inventors of the present invention found that controlling deformation recovery of the friction body particularly in the high-temperature range is effective for reducing the aforementioned destruction of the friction body.

[0014] Since the friction body provided by one aspect of the present invention has suitable hardness and demonstrates favorable deformation recovery even at high temperatures as a result of controlling the balance between Shore A hardness and compression set in the high-temperature range, in addition to allowing an image having thermochromicity to favorably change color (namely, impart a favorable color change) by rubbing, it is capable of reducing soiling of the paper surface due to infrequent occurrence of destruction of the friction body attributable to strong force and/or repeated rubbing motion.

[0015] The friction body has compression set at 120°C (also referred to as "120°C compression set" in the present

disclosure) of 80% or less. A small 120°C compression set is an indicator of favorable deformation recovery of the friction body under rubbing conditions (namely, under high-temperature conditions), and this favorable deformation recovery contributes to maintaining favorable wear resistance of the friction body particularly under rubbing conditions (namely, under high-temperature conditions).

[0016] 120°C compression set may be 80% or less, 70% or less or 60% or less from the viewpoint of favorable wear resistance of the friction body under high-temperature conditions. 120°C compression set is preferably as small as possible from the viewpoint of wear resistance under high-temperature conditions. Furthermore, in the present disclosure, compression set is a value measured in compliance with JIS K6262-2013.

[0017] In general, the compression set of a molded body formed from an elastomer tends to increase accompanying a rise in temperature. The friction body of the present disclosure has a small 120°C compression set within a specific range as described above. It is advantageous from the viewpoint of obtaining this 120°C compression set that there is little temperature dependency of the compression set of the friction body. Thus, the ratio (A)/(B) of the compression set of the friction body at 120°C (A) to the compression set of the friction body at 70°C (B) may be 1.0 to 1.7, 1.0 to 1.5, 1.0 to 1.4 or 1.0 to 1.3.

[0018] The friction body has Shore A hardness of 60 to 98. From the viewpoints of favorable color change of an image having thermochromicity and favorable wear resistance of the friction body, Shore A hardness may be 60 or more, 70 or more or 80 or more. From the viewpoint of increasing contact area with the paper surface as a result of pressing the friction body onto the paper surface, and therefore allowing a favorable color change to be easily obtained, Shore A hardness may be 98 or less, 95 or less or 90 or less. Furthermore, in the present disclosure, Shore A hardness is a value measured in compliance with JIS K 6253-3-2012.

[0019] The composition of material components composing the friction body of the present disclosure is designed so as to impart the desired 120°C compression set and Shore A hardness as described above. Typically, the friction body contains an elastomer component and an additive component. Although the following indicates examples of preferable material components for forming a friction body in which both 120°C compression set and Shore A hardness are controlled to within the desired ranges of the present disclosure, the material components are not limited to those exemplified below.

[Elastomer Component (Component (A))]

[0020] Although examples of the elastomer component include styrene-based elastomers, polyester-based elastomers and olefin-based elastomers, from the viewpoint of easily realizing the desired 120°C compression set and Shore A hardness, the elastomer component contains a styrene-based elastomer and is preferably composed of a styrene-based elastomer.

[0021] In the present disclosure, a "styrene-based elastomer" refers to an elastomer that contains a styrene constituent unit in the main chain thereof, and is typically a thermoplastic elastomer. From the viewpoint of easily realizing the desired 120°C compression set and Shore A hardness, the styrene-based elastomer is preferably a block copolymer having a polymer block composed mainly of a constituent unit derived from a styrene skeleton-containing compound and a polymer block composed mainly of a constituent unit derived from a conjugated diene compound (to be referred to as a "styrene-based block copolymer"), a hydrogenation product of the block copolymer, or a mixture thereof. Furthermore, the aforementioned "polymer block composed mainly of a constituent unit derived from a styrene skeleton-containing compound (or conjugated diene compound)" refers to a polymer block such that the constituent unit present at the highest weight ratio in the polymer block is a constituent unit derived from a styrene skeleton-containing compound (or conjugated diene compound).

[0022] The aforementioned styrene-based block copolymer is normally a block copolymer having one or more polymer blocks X mainly composed of a constituent unit derived from a styrene skeleton-containing compound, preferably 2 or more from the viewpoint of mechanical properties, and one or more polymer blocks Y mainly composed of a constituent unit derived from a conjugated diene compound. Examples thereof include block copolymers having the structures X-Y, X-Y-X, Y-X-Y-X or X-Y-X-Y-X.

[0023] Hydrogenation products of the aforementioned styrene-based block copolymer are obtained by adding hydrogen to carbon-carbon double bonds present in the aforementioned styrene-based block copolymer to convert to carbon-carbon single bonds. The aforementioned hydrogenation can be carried out by a known method such as hydrogen treatment using a hydrogenation catalyst in an inert solvent.

[0024] From the viewpoints of improving erasing performance, paper soiling resistance and wear resistance, the hydrogenation rate of the aforementioned hydrogenated styrene-based block copolymer (namely, the ratio of the number of carbon-carbon single bonds formed during hydrogenation to the number of carbon-carbon double bonds in the styrene-based block copolymer prior to hydrogenation) may be 50% or more, 70% or more or 90% or more. Furthermore, the aforementioned hydrogenation rate refers to a value measured by ¹H-NMR unless specifically indicated otherwise.

[0025] The styrene skeleton-containing compound is a polymerizable monomer having a polymerizable carbon-carbon double bond and an aromatic ring. Examples of the aforementioned styrene skeleton-containing compound include

styrene, t-butylstyrene, α -methylstyrene, divinylbenzene, 1,1-diphenylstyrene, N,N-diethyl-p-aminoethylstyrene, p-t-butylstyrene and alkylstyrenes in which at least one alkyl group having 1 to 8 carbon atoms is bound to a benzene ring. Among these, styrene and alkylstyrenes in which at least one alkyl group having 1 to 8 carbon atoms is bound to a benzene ring are preferable. One of more types of these compounds can be used for the aforementioned styrene skeleton-containing compound.

[0026] Examples of the aforementioned alkylstyrenes in which at least one alkyl group having 1 to 8 carbon atoms is bound to a benzene ring include alkylstyrenes such as o-alkylstyrenes, m-alkylstyrenes, p-alkylstyrenes, 2,4-dialkylstyrenes, 3,5-dialkylstyrenes or 2,4,6-trialkylstyrenes, and halogenated alkylstyrenes in which one or two or more hydrogen atoms of an alkyl group in these alkylstyrenes are substituted with halogen atoms. Specific examples thereof include o-methylstyrene, m-methylstyrene, p-methylstyrene, 2,4-dimethylstyrene, 3,5-dimethylstyrene, 2,4,6-trimethylstyrene, o-ethylstyrene, m-ethylstyrene, p-ethylstyrene, 2,4-diethylstyrene, 3,5-diethylstyrene, 2,4,6-triethylstyrene, o-propylstyrene, m-propylstyrene, p-propylstyrene, 2,4-dipropylstyrene, 3,5-dipropylstyrene, 2,4,6-tripropylstyrene, 2-methyl-4-ethylstyrene, 3-methyl-5-ethylstyrene, o-chloromethylstyrene, m-chloromethylstyrene, p-chloromethylstyrene, 2,4-bis(chloromethyl)styrene, 3,5-bis(chloromethyl)styrene, 2,4,6-tri(chloromethyl)styrene, o-dichloromethylstyrene, m-dichloromethylstyrene and p-dichloromethylstyrene. Among these, p-methylstyrene is particularly preferable from the viewpoint of crosslinkability.

[0027] The aforementioned alkylstyrenes in which at least one alkyl group having 1 to 8 carbon atoms is bound to a benzene ring are used preferably as materials of crosslinked styrene-based elastomers.

[0028] The ratio of the aforementioned alkylstyrene in which at least one alkyl group having 1 to 8 carbon atoms is bound to a benzene ring in the aforementioned polymer block X is preferably 1% by weight or more, more preferably 50% by weight or more, and even more preferably 100% by weight from the viewpoint of crosslinkability.

[0029] The aforementioned conjugated diene compound is a polymerizable monomer having a structure in which two carbon-carbon double bonds are bound by a single carbon-carbon single bond. Examples of the aforementioned conjugated diene compound include 1,3-butadiene, isoprene (2-methyl-1,3-butadiene), 2,3-dimethyl-1,3-butadiene and chloroprene (2-chloro-1,3-butadiene). Among these, 1,3-butadiene and isoprene are preferable. One or more types of these conjugated diene compounds can be used for the aforementioned conjugated diene compound.

[0030] Although there are no particular limitations thereon, the content of the aforementioned constituent unit derived from a styrene skeleton-containing compound in the aforementioned styrene-based block copolymer or hydrogenation product thereof may be 5% by weight to 50% by weight or 20% by weight to 40% by weight from the viewpoints of mechanical strength, cold resistance, heat resistance and flexibility.

[0031] The aforementioned polymer block X is preferably a polymer block derived only from the aforementioned styrene skeleton-containing compound or a copolymer block consisting of the aforementioned styrene skeleton-containing compound and the aforementioned conjugated diene compound. In the case the polymer block X is the aforementioned copolymer block, although there are no particular limitations thereon, the content of the aforementioned constituent unit derived from the styrene skeleton-containing compound in the aforementioned polymer block X may normally be 50% by weight or more, 70% by weight or more or 90% by weight or more from the viewpoint of heat resistance. There are no particular limitations on the distribution of the aforementioned constituent unit derived from the conjugated diene compound in the aforementioned polymer block X. When there are two or more of the polymer blocks X in the styrene-based elastomer molecule, the polymer blocks X may have the same structure or may have mutually different structures.

[0032] The aforementioned polymer block Y is preferably a polymer block composed only of the aforementioned conjugated diene compound or a copolymer block consisting of the aforementioned styrene skeleton-containing compound and the conjugated diene compound. In the case the polymer block Y is the aforementioned copolymer block, although there are no particular limitations thereon, the content of the aforementioned constituent unit derived from the conjugated diene compound in the polymer block Y may normally be 50% by weight or more, 70% by weight or more or 90% by weight or more from the viewpoint of heat resistance. There are no particular limitations on the distribution of the aforementioned constituent unit derived from the styrene skeleton-containing compound in the polymer block Y. There are also no particular limitations on the bonding form between the aforementioned conjugated diene compound and the aforementioned styrene skeleton-containing compound. When there are two or more of the polymer blocks Y in the styrene-based elastomer molecule, the polymer blocks Y may have the same structure or may have mutually different structures.

[0033] Examples of the aforementioned styrene-based block copolymer include styrenebutadiene-styrene block copolymer (SBS) and styrene-isoprene-styrene block copolymer (SIS).

[0034] Examples of hydrogenation products of the aforementioned styrene-based block copolymer include styrene-ethylene-butene copolymer (SEB), styrene-ethylene-propylene copolymer (SEP), styrene-ethylene-butene-styrene copolymer (SEBS), styrene-ethylene-propylene-styrene copolymer (SEPS) and styrene-ethylene-ethylene-propylene-styrene copolymer (SEEPS).

[0035] Among these, styrene-ethylene-propylene-styrene copolymer (SEPS), styrene-ethylene-ethylene-propylene-styrene copolymer (SEEPS) and styrene-ethylene-butadiene-styrene copolymer (SEBS) are preferable, and styrene-

ethylene-propylene-styrene copolymer (SEPS) and styrene-ethylene-ethylene-propylene-styrene copolymer (SEEPS) are particularly preferable, from the viewpoint of wear resistance.

[0036] One or two or more types of the aforementioned examples of styrene-based block copolymers and/or hydrogenation products thereof can be used as a mixture.

[0037] The styrene-based elastomer may be crosslinked. Increasing the degree of crosslinking contributes to a decrease in 120°C compression set and an increase in Shore A hardness. In this case, SEBS, SEPS and SEEPS, in which styrene is substituted with p-methylstyrene, are preferable from the viewpoints of heat resistance and wear resistance. Furthermore, whether or not the styrene-based elastomer is crosslinked can be distinguished by immersing in hot xylene at 120°C for 24 hours followed by visually observing whether a gel fraction remains or measuring residual weight. A crosslinking agent to be subsequently described (component (E)) can be used for crosslinking. In the exemplified aspects, the friction body is not required to contain a polymer insoluble in hot xylene at 120°C other than a crosslinked styrene-based elastomer. In this case, whether or not the styrene-based elastomer is crosslinked can be evaluated by subjecting the friction body to the aforementioned hot xylene treatment.

[0038] The weight average molecular weight (M_w) of the styrene-based elastomer is preferably 150,000 to 500,000. The weight average molecular weight may be 150,000 or more, 180,000 or more or 200,000 or more from the viewpoint of obtaining a friction body having favorable wear resistance. On the other hand, the weight average molecular weight may be 500,000 or less, 450,000 or less or 400,000 or less from the viewpoint of favorable processability during production of the friction body. In the present disclosure, molecular weight refers to the value as polystyrene when measured according to gel permeation chromatography (GPC) unless specifically indicated otherwise.

[Other Components]

[0039] One or more types of propylene-based resin (Component (B)), rubber softening agent (Component (C)), lubricant (Component (D)), crosslinking agent (Component (E)), crosslinking assistant (Component (F)), colorant (Component (G)), polymer component other than the aforementioned propylene-based resin, stabilizer and filler can be used as other components.

[Propylene-Based Resin (Component (B))]

[0040] Use of a propylene-based resin (Component (B)) is advantageous for improving wear resistance and paper soiling resistance of the friction body. Examples of Component (B) include propylene homopolymers, propylene-based random copolymers and propylene-based block copolymers, and one type of these components can be used alone or two or more types can be used in combination. From the viewpoint of heat resistance, a propylene homopolymer or propylene-based block copolymer is more preferable, while a propylene homopolymer is even more preferable.

[0041] Component (B) is most preferably a propylene homopolymer since polymers composed of a propylene unit only have high crystallinity and melting point.

[0042] Examples of propylene-based random copolymers include propylene-ethylene random copolymers obtained by copolymerizing propylene and ethylene, propylene- α -olefin random copolymers obtained by copolymerizing propylene and at least one type of α -olefin having 4 to 20 carbon atoms, and propylene-ethylene- α -olefin random copolymers obtained by copolymerizing propylene, ethylene and at least one type of α -olefin having 4 to 20 carbon atoms.

[0043] Examples of α -olefins having 4 to 20 carbon atoms include 1-butene, 2-methyl-1-propene, 1-pentene, 2-methyl-1-butene, 3-methyl-1-butene, 1-hexene, 2-ethyl-1-butene, 2,3-dimethyl-1-butene, 2-methyl-1-pentene, 3-methyl-1-pentene, 4-methyl-1-pentene, 3,3-dimethyl-1-butene, 1-heptene, methyl-1-hexene, dimethyl-1-pentene, ethyl-1-pentene, trimethyl-1-butene, methylethyl-1-butene, 1-octene, methyl-1-pentene, ethyl-1-hexene, dimethyl-1-hexene, propyl-1-heptene, methylethyl-1-heptene, trimethyl-1-pentene, propyl-1-pentene, diethyl-1-butene, 1-nonene, 1-decene, 1-undecene and 1-dodecene. The α -olefin having 4 to 20 carbon atoms is preferably 1-butene, 1-pentene, 1-hexene or 1-octene and more preferably 1-butene or 1-hexene.

[0044] Specific examples of propylene-based random copolymers include propylene-ethylene random copolymers, propylene-1-butene random copolymers, propylene-1-hexene random copolymers, propylene-1-octene random copolymers, propylene-ethylene-1-butene random copolymers, propylene-ethylene-1-hexene random copolymers and propylene-ethylene-1-octene random copolymers, and preferably include propylene-ethylene random copolymers, propylene-1-butene random copolymers, propylene-1-hexene random copolymers, propylene-ethylene-1-butene random copolymers and propylene-ethylene-1-hexene random copolymers.

[0045] Examples of propylene-based block copolymers include block copolymers composed of a crystalline propylene-based polymer site and an amorphous propylene- α -olefin copolymer site.

[0046] Examples of crystalline propylene-based polymers include propylene homopolymers and random copolymers consisting of propylene and a small amount of another α -olefin.

[0047] On the other hand, examples of amorphous propylene- α -olefin copolymers include amorphous random copol-

ymers of propylene and another α -olefin. Examples of other α -olefins preferably include those having 2 or 4 to 12 carbon atoms, specific examples of which include ethylene, 1-butene, 3-methyl-1-butene, 3-methyl-1-pentene, 4-methyl-1-pentene, 4,4-dimethyl-1-pentene, vinylcyclopentane and vinylcyclohexane. One type of these α -olefins can be used alone or two or more types can be used in combination.

[0048] Ternary, quaternary or multiple copolymers obtained by copolymerizing, in addition to the aforementioned other α -olefins, a non-conjugated diene can also be used as propylene-based block copolymers, examples of which include 1,4-hexadiene, 5-methyl-1,5-hexadiene, 1,4-octadiene, cyclohexadiene, cyclooctadiene, dicyclopentadiene, 5-methylene-2-norbornene, 5-ethylidene-2-norbornene, 5-butyldiene-2-norbornene and 5-isopropenyl-2-norbornene.

[0049] From the viewpoint of moldability, the melt mass-flow rate of the aforementioned Component (B) may be 0.01 g/10 min to 100 g/10 min, 0.1 g/10 min to 50 g/10 min or 0.3 g/10 min to 10 g/10 min when measured under conditions of 230°C and 21.18 N in compliance with JIS K 7210-1999.

[0050] In addition, the melting point of Component (B) may be 150°C or higher or 160°C or higher from the viewpoint of heat resistance. Although there are no particular limitations on the upper limit of the melting point, since Component (B) is a polypropylene-based resin, the upper limit of the melting point thereof is about 167°C. Furthermore, the aforementioned melting point refers to a melting point corresponding to the top of the peak appearing at the highest temperature on the second melting curve (namely, the melting curve measured during the final heating process) when measuring according to a heating program consisting of holding for 5 minutes at 230°C, cooling to -10°C at the rate of 10°C/min, holding at -10°C for 5 minutes and heating to 230°C at the rate of 10°C/min using a DSC type differential scanning calorimeter (such as the Diamond System manufactured by PerkinElmer Japan).

[0051] The incorporated amount of Component (B) may be 30 parts by weight to 300 parts by weight, 35 parts by weight to 250 parts by weight or 40 parts by weight to 180 parts by weight based on 100 parts by weight of the aforementioned Component (A). As a result of making the incorporated amount to be within these ranges, the balance among flexibility, wear resistance and paper soiling resistance becomes favorable.

[Rubber Softening Agent (Component (C))]

[0052] Various compounds understood by persons with ordinary skill in the art to function as a softening agent in the art can be used as the rubber softening agent (Component (C)). The use of component (C) is advantageous for improving flexibility of the friction body. Component (C) is typically a non-aromatic rubber softening agent. Examples of non-aromatic rubber softening agents include non-aromatic mineral oils (namely, hydrocarbon compounds derived from petroleum and the like that are not classified as aromatics according to the classifications to be subsequently described (namely, those in which the number of aromatic carbon atoms is less than 30%)) and non-aromatic synthetic oils (namely, synthetic hydrocarbon compounds that do not use aromatic monomers). Non-aromatic rubber softening agents are normally in the form of a liquid, gel or rubber at normal temperature.

[0053] The mineral oils used as Component (C) are mixtures of compounds having at least one type of paraffin chain, naphthene ring and aromatic ring, and are distinguished based on the number of carbons by referring to that in which the naphthene ring accounts for 30% to 45% as a naphthene-based mineral oil, that in which the aromatic ring accounts for 30% or more as an aromatic-based mineral oil, and that which is not classified as a naphthene-based mineral oil or aromatic-based mineral oil and in which the paraffin chain accounts for 50% or more based on the number of carbons as a paraffin-based mineral oil.

[0054] Examples of the aforementioned Component (C) include paraffin-based mineral oils such as linear saturated hydrocarbons, branched saturated hydrocarbons or derivatives thereof, naphthene-based mineral oils, synthetic oils such as hydrogenated polyisobutylene, polyisobutylene or polybutene. Among these, paraffin-based mineral oils are preferable and paraffin-based mineral oils having a small number of aromatic carbons are more preferable from the viewpoint of compatibility with an elastomer component. In addition, those that are a liquid at room temperature are preferable from the viewpoint of handling ease.

[0055] From the viewpoints of heat resistance and handling ease, dynamic viscosity of the aforementioned Component (C) at 37.8°C as measured in compliance with JIS K2283-2000 may be 20 cSt to 1000 cSt or 50 cSt to 500 cSt. In addition, from the viewpoint of handling ease, pour point of Component (C) as measured in compliance with JIS K2269-1987 may be -10°C to -25°C. Moreover, from the viewpoint of safety, flash point (COC) of Component (C) as measured in compliance with JIS K2265-2007 may be 170°C to 300°C.

[0056] The incorporated amount of the aforementioned Component (C) may be 1 part by weight to 400 parts by weight, 10 parts by weight to 250 parts by weight or 40 parts by weight to 180 parts by weight based on 100 parts by weight of the aforementioned Component (A) from the viewpoints the balance between flexibility and mechanical properties.

[Lubricant (Component (D))]

[0057] Various compounds understood by persons with ordinary skill in the art to function as a lubricant in the art can

be used as lubricant (Component (D)). Use of Component (D) is advantageous for mold release properties and inhibiting friction of the paper surface.

[0058] Examples of the aforementioned Component (D) include silicone-based compounds, fluorine-based compounds and surfactants, and silicone-based compounds are preferable from the viewpoint of inhibiting friction of the paper surface.

[0059] Silicone oil or silicone rubber, for example, can be used for the aforementioned silicone-based compound. Among these, those having a high molecular weight are preferable from the viewpoints of heat resistance, bleed resistance and inhibiting friction of the paper surface. In general, however, since high molecular weight silicone-based compounds tend to have poor handling as a result of being highly viscous liquids or rubber-like, resin blends or copolymers with resin are preferable in terms of use. Although resins used here are selected in consideration of such factors as compatibility with other components composing the friction body and compatibility with the aforementioned Component (A) in particular, typically polyethylene, polypropylene or other olefin-based resins are preferable.

[0060] Polyvinylidene fluoride or polyvinyl fluoride, for example, can be used for the aforementioned fluorine-based compound. Among these, polyvinylidene fluoride is preferable from the viewpoint of inhibiting friction of the paper surface.

[0061] Any of anionic, cationic or nonionic surfactants can be used for the aforementioned surfactant.

[0062] The incorporated amount of the aforementioned Component (D) may be 0.1 parts by weight to 30 parts by weight, 0.5 parts by weight to 20 parts by weight or 1 part by weight to 10 parts by weight based on 100 parts by weight of the aforementioned Component (A) from the viewpoint of inhibiting friction of the paper surface.

[0063] The content of Component (D) in the friction body (the content of silicone oil in a preferable aspect thereof or the content of fluorine-based compound in another preferable aspect) is preferably 0.1% by weight to 3.0% by weight.

The aforementioned content may be 0.1% by weight or more, 0.3% by weight or more or 0.5% by weight or more from the viewpoint of inhibiting friction of the paper surface, and 3.0% by weight or less, 2.5% by weight or less or 2.0% by weight or less from the viewpoint of obtaining favorable erasing performance and paper soiling resistance.

[Crosslinking Agent (Component (E))]

[0064] Various compounds understood by persons with ordinary skill in the art to function as a crosslinking agent in the art can be used as crosslinking agent (Component (E)). Component (E) is incorporated in the friction body mainly for the purpose of crosslinking the aforementioned Component (A). Use of Component (E) is advantageous for reducing 120°C compression set and increasing Shore A hardness.

[0065] Organic peroxides and phenol-based compounds, for example, can be used for the aforementioned Component (E) and organic peroxides are preferable from the viewpoint of wear resistance.

[0066] The aforementioned organic peroxides are compounds in which one or two or more hydrogen atoms of hydrogen peroxide are substituted with free organic groups. Since organic peroxides have a peroxide bond in a molecule thereof, these organic peroxides generate radicals during production of the friction body (such as during melting and kneading of the material composition) and these radicals react in the manner of chain reaction to act to crosslink the aforementioned Component (A).

[0067] Examples of the organic peroxides include dicumyl peroxide, di-tert-butyl peroxide, 2,5-dimethyl-2,5-di-(tert-butylperoxy)hexane, 2,5-dimethyl-2,5-di-(tert-butylperoxy)hexyne-3, 1-3-bis(tert-butylperoxyisopropyl)benzene, 1,1-bis(tert-butylperoxy)-3,3,5-trimethylcyclohexane, n-butyl-4,4-bis(tert-butylperoxy)valerate, benzoyl peroxide, p-chlorobenzoyl peroxide, 2,4-dicyclobenzoyl peroxide, tert-butylperoxy benzoate, tert-butylperoxyisopropyl carbonate, diacetyl peroxide, lauroyl peroxide and tert-butylcumyl peroxide. Among these, 2,5-dimethyl-2,5-di-(tert-butylperoxy)hexane and 2,5-dimethyl-2,5-di-(tert-butylperoxy)hexyne-3 are preferable from the viewpoints of low odor intensity, low colorability and scorch safety.

[0068] Furthermore, in the case of using an organic peroxide for Component (E), a crosslinking assistant (Component (F)) to be subsequently described is also used preferably. The use of Component (F) makes it possible to carry out a uniform and efficient crosslinking reaction.

[0069] A resole resin is preferable for the aforementioned phenol-based compound from the viewpoint of normally being in a liquid state. Resole resins are produced by condensation of an aldehyde (and preferably formaldehyde) in an alkaline medium or by condensation of a bifunctional phenol dialcohol. The alkyl-substituent portion of an alkyl-substituted phenol typically has 1 to 10 carbon atoms. Dimethylol phenol or phenol resin substituted at the p-position with an alkyl group having 1 to 10 carbon atoms is preferable.

[0070] Among the aforementioned phenol-based compounds, alkylphenol formaldehyde resins, methylolated alkylphenol resins and brominated alkylphenol resins, for example, are preferable. Although non-brominated forms are preferable based on environmental considerations, the terminal hydroxyl group may be brominated. Alkylphenol formaldehyde resins are particularly preferable.

[0071] The incorporated amount of the aforementioned Component (E) may be 0.01 parts by weight to 20 parts by weight, 0.1 parts by weight to 10 parts by weight or 0.5 parts by weight to 5 parts by weight based on 100 parts by weight of Component (A). An incorporated amount equal to or greater than the aforementioned lower limit values is preferable

from the viewpoint of allowing the crosslinking reaction to proceed favorably, while on the other hand, an incorporated amount equal to or less than the aforementioned upper limit values is preferable from the viewpoint of favorably maintaining moldability without allowing crosslinking to proceed excessively.

[Crosslinking Assistant (Component (F))]

[0072] Various compounds understood by persons with ordinary skill in the art to function as a crosslinking assistant or crosslinking promoter in the art can be used as crosslinking assistant (Component (F)).

[0073] Examples of the aforementioned Component (F) include multifunctional methacrylate compounds in the manner of triallyl cyanurate, ethylene glycol dimethacrylate, diethylene glycol dimethacrylate, triethylene glycol dimethacrylate, tetraethylene glycol dimethacrylate, polyethylene glycol dimethacrylate having 9 to 14 repeating ethylene glycol units, trimethylolpropane trimethacrylate, allyl methacrylate, 2-methyl-1,8-octanediol dimethacrylate or 1,9-nonanediol dimethacrylate; multifunctional acrylate compounds in the manner of polyethylene glycol diacrylate, 1,6-hexanediol diacrylate, neopentyl glycol diacrylate or propylene glycol diacrylate; and multifunctional vinyl compounds in the manner of vinyl butyrate or vinyl stearate. One or more types of these compounds can be used for Component (F).

[0074] Among the aforementioned examples of Component (F), multifunctional acrylate compounds and multifunctional methacrylate compounds are preferable, and triallyl cyanurate, triethylene glycol dimethacrylate and tetraethylene glycol dimethacrylate are particularly preferable. In addition to facilitating handling, since these compounds have an action that solubilizes organic peroxides and act as dispersion assistants of organic peroxide, crosslinking can be made to be more uniform and efficient when used in combination with an organic peroxide.

[0075] The incorporated amount of the aforementioned Component (F) may be 0.01 parts by weight to 50 parts by weight, 0.5 parts by weight to 30 parts by weight or 1 part by weight to 20 parts by weight based on 100 parts by weight of Component (A). An incorporated amount equal to or greater than the aforementioned lower limit values is preferable from the viewpoint of allowing the crosslinking reaction to proceed favorably, while on the other hand, an incorporated amount equal to or less than the aforementioned upper limit values is preferable from the viewpoint of favorably maintaining dispersion of the crosslinked product in the friction body without allowing crosslinking to proceed excessively.

[Colorant (Component (G))]

[0076] Various compounds understood by persons with ordinary skill in the art to function as a colorant in the art can be used as colorant (Component (G)). An inorganic pigment or organic pigment, for example, is preferable as Component (G).

<Production of Friction Body>

[0077] The friction body can be produced by, for example, the method indicated below, although there are no particular limitations thereon. First, a material composition is prepared by mechanically melting and kneading the aforementioned material components. An ordinary melting-kneading machine such as a Banbury mixer, various types of kneaders or single- or twin-screw extruder can be used for melting and kneading. Next, the resulting material composition is molded with an ordinary method used to mold thermoplastic resin such as injection molding, extrusion molding or blow molding to obtain a friction body of a desired shape. Examples of preferable shapes of the friction body are subsequently described with reference to the drawings.

<Writing Instrument and Writing Instrument Set>

[0078] The present disclosure includes a writing instrument and writing instrument set provided with the previously described friction body.

[0079] Another aspect of the present invention provides:

a writing instrument having a thermochromic ink and a friction body that allows handwriting written with the thermochromic ink to change color with frictional heat; wherein, the friction body is the friction body of the present disclosure.

[0080] The following provides a detailed explanation of embodiments of the present invention with reference to the drawings. The same reference signs are used to indicate corresponding constituents throughout all of the drawings.

[0081] FIG. 1 is a partial cross-sectional view of a writing instrument according to one embodiment of the present invention. A writing instrument 1 has a cylindrical barrel 2, a writing body in the form of a refill cartridge (not shown) arranged within the barrel 2 and provided with a writing portion 3 on one end thereof, a friction body 5 provided on the

rear end of the barrel 2 via a retaining member 4, a cover member 6 covering the friction body 5 and is removable from the friction body 5, and a clip 7 attached to the side of the rear end of the barrel 2 that clips onto an article. In the present disclosure, the side of the writing portion 3 in the axial direction of the writing instrument 1 is defined as the "front", while the opposite side from the writing portion 3 is defined as the "rear". Unless specifically indicated otherwise, the central axis refers to the central axis of the writing instrument 1.

[0082] The writing instrument 1 is a thermochromic writing instrument that houses a thermochromic ink in the refill cartridge thereof, and allows handwriting written with the writing instrument 1 to thermally change color due to frictional heat generated when rubbed with the friction body 5.

[0083] The friction body 5 can be moved relative to the barrel 2 by pressing forward. In the writing instrument 1, the refill cartridge is moved forward and backward within the barrel 2 by a knocking operation in which the friction body 5 is pushed forward in opposition to the urging force of a spring arranged within the barrel 2. At this time, the state in which the writing portion 3 protrudes from the barrel 2 is referred to as the writing state (FIG. 1), while the state in which the writing portion 3 is embedded within the barrel 2 is referred to as the non-writing state (not shown).

[0084] FIG. 2 is a perspective view of the friction body 5 and retaining member 4 of the writing instrument 1. In FIG. 2, the bottom of the drawing indicates the front side of the writing instrument 1. The friction body 5 is provided on the retaining member 4 by engaging therewith or by two-color molding.

[0085] The friction body 5 is formed into the shape of a tapered truncated triangular pyramid having a roughly triangular cross-sectional shape. More specifically, in a cross-section thereof, the vertex of the triangle is rounded and formed into the shape of an arc, and the radius of curvature of that arc becomes larger towards the rear end of the friction body 5.

A rear end surface 5a of the friction body 5 is formed into the shape of a curve. Thus, the boundaries between the rear end surface 5a and peripheral surfaces 5b of the friction body 5 constitute ridgelines 5c.

[0086] In the friction body 5, the use of the rear end surface 5a makes it possible to rub a wider area. In addition, the friction body 5 is also able to rub a wider area by using the ridgelines 5c equivalent to the sides of a triangle, and is able to rub a narrower area by using the portion equivalent to the vortex of a triangle. Namely, the employing of a shape having one or more corners (such as the vertexes of a triangle) as viewed from the axial direction by the friction body 5 is advantageous from the viewpoint of favorably rubbing both wide areas and narrow areas. Furthermore, the cross-sectional shape of the friction body 5 is naturally not limited to a triangle, but rather may be that of a tetragon, hexagon or other polygon.

[0087] Furthermore, the friction body may also be provided on a portion, other than the rear end portion of the barrel 2, of the writing instrument 1 such as the front end portion of the barrel 2 or the clip 7. In addition, the friction body may also be provided on a thermochromic writing instrument other than a knock-type writing instrument as shown in FIG. 1, such as on the rear end portion of the barrel or on the tip of a cap in a capped writing instrument.

[0088] Another aspect of the present invention provides:

a writing instrument set provided with a writing instrument having a thermochromic ink and a friction body that allows handwriting written with the thermochromic ink to change color with frictional heat; wherein, the friction body is the friction body of the present disclosure.

[0089] The friction body of the present disclosure may be provided separately from the writing instrument having thermochromic ink to provide a writing instrument set provided with a writing instrument and friction body. FIG. 3 is a perspective view of a separate friction body 10. Although the friction body 10 in FIG. 3 is in the shape of a rectangular parallelepiped housed in a case 11, it may also be in the shape of a cube or cylindrical column.

[Thermochromic Ink]

[0090] The writing instrument of the present disclosure has a thermochromic ink. In the present disclosure, a "thermochromic ink" refers to an ink that has the property of maintaining a prescribed color (first color) at normal temperature (such as 25°C), changing to a different color (second color) when the temperature thereof is raised to a prescribed temperature (such as 60°C), and optionally returning to the original color (first color) when subsequently cooled to a prescribed temperature (such as -5°C). The thermochromic ink can be designed corresponding to the application, such as employing a combination in which one of the first color and second color is colored while the other is colorless, or a combination in which both the first color and second color are colored.

[0091] The thermochromic ink has a thermochromic colorant. There are no particular limitations on the thermochromic microcapsule pigment serving as the thermochromic colorant provided it is that which changes color due to frictional heat or other heat, such as that which changes from colored to colorless, one color to a different color, or from colorless to colored, and various such pigments can be used, examples of which include those in which a thermochromic composition at least containing a leuco pigment, developer and color change temperature adjusting agent is microencapsulated.

[0092] There are no particular limitations on leuco pigment that can be used provided it is an electron-donating dye that functions as a coloring agent. More specifically, triphenylmethane-based, spiropyran-based, fluoran-based, diphenylmethane-based, rhodamine lactam-based, indolyl phthalide-based, leuco oramine-based and other conventionally known leuco pigments can be used alone (one type) or two or more types can be used as a mixture (to be simply referred to as "at least one type") from the viewpoint of obtaining an ink having superior coloring properties.

[0093] The developer that can be used serves as a component that has the ability to cause the aforementioned leuco pigment to become colored, and examples thereof include phenol resin-based compounds, salicylic acid-based metal chlorides, salicylic acid resin-based metal chlorides and solid acid-based compounds.

[0094] The amount of developer used is arbitrarily selected corresponding to the desired color density, and although there are no particular limitations thereon, normally the amount used thereof is preferably selected within the range of about 0.1 parts by weight to 100 parts by weight based on 1 part by weight of the aforementioned leuco pigment.

[0095] The color change temperature adjusting agent that can be used is a substance that controls the temperature of the color change during coloring by the aforementioned leuco pigment and developer. A conventionally known color change temperature adjusting agent can be used for the color change temperature adjusting agent able to be used. Specific examples thereof include alcohols, esters, ketones, ethers, acid amides, azomethines, fatty acids and hydrocarbons.

[0096] The amount of this color change temperature adjusting agent used is suitably selected corresponding to such factors as the desired hysteresis error or color density during coloring, and although there are no particular limitations thereon, normally the amount used thereof is preferably selected within the range of about 1 part by weight to 100 parts by weight based on 1 part by weight of the leuco pigment.

[0097] The thermochromic microcapsule pigment can be produced microencapsulating a thermochromic composition at least containing the aforementioned leuco pigment, developer and color change temperature adjusting agent so that the mean particle diameter thereof is 0.2 μm to 3 μm . Examples of microencapsulation methods include interfacial polymerization, interfacial polycondensation, in situ polymerization, liquid cured coating, phase separation from an aqueous solution, phase separation from an organic solvent, melt dispersion cooling, air suspension coating and spray drying, and can be suitably selected corresponding to the application.

[0098] Although the contents of the leuco pigment, developer and color change temperature adjusting agent vary according to such factors as the types of leuco pigment, developer and color change temperature adjusting agent used or type of microencapsulation method, the content thereof based on weight ratio is 0.1 to 100 of the color developer and 1 to 100 of the color change temperature adjusting agent based on 1 part of the leuco pigment. In addition, the content of capsule membrane agent is 0.1 to 1 as the weight ratio based on the weight of the capsule contents.

[0099] The coloring temperature (such as coloring at 0°C or higher) and decoloring temperature (such as decoloring at 50°C or higher) of each color of the thermochromic microcapsule pigment can be set to a preferable temperature by preferably combining the types and quantities of the aforementioned leuco pigment, developer and color change temperature adjusting agent, and the thermochromic microcapsule pigment preferably is changed from colored to colorless by frictional heat imparted by the friction body of the present disclosure.

[0100] The wall film of the thermochromic microcapsule pigment is preferably formed with urethane resin, urea/urethane resin, epoxy resin or amino resin from the viewpoints of improving drawn line concentration, storage stability and writing properties. The thickness of the wall film of the microcapsule colorant is suitably determined corresponding to the required wall film strength and drawn line concentration.

[0101] In addition to the aforementioned thermochromic microcapsule pigment, the thermochromic ink can suitably also contain as the remainder thereof a solvent in the form of water (such as tap water, purified water, distilled water, ion exchange water or pure water) as well as a water-soluble organic solvent, thickener, lubricant, rust inhibitor, preservative or antibacterial agent and the like corresponding to the application of each type of writing instrument (such as a ball pen or marking pen) within a range that does not impair the effect thereof.

[0102] A conventionally known method can be employed to produce the thermochromic ink, and for example, the thermochromic ink can be obtained incorporating prescribed amounts of the aforementioned thermochromic or photochromic microcapsule pigment and each of the aforementioned aqueous components followed by stirring and mixing with a homomixer or stirrer such as a disperser. Coarse particles present in the thermochromic ink may be further removed by filtration or centrifugal separation as is necessary.

[0103] The viscosity value of the thermochromic ink at 25°C and shear velocity of 3.83/s is preferably 500 mPa·s to 2000 mPa·s while that at a shear velocity of 383/s is preferably 20 mPa·s to 100 mPa·s. An ink demonstrating superior writing properties and stability over time can be obtained by setting the viscosity value to be within the aforementioned viscosity ranges.

[0104] The surface tension of the thermochromic ink is preferably 25 mN/m to 45 mN/m and more preferably 30 mN/m to 40 mN/m. If within these ranges, balance between the wettability of the inside of the pen tip and the ink becomes suitable, thereby making it possible to prevent the ink from backing up.

[0105] Additional details regarding the thermochromic ink are described in, for example, JP-A-2015-229708, WO

2015/033750 and WO 2011/070966.

EXAMPLES

5 **[0106]** Although the following provides a more detailed explanation of specific aspects of the present invention by listing examples thereof, the present invention is not limited in any way to these examples.

<Materials Used>

10 **[0107]**

Component (A)

15 (A-1) Septon 4077 (trade name), Kuraray
 SEEPS, weight average molecular weight: 330,000
 (A-2) Septon 4055 (trade name), Kuraray
 SEEPS, weight average molecular weight: 260,000
 (A-3) Septon 2005 (trade name), Kuraray
 SEPS, weight average molecular weight: 250,000
 20 (A-4) Kraton G1651H (trade name), Kraton
 SEBS, weight average molecular weight: 260,000
 (A-5) Septon V9461 (trade name), Kuraray
 SEEPS obtained by substituting styrene with p-methylstyrene, weight average molecular weight: 300,000
 (A-6) Septon V9827 (trade name), Kuraray
 25 SEBS obtained by substituting styrene with p-methylstyrene, weight average molecular weight: 90,000
 (A-7) Septon 4033 (trade name), Kuraray
 SEEPS, weight average molecular weight: 100,000
 (A-8) Engage EG8100 (trade name), Dow Chemical
 Ethylene- α -olefin copolymer-based elastomer

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Component (B)

(B-1) VS200A (trade name), Sun Aroma
 Propylene homopolymer, MFR: 0.5, melting point: 165°C
 35 (B-2) PM940M (trade name), Sun Aroma
 Propylene-ethylene random copolymer, MFR: 30, melting point: 136°C

Component (C)

(C-1) Diana Process Oil PW-380 (trade name), Idemitsu Kosan
 40 Paraffin-based mineral oil

Component (D)

(D-1) BY27-001 (trade name), Dow Corning Toray
 Silicon-based compound (alloy of polypropylene and ultra-high molecular weight silicon polymer, ratio of ultra-
 45 high molecular weight silicone polymer: 50% by weight)
 (D-2) Neoflon ETFE (trade name), Daikin Industries
 Fluorine-based compound (copolymer of tetrafluoroethylene and ethylene)

Component (E)

50 (E-1) Perhexa 25B (trade name), NOF
 Organic peroxide, 2,5-dimethyl-2,5-di-(tert-butylperoxy)hexane

Component (F)

(F-1) TAIC (trade name), Nihon Kasei
 55 Triallyl isocyanurate

<Production of Friction Bodies>

[0108] Material compositions containing the components indicated in Table 1 were kneaded with a twin-screw extruder

to obtain friction bodies.

<Evaluation>

5 (Weight Average Molecular Weight of Elastomer Component)

[0109] The weight average molecular weights of Components (A-1) to (A-7) were obtained by gel permeation chromatography ("LC-2000 Plus" (trade name) High-Performance Chromatography System, JASCO) using chloroform for the mobile phase based on polystyrene standards.

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(Evaluation of Friction Body)

Compression Set

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[0110] Compression set was measured at a compression ratio of 25% for 22 hours at 70°C and for 72 hours at 120°C for small test pieces fabricated from pressed sheets having a thickness of 6.3 mm in compliance with JIS K6262-2013.

Shore A Hardness

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[0111] Shore A hardness was determined by measuring the value for a pressed sheet having a thickness of 6.3 mm after 15 seconds using a type A durometer in compliance with JIS K6253-3-2012.

Color Change

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[0112] Test pieces were fabricated by uniformly spreading the thermochromic ink over a test paper defined in ISO 12757-1 with a bar coater (No. 6, Yasuda Seiki). After allowing the test pieces to dry completely, the friction body was contacted with the paper at an angle of 60 degrees from the paper surface and the paper surface was rubbed back and forth in a state in which the load applied to the paper was 5 N while maintaining a speed of about 8 m/sec to 10 m/sec. Subsequently, Ns values representing the soiling level of the rubbed portions were measured with a spectrophotometer (SC-P, Suga Test Instruments) followed by evaluating color change based on the criteria indicated below.

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- A: Ns value of 4.0 or more
- B: Ns value of 3.0 to less than 4.0
- C: Ns value of 2.0 to less than 3.0
- 35 D: Ns value of less than 2.0

Soiling Resistance

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[0113] Soiling resistance was evaluated based on the criteria indicated below by carrying out a soiling test consisting of pressing the friction body against the paper surface (test paper defined in ISO 12757-1) at an angle of 60 degrees to 90 degrees and rubbing back and forth in a state in which the load applied to the paper was about 15 N to 20 N while maintaining a speed of about 8 m/sec to 10 m/sec followed by confirming the presence of adhesion of debris to the paper surface or destruction of the paper surface per se.

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- A: No adherence of debris to paper surface or destruction of paper surface per se observed whatsoever
- B: Extremely low levels of adherence of debris to paper surface and destruction of paper surface per se observed
- D: Adherence of debris to paper surface and destruction of paper surface per se observed

[Table 1]

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[0114]

Table 1

Incorporated Amount (parts by weight)	Ex.1	Ex.2	Ex.3	Ex.4	Ex.5	Ex.6	Ex.7	Ex.8	Ex.9	Ex. 10	Ex. 11	Ex. 12	Ex. 13	Ex. 14
Elastomer Component (Component A)	100	100	100	100	100	100	100	100	100	100	100	100	100	100
	A-1													
	A-2													
	A-3													
	A-4													
	A-5													
Propylene-based Resin (Component B)	100	100	100	100	100	100	100	50	150	100	100	100	100	100
	B-1													
	B-2													
Rubber Softening Agent (Component C)	110	110	110	110	110	110	110	110	110	50	150	110	110	110
	C-1													
Lubricant (Component D)	4	4	4	4	4	4	4	4	4	4	4	0.8	17	2
	D-1													
	D-2													
Crosslinking Agent (Component E)					2	2	2	2	2	2	2	2	2	2
	E-1													
Crosslinking Assistant (Component F)					5	5	5	5	5	5	5	5	5	5
	F-1													

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(continued)

	Ex.1	Ex.2	Ex.3	Ex.4	Ex.5	Ex.6	Ex.7	Ex.8	Ex.9	Ex.10	Ex.11	Ex.12	Ex.13	Ex.14
Evaluation	Compression Set	120°C, 72 hours (A)	70	75	75	48	48	73	59	65	77	63	56	67
		70°C, 22 hours (B)	45	45	48	48	56	49	47	46	49	48	58	59
		A/B	1.56	1.67	1.56	1.52	1.38	1.29	1.19	1.46	1.24	1.23	1.23	1.23
	Shore A Hardness	15 second value	87	90	89	88	88	88	92	93	83	90	91	89
		Friction Body Performance	B	B	B	B	A	A	B	B	A	A	B	A
	Soiling resistance		B	B	B	B	B	B	A	B	B	A	A	A

[Table 2]

[0115]

Table 2

			Comp. Ex. 1	Comp. Ex. 2	Comp. Ex. 3
Incorporated amount (parts by weight)	Elastomer Component (Component A)	A-2			100
		A-7	100		
		A-8		100	
	Propylene-based Resin (Component B)	B-1	100	25	70
	Rubber softening agent (Component C)	C-1	110		190
	Lubricant (Component D)	D-1	4		
Evaluation	Compression Set	120°C, 72 hours (A)	101	118	50
		70°C, 22 hours (B)	92	100	30
		A/B	1.10	1.18	1.67
	Shore A Hardness	15 second value	87	67	55
	Friction Body Performance	Color change	C	C	B
		Soiling resistance	D	D	D

INDUSTRIAL APPLICABILITY

[0116] The friction body of the present disclosure is preferably used in a writing instrument or writing instrument set composed so as to allow thermochromic handwriting to change color with frictional heat.

REFERENCE SIGN LIST

[0117]

1 Writing instrument

2 Barrel

3 Writing portion

4 Retaining member

5 Friction body

6 Cover member

7 Clip

10 Friction body

11 Case

Claims

- 5
1. A friction body that allows an image having thermochromicity to change color with frictional heat, the friction body containing a styrene-based elastomer, and
- 10 having compression set at 120°C of 80% or less, and
Shore A hardness of 60 to 98.
2. The friction body according to claim 1, wherein the styrene-based elastomer is crosslinked.
- 15 3. The friction body according to claim 1 or 2, wherein the styrene-based elastomer is selected from the group consisting of styrene-ethylene-propylene-styrene (SEPS), styrene-ethylene-ethylene-propylene-styrene (SEEPS) and styrene-ethylene-butadiene-styrene (SEBS).
4. The friction body according to any of claims 1 to 3, containing 0.1% by weight to 3.0% by weight of a lubricant.
- 20 5. A writing instrument having a thermochromic ink and a friction body that allows handwriting written with the thermochromic ink to change color with frictional heat; wherein, the friction body is the friction body according to any of claims 1 to 4.
- 25 6. A writing instrument set provided with a writing instrument having a thermochromic ink and a friction body that allows handwriting written with the thermochromic ink to change color with frictional heat; wherein, the friction body is the friction body according to any of claims 1 to 4.
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FIG. 1

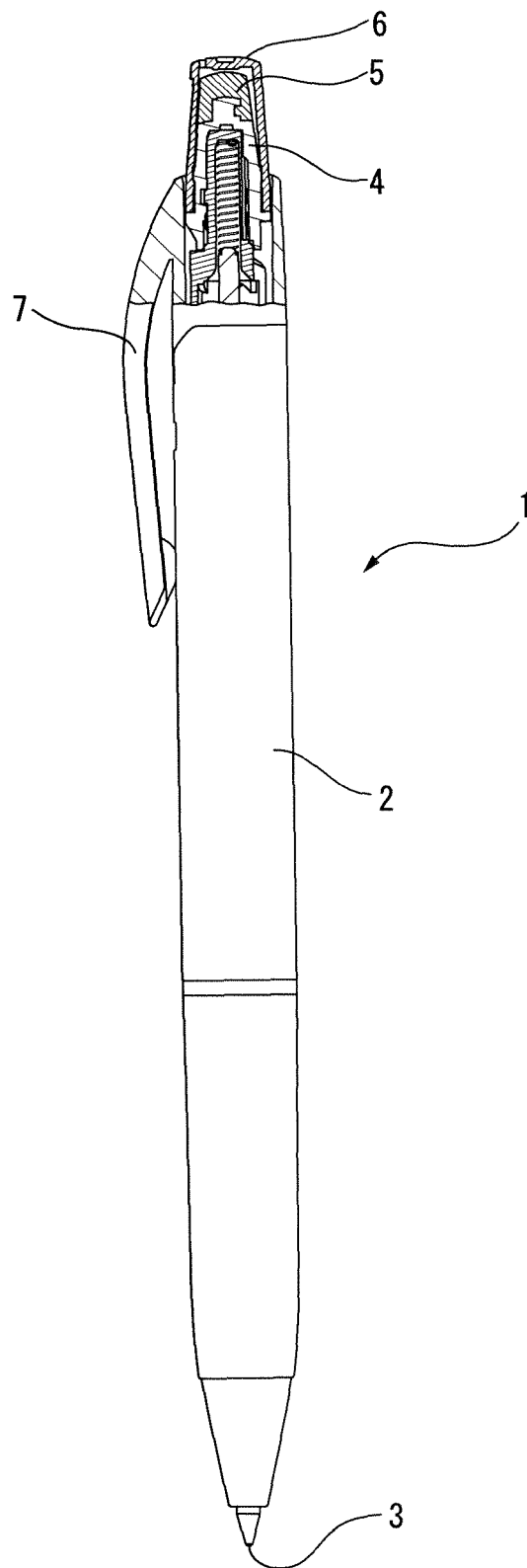


FIG. 2

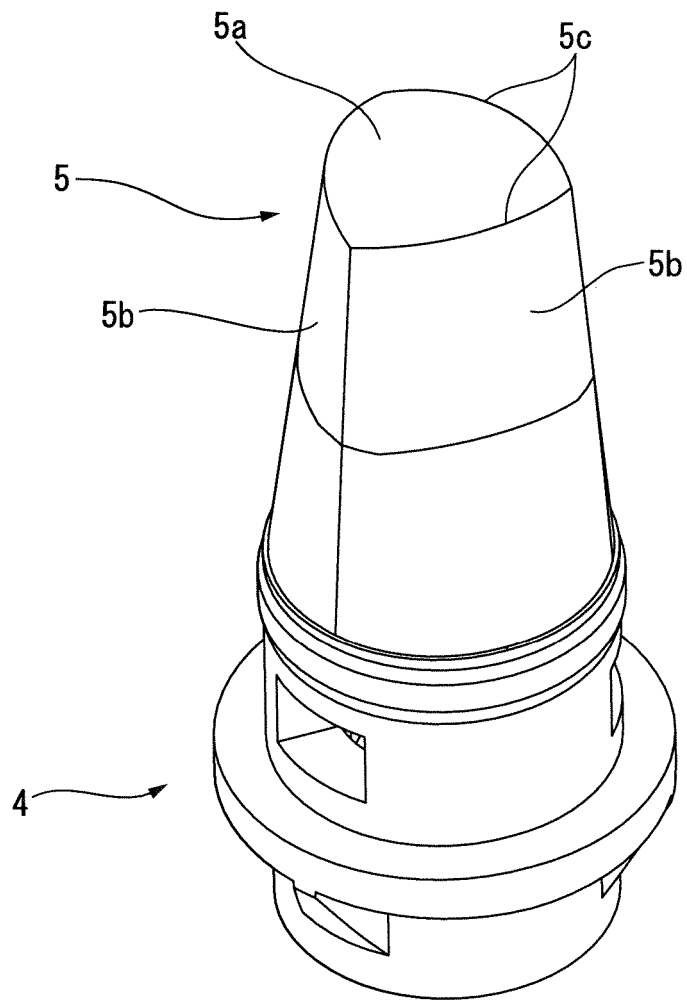
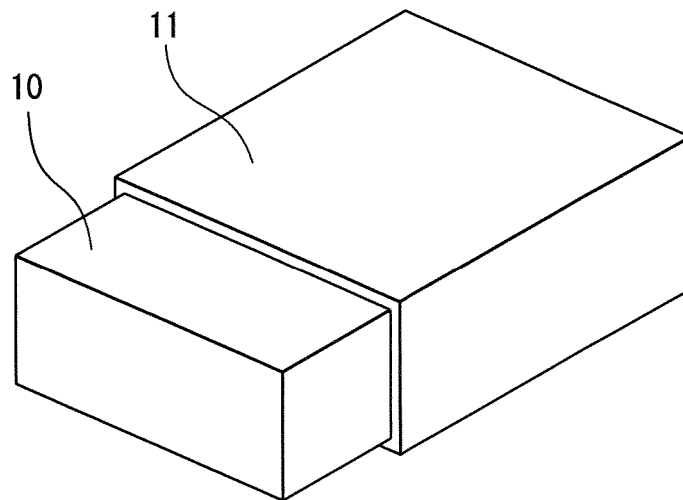


FIG. 3



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/021671

A. CLASSIFICATION OF SUBJECT MATTER

B43L19/00(2006.01)i, B43K29/02(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B43L19/00, B43K1/00-31/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2017

Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2006-123324 A (The Pilot Ink Co., Ltd.), 18 May 2006 (18.05.2006), claims 1, 2, 5, 9; paragraphs [0018] to [0020], [0040], [0041] (Family: none)	1-6
Y	Manpei HORII, Gijutsu Kaihatsu Center ni Okeru Kaihatsu Shohin Shokai, Toa Gosei Kenkyu Nenpo TREND, 2004, no.7, pages 54 to 57	1-6
Y	<Septon> V Series no Kaihatsu ni Tsuite, [online], Kuraray Co., Ltd., 26 January 2004 (26.01.2004), [retrieval date 13 July 2017 (13. 07.2017)], Internet:<URL:http://www.kuraray.co. jp/release/2004/040126.html>	1-6

☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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Date of the actual completion of the international search
13 July 2017 (13.07.17)Date of mailing of the international search report
01 August 2017 (01.08.17)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
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Authorized officer

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	JP 2013-111952 A (Mitsubishi Pencil Co., Ltd.), 10 June 2013 (10.06.2013), claim 1; paragraph [0027] (Family: none)	3-6

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REFERENCES CITED IN THE DESCRIPTION

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