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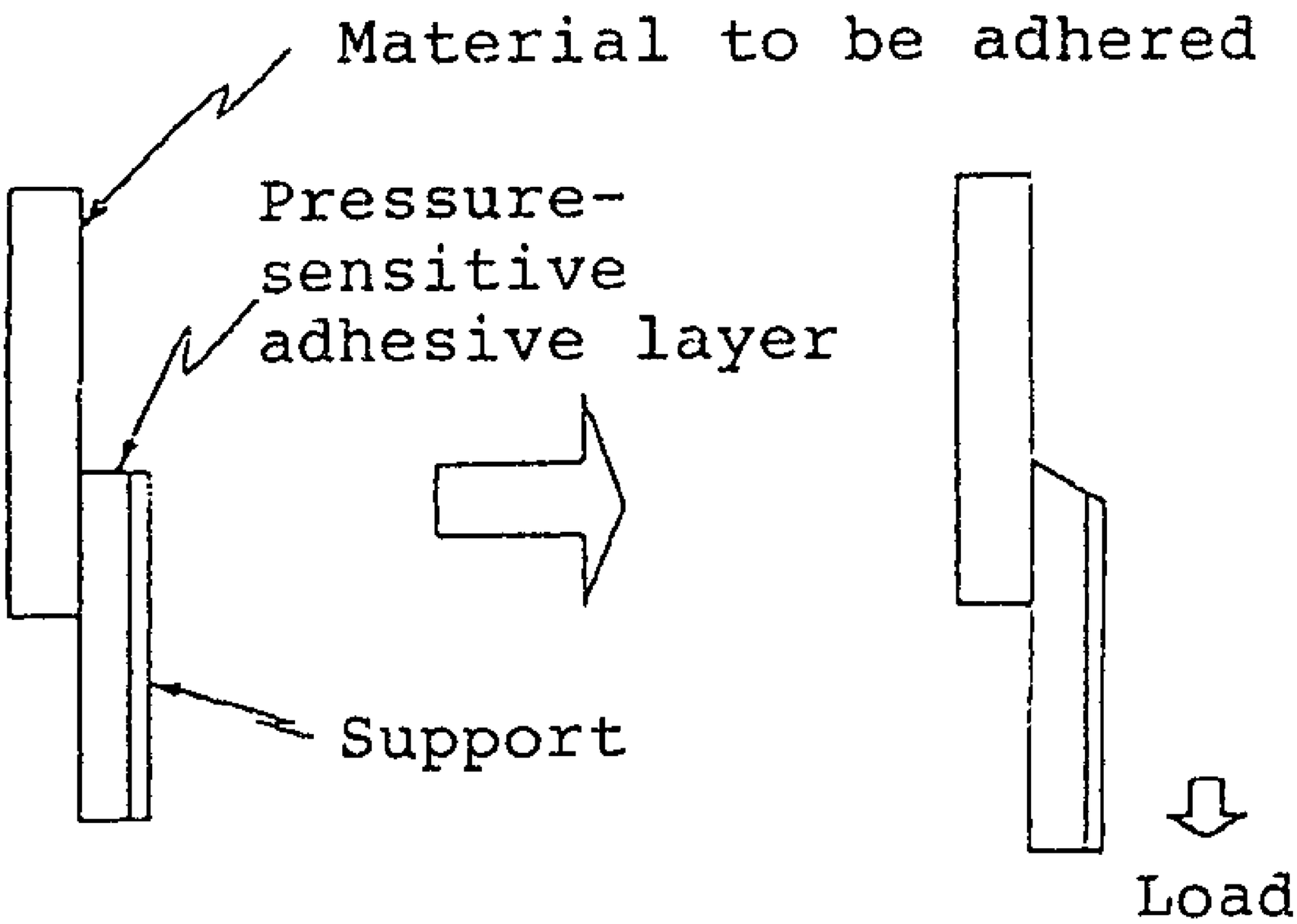


(57) Abrégé/Abstract:
A medical adhesive tape and a tape preparation comprising the medical adhesive tape containing percutaneous absorption-type drugs in a pressure-sensitive adhesive layer are disclosed. The medical adhesive tape comprises a flexible support having formed on at least one surface thereof a hydrophobic pressure-sensitive adhesive layer, wherein when the pressure-sensitive adhesive layer is adhered to a bakelite plate, an initial shear modulus at applying a load of 50 g/cm^2 to a shearing direction is 1x10^5 dyn/cm^2 or less and the permanent shearing strain occurring in the pressure-sensitive adhesive layer at removing the load after adding the load for 30 minutes is 30% or less of the shearing strain at removing the load.

ABSTRACT OF THE DISCLOSURE

A medical adhesive tape and a tape preparation comprising the medical adhesive tape containing percutaneous absorption-type drugs in a pressure-sensitive adhesive layer are disclosed. The medical adhesive tape comprises a flexible support having formed on at least one surface thereof a hydrophobic pressure-sensitive adhesive layer, wherein when the pressure-sensitive adhesive layer is adhered to a bakelite plate, an initial shear modulus at applying a load of 50 g/cm^2 to a shearing direction is $1x10^5$ dyn/cm^2 or less and the permanent shearing strain occurring in the pressure-sensitive adhesive layer at removing the load after adding the load for 30 minutes is 30% or less of the shearing strain at removing the load.

MEDICAL ADHESIVE TAPE AND TAPE PREPARATION

FIELD OF THE INVENTION

The present invention relates to a medical adhesive tape used for protecting a skin surface by adhering the same onto the skin surface and also to a tape preparation for continuously administering percutaneous absorption-type drugs into a living body through the skin by incorporating the percutaneous absorption-type drugs in a pressure-sensitive adhesive layer of the medical adhesive tape.

BACKGROUND OF THE INVENTION

Various types each comprising a nonwoven fabric or a plastic film having formed on one surface thereof a pressure-sensitive adhesive layer are proposed as a medical adhesive tape for protecting an injured portion of a skin surface and a tape preparation for percutaneous absorption for administering drugs into a living body through the skin surface. Usually, the medical adhesive tape, etc., using such a pressure-sensitive adhesive is required to have a skin adhesive force in a certain extent for preventing the adhesive from falling off from the skin surface to which the adhesive tape is applied. However, as the skin adhesive force becomes larger, a physical stimulative property at releasing the adhesive tape from a skin surface becomes larger to cause a pain or the release of a keratin layer at releasing the adhesive tape, whereby there is

a possibility to give a pain to a user by giving an unnecessary stimulation or injury to the skin surface.

Accordingly, in the case of developing the medical adhesive tapes and tape preparations which are applied to a skin surface, the development of a material which has a good tackiness or adhesion to a skin surface and an excellent skin adhesive force which does not give a physical stimulation at releasing it from a skin surface and does not injure the skin surface has been desired.

Thus, as a result of various investigations to overcome the above problems, the inventors previously found that the skin stimulative property could be greatly reduced by using a pressure-sensitive adhesive layer which causes a specific shear deformation when a shearing stress is applied, and proposed the pressure-sensitive adhesive layer as described in JP-A-5-64460 (the term "JP-A" as used herein means an "unexamined published Japanese patent application").

Thereafter, as a result of further investigations, the inventors have found that by designing the pressure-sensitive adhesive layer such that the layer has the creep characteristics that the permanent strain formed in the pressure-sensitive adhesive layer and the initial shear modulus at applying a shearing stress to the pressure-sensitive adhesive layer are reduced as small as possible, the pressure-sensitive adhesive layer gives a proper soft feeling during the application thereof to a skin surface and the skin stimulative

property at releasing the pressure-sensitive adhesive layer from the skin surface can be reduced, and have accomplished the present invention based on this finding.

Furthermore, it has also been found that when a shearing elastic coefficient (G) and a retarding time (τ) in the case of simply applying a deformation strain of the pressure-sensitive layer to the Voigt model are adjusted to the ranges of specific values, the pressure-sensitive adhesive layer is excellent in the adhesive property to a skin surface and the moderating and dispersing properties of a stress occurring at releasing the pressure-sensitive adhesive layer and further can maintain a delicate balance between the skin adhesion and the non-stimulative property.

SUMMARY OF THE INVENTION

Accordingly, one object of the present invention is to provide a medical adhesive tape comprising a flexible support having formed at least one surface thereof a hydrophobic pressure-sensitive adhesive layer, wherein when the pressure-sensitive adhesive layer is adhered to a bakelite plate, an initial shear modulus in the case of applying a load of 50 g/cm^2 to a shearing direction for 30 seconds is 1×10^5 dyn/cm^2 or less and a permanent shearing strain formed in the pressure-sensitive adhesive layer in the case of removing the load after applying the load for 30 minutes is 30% or less of the shearing strain at removing the load.

In the particularly preferred embodiment of the medical adhesive tape of the present invention, when the deformation strain at applying a shearing stress is applied to the simple Voigt model, the deformation strain has the shearing elastic coefficient (G) and the retarding time (τ) satisfying the values of the following formulae;

$$6.0\times10^4 > G > 2.0\times10^3 \ (dyn/cm^2)$$

$$30 > \tau \ (sec.)$$

Another embodiment of the present invention is to provide a tape preparation comprising the above-described medical adhesive tape containing percutaneous absorption-type drugs in the pressure-sensitive adhesive layer.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a view explaining the measurement method of the shear modulus in the Examples,

Figure 2 is a schematic view explaining the Voigt model,

Figure 3 is graph showing the time-strain curve in the case of applying a definite stress by the Voigt model, and

Figure 4 is a side view explaining the deformation occurred at applying a stress to the pressure-sensitive adhesive layer of the medical adhesive tape and the tape preparation of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is described in detail below.

The medical adhesive tape and the tape preparation of the present invention each comprises a flexible support having formed on at least one surface thereof a hydrophobic pressure-sensitive adhesive layer having specific properties containing optional percutaneous absorption-type drugs. The pressure-sensitive adhesive layer may be directly formed on the surface of the support or may be indirectly formed thereon via a conventional undercoat as a means for improving an anchoring property.

The thickness of the support is usually from about 0.5 to 50 μm, and preferably from about 1 to 25 μm from the point of the handling property and the occlusive dressing technique effect (ODT effect).

There is no particular restriction on the material for the support so long as the material has a flexibility, but in the case of the tape preparation, it is preferred to select from the materials that the percutaneous absorption-type drugs contained in the pressure-sensitive adhesive layer do not decrease the content thereof by being lost from the back surface of the support, that is, these components (components contained in the pressure-sensitive adhesive layer, e.g., a pressure-sensitive adhesive, a drug and an organic liquid material) do not permeate through the material. Practically, the single film of polyester, nylon, Saran™ (trade name of Dow Chemical Co.), polyethylene, polypropylene, an ethylene-vinyl acetate copolymer, polyvinyl chloride, an ethylene-ethyl

acrylate copolymer, polytetrafluoroethylene, surlyn, a metal foil, etc., or laminated films thereof can be used.

Of these materials, to improve the adhesion (anchoring property) between the support and the hydrophobic pressure-sensitive adhesive layer described hereinafter, it is preferred that the support has a laminate structure comprising a non-porous sheet of the above-described material and a porous sheet such as a paper, a woven fabric, a nonwoven fabric, etc., and the pressure-sensitive adhesive layer is formed on the porous sheet side. When a woven fabric or a nonwoven fabric is used as the porous sheet, the weight thereof per unit area is from 5 to 30 g/m^2, and preferably from 8 to 20 g/m^2 from the point of improving the anchoring property.

The hydrophobic pressure-sensitive adhesive layer formed on at least one surface of the support described above in the present invention does not comprise polyacrylic acid, a polyacrylate, gelatin, etc., having an affinity with water such as a so-called hydrogel as the base material, but comprises a polymer of a monomer having a hydrophobic property as the main component.

The polymer which is preferably used is a (meth)acrylic acid alkyl ester polymer obtained by polymerizing a (meth)acrylic acid alkyl ester which can relatively easily control the pressure-sensitive adhesive characteristics as the main component monomer. Further, it is a preferred means to

crosslink the pressure-sensitive adhesive layer to render the layer hydrophobic.

In the present invention, in addition to the above-described (meth)acrylic acid alkyl ester polymer, other hydrophobic pressure-sensitive adhesive such as a silicone polymer, a vinyl ether polymer, a rubber polymer, etc., can be used, but in the case of using such a pressure-sensitive adhesive, since the pressure-sensitive adhesive is difficult to control such that it satisfies the creep characteristics in the present invention and also has a selectivity in the solubility and the releasing property of percutaneous absorption-type drugs, it is necessary to pay close attention to handling thereof.

The (meth)acrylic acid alkyl ester polymer used in the present invention is a polymer obtained by homopolymerizing a (meth)acrylic acid alkyl ester or obtained by copolymerizing a (meth)acrylic acid alkyl ester as a main component and a copolymerizable monomer. The polymer becomes the main base material for showing a skin adhesion.

As the (meth)acrylic acid alkyl ester, the ester having an alkyl group having an average carbon atom number of from 4 to 18 is preferred from the point of the pressure-sensitive adhesive characteristics at adhering to a skin. Specific examples of the alkyl ester are straight chain alkyl esters and branched alkyl esters, such as a butyl ester, a pentyl ester, a hexyl ester, a heptyl ester, an octyl ester, a nonyl ester,

a decyl ester, an undecyl ester, a dodecyl ester, a tridecyl ester, etc. These (meth)acrylic acid alkyl esters can be used alone or as a mixture thereof.

The average carbon atom number used herein means the average of the carbon atom number of the alkyl group in the (meth)acrylic acid alkyl ester used for the polymerization reaction, and the present invention does not exclude a (meth)acrylic acid alkyl ester having an alkyl group having from 1 to 3 carbon atoms or an alkyl group having 19 or more carbon atoms.

Examples of the monomer copolymerizable with the (meth)acrylic acid alkyl ester are carboxyl group-containing monomers such as (meth)acrylic acid, itaconic acid, maleic acid, maleic anhydride, crotonic acid, etc.; sulfoxy group-containing monomers such as styrenesulfonic acid, allylsulfonic acid, sulfopropyl (meth)acrylate, (meth)acryloyloxynaphthalene-sulfonic acid, acrylamidomethylpropanesulfonic acid, etc.; hydroxyl group-containing monomers such as (meth)acrylic acid hydroxyethyl ester, (meth)acrylic acid hydroxypropyl ester, etc.; amido group-containing monomers such as (meth)acrylamide, dimethyl(meth)acrylamide, N-butylacrylamide, N-methylol (meth)acrylamide, N-methylolpropane (meth)acrylamide, etc.; alkylaminoalkyl group-containing monomers such as (meth)acrylic acid aminoethyl ester, (meth)acrylic acid dimethylaminoethyl ester, (meth)acrylic acid tert-butylaminoethyl ester, etc.; (meth)acrylic acid alkoxyalkyl esters such as (meth)acrylic

acid methoxyethyl ester, (meth)acrylic acid ethoxyethyl ester, etc.; alkoxy group(or having an oxide bond at the side chain)-containing (meth)acrylic acid esters such as (meth)acrylic acid tetrahydrofurfuryl ester, (meth)acrylic acid methoxyethylene glycol ester, (meth)acrylic acid methoxydiethylene glycol ester, (meth)acrylic acid methoxypolyethylene glycol ester, etc.; vinyl monomers having a heterocyclic ring, such as N-vinyl-2-pyrrolidone, methylvinyl pyrrolidone, vinylpyridine, vinylpiperidone, vinylpyrimidine, vinylpiperazine, vinylpyrazine, vinylpyrrole, vinylimidazole, vinylcaprolactam, vinyloxazole, vinylmorpholine, etc.; vinyl ester monomers such as vinyl acetate, vinyl propionate, etc.; (meth)acrylonitrile, etc.

These monomers can be used alone or as a mixture thereof for the copolymerization.

The preferred monomers in the above monomers are the carboxyl group-containing monomers such as (meth)acrylic acid, etc., and the hydroxyl group-containing monomers such as (meth)acrylic acid hydroxyethyl ester, etc.

These monomers used for the copolymerization can be used to control a cohesive force of the pressure-sensitive adhesive layer and to control a solubility of a drug when the pressure-sensitive adhesive layer contains the drug. Further, the copolymerization amount of the monomer can be optionally selected in the range of 50% by weight or less, and preferably from 2 to 40% by weight, according to the purpose.

In the present invention, to obtain the specific creep characteristics, it is preferred to design such that the pressure-sensitive adhesive layer has a feeling as soft as possible and for the purpose, it is preferred to add an organic liquid material compatible to the hydrophobic pressure-sensitive adhesive layer. In this case, by the addition of the organic liquid material, the pressure-sensitive adhesive layer is plasticized to decrease a cohesive force, whereby there is a possibility to lose the desired creep characteristics. Accordingly, in such a case, it is preferred that the pressure-sensitive adhesive layer is subjected to a crosslinking treatment by an optional crosslinking means to form the pressure-sensitive adhesive layer having a crosslinked structure.

The organic liquid material is a material which is in a liquid state at room temperature and is compatible with the hydrophobic pressure-sensitive adhesive layer.

Examples of the organic liquid material are glycols such as ethylene glycol, diethylene glycol, triethylene glycol, propylene glycol, polyethylene glycol, polypropylene glycol, etc.; fats and oils such as an olive oil, a castor oil, squalene, lanolin, etc.; organic solvents such as ethyl acetate, ethanol, dimethyldecyl sulfoxide, methyloctyl sulfoxide, dimethyl sulfoxide, dimethyl formamide, dimethyl acetamide, dimethyl laurylamide, dodecyl pyrrolidone, N-methylpyrrolidone, isosorbitol, etc.; liquid surface active

agents; plasticizers such as diisopropyl adipate, phthalic acid esters, diethyl sebacate, etc.; hydrocarbons such as fluid paraffin, etc.; fatty acid esters such as isopropyl myristate, isotridecyl myristate, diethyl sebacate, ethyl laurate, ethyl oleate, oleic acid, diisopropyl adipate, isopropyl palmitate, octyl palmitate, etc.; fatty acids for obtaining these fatty acid esters; and organic compounds which are in liquid state at room temperature, such as a glycerol ester, ethoxylated stearyl alcohol, 1,3-butanediol, etc.

These organic liquid materials can be used alone or as a mixture thereof. In these organic liquid materials, the fatty acid esters such as isopropyl myristate, diethyl sebacate, octyl palmitate, ethyl oleate, diethyl phthalate, diisopropyl adipate, etc.; the fatty acids such as monocaprylic acid, caprylic acid, oleic acid, etc.; and the surface active agents such as sorbitan monocaprylate, etc., can be preferably used from the points of non-stimulative property to a skin surface and the improvement of percutaneous absorption property of drugs in the case of the tape preparation.

The organic liquid material plasticizes the pressure-sensitive adhesive layer to give thereto a soft feeling and also by, if necessary, crosslinking the pressure-sensitive adhesive layer, the organic liquid material is held in the hydrophobic pressure-sensitive adhesive layer in a compatible state therewith to give proper creep characteristics. As the result, when the pressure-sensitive adhesive layer is released

from a skin surface, the organic liquid material has a function to reduce the pain and the skin stimulative property caused by the skin adhesive force of the pressure-sensitive adhesive layer.

The content of the organic liquid material contained in the pressure-sensitive adhesive layer is from 15 to 75% by weight, and preferably from 25 to 65% by weight, from the points of reducing the skin stimulative property and giving excellent creep characteristics. If the content of the organic liquid material is less than 15% by weight, there is a tendency that a sufficient effect of reducing the skin stimulative property cannot be expected, while if the content is over 75% by weight, the cohesive force of the pressure-sensitive adhesive layer is decreased and the pressure-sensitive adhesive layer causes a cohesive failure at releasing the layer, whereby the skin stimulative property tends to become large.

It is preferred in the present invention to make the pressure-sensitive adhesive layer a crosslinked structure to increase the cohesive force of the pressure-sensitive adhesive layer, whereby the desired creep characteristics are liable to obtain. That is, by making the pressure-sensitive adhesive layer a crosslinked structure, even when after adhering the pressure-sensitive adhesive layer to a skin surface, a shearing stress is added from the outside, the cohesive failure in the inside of the pressure-sensitive adhesive layer does not occur and the pressure-sensitive adhesive layer becomes a

viscoelastic material which does not cause a peeling in the laminate interface between the support and the pressure-sensitive adhesive layer and a peeling at the adhered interface to a skin surface to which the pressure-sensitive adhesive layer is adhered. In particular, when the organic liquid material is compounded with the pressure-sensitive adhesive layer, the layer is plasticized. Therefore, it is effective to apply a crosslinking treatment to the pressure-sensitive adhesive layer.

The crosslinking treatments which can be employed are a physical crosslinking treatment by a radiation irradiation such as an ultraviolet irradiation, an electron-ray irradiation, etc., and a chemical crosslinking treatment using a crosslinking agent such as polyisocyanate compounds, organic peroxides, organic metal salts, metal alcoholates, metal chelate compounds, melamine derivatives, polyfunctional compounds, etc.

In these crosslinking means, when the radiation irradiation or the organic peroxide is used, it sometimes happens that a degradation reaction of the drug occurs according to the kind of the drug used, and also when a high-reactive isocyanate, or a metal salt or an organic metal salt used for an ordinary crosslinking reaction is used, it sometimes happens that after compounding such a crosslinking agent, a viscosity increasing phenomenon of the solution occurs to reduce the workability.

A method of previously copolymerizing a polyfunctional monomer such as a diacrylate, etc., with the acrylic polymer as the pressure-sensitive adhesive may be considered, but in this case, there is a possibility that the solution viscosity is increased at coating.

Accordingly, of these crosslinking agents, trifunctional isocyanates, metal alcoholates comprising titanium or aluminum, or metal chelate compounds are suitable from the points of reactivity and handling property. These crosslinking agents do not cause the viscosity increasing phenomenon of solution before coating and drying, and thus are very excellent in workability.

The amount of the crosslinking agent added in this case to obtain the creep characteristics in the numeral range of the present invention is as follows. For example, when the pressure-sensitive adhesive layer is formed using an acrylic acid alkyl ester polymer, the amount of the crosslinking agent added is from about 0.01 to 2 parts by weight per 100 parts by weight of the acrylic acid alkyl ester polymer.

Even when the polymer to be crosslinked which forms the pressure-sensitive adhesive layer does not have a functional group which is reacted with the crosslinking agent, the polymer can be denatured into a structure capable of being crosslinked by applying an alkali treatment, etc., to the polymer to be crosslinked.

By containing percutaneous absorption-type drugs in the pressure-sensitive adhesive layer of the medical adhesive tape of the present invention, a tape preparation which is utilized for the treatment and prophylaxis of various diseases by percutaneously administering the drugs into a living body is obtained. The pressure-sensitive adhesive layer of the tape preparation contains percutaneous absorption-type drugs in a dissolved state or a dispersed state.

The drug contained can be optionally selected according to the treatment purpose of a disease. Examples of the drugs used for the tape preparation of the present invention are corticosteroids, analgetic anti-inflammatory agents, hypnotic sedatives, tranquilizers, antihypertensive agents, hypotensive diuretics, antibiotics, anesthetics, antibacterial agents, antimycois agents, vitamins, coronary vasodilator agents, antihistamic agents, antitussive agents, sex hormones, antidepressive agents, cerebral improving agents, antiemetic agents, antitumor agents, and living body drugs. These drugs can be used alone or, if necessary, as a mixture thereof.

The content of the drugs can be properly selected according to the kind of the drugs and the administration purpose, but is usually from 1 to 40% by weight, and preferably from about 2 to 30% by weight, in the pressure-sensitive adhesive layer. If the content of the drugs is less than 1% by weight, the release of the amount of the drugs effective for the treatment of a disease cannot expected, and if the content

is over 40% by weight, the limit occurs for the treatment effect of a disease and also the use of such a large amount of the drugs is economically disadvantageous

The medical adhesive tape and the tape preparation of the present invention have the feature in the creep characteristics of the pressure-sensitive adhesive layer. That is, the pressure-sensitive adhesive layer has the creep characteristics that when the pressure-sensitive adhesive layer is adhered to a bakelite plate, the initial shear modulus in the case of applying a load of 50 g/cm^2 to the shearing direction for 30 seconds is 1×10^5 dyn/cm^2 or less and when the load is applied for 30 minutes and the load is then removed, the permanent shearing strain formed in the pressure-sensitive adhesive layer becomes 30% or less of the shearing strain at removing the load.

The initial shear modulus in the present invention is calculated from the shearing strain after passing 30 seconds since the application of the load as shown in the measurement method described hereinafter, and the permanent shearing strain in the present invention is the shear occurring at the adhered interface of the surface of a bakelite plate and the pressure-sensitive layer or in the case of occurring a flow in the pressure-sensitive adhesive layer when the pressure-sensitive adhesive layer is adhered to the bakelite plate and a shearing stress is then applied.

By that the pressure-sensitive adhesive layer has the creep characteristics described above, the pressure-sensitive adhesive layer is excellent in the cohesive force and the damage to the skin surface at releasing the pressure-sensitive adhesive layer from the skin surface can be reduced as small as possible.

In a more preferred embodiment, by applying a crosslinking treatment to the pressure-sensitive adhesive layer in the present invention, the pressure-sensitive adhesive layer becomes a viscoelastic material satisfying the simple Voigt model and in the test conditions as described below, the cohesive failure which is an independent viscosity factor other than the viscosity factor (dash pot) connected in parallel with an elastic factor (spring) can be excluded. In addition, in order to coincide with the simple Voigt model, it is a necessary condition in the present invention that in the test method described hereinafter, the deformation is completed within 1,000 seconds.

That is, if the interfacial breakdown at the adhesion interface between a material to be adhered and the pressure-sensitive adhesive layer occur, the movement is not stopped even if the deformation is finished, whereby the pressure-sensitive adhesive layer is measured such that as if the layer has the independent viscosity factor and causes a cohesive failure, and an erroneous judgement is made that the pressure-

sensitive adhesive layer does not satisfy the conditions (the G value and the τ value) of the present invention.

Accordingly, it is preferred that by using the pressure-sensitive adhesive layer described above for the medical adhesive tape and the tape preparation of the present invention, the pressure-sensitive adhesive layer coincides with the simple Voigt model and has the shearing elastic coefficient (G) and the retarding time (τ) satisfying the following values.

$$6.0\times10^4 > G > 2.0\times10^3 \ (dyn/cm^2)$$

$$30 > \tau \ (sec.)$$

The Voigt model is a model shown by a parallel bonding of a spring as an elastic body and a dash pot moving in a liquid having a viscosity coefficient (η) as shown in Fig. 2, and is a model which is finally an elastic body when it is applied with an external force but showing a viscoelastic body showing a so-called deformation having a retarded elasticity, that is, showing that the increase of the deformation is retarded in time.

That is, as shown in Fig. 3, the strain (ε) to a definite stress is increased with time (t) but is gradually converged to a definite value. In the pressure-sensitive adhesive layer, the time until the strain is covered to a definite value is within 1,000 seconds.

The shearing elastic coefficient (G) and the retarding time (τ) in the present invention are calculated from the sample deformed as shown in Fig. 4 by the test shown below.

That is, if the strain of the shearing creep at a time t is $\varepsilon(t)$, in the Voigt model the strain becomes as shown in the following formula.

$$\varepsilon(t) = \sigma \cdot 1/G \cdot (1 - e^{-t/\tau}) \qquad (1)$$

σ: Stress (dyn/cm^2)

G: Shearing elastic coefficient (dyn/cm^2)

τ: Retarding time (second)

or $\varepsilon = d/H$

Since the deformation is finished at t = 1000, then

$$\varepsilon(\infty) \fallingdotseq \varepsilon(1000) = \sigma \cdot 1/G.$$

If H is assumed to be unchanged, ε (1000) becomes as follows.

$$\varepsilon(1000) = d(t=1000)/H = \sigma \cdot 1/G \qquad (2)$$

Next, if $t = \tau$, the formula 1 becomes as follows.

$$\varepsilon(\tau) = \sigma \cdot 1/G \cdot (1 - e^{-1})$$

$$\fallingdotseq \varepsilon(\infty) \times 0.632$$

$$\fallingdotseq \varepsilon(1000) \times 0.632$$

$$d(t=\tau) \fallingdotseq d(t=1000) \times 0.632 \qquad (4)$$

Thus, the shearing elastic coefficient (G) is obtained from formula 2 described above. Further, d at $t=\tau$ is obtained from formula 3, and retarding time (τ) can be presumed from the actually measured value.

In the medical adhesive tape of the present invention, the shearing elastic coefficient (G) of the pressure-sensitive adhesive layer obtained as described above is adjusted to be from 2.0×10^3 to 6.0×10^4 dyn/cm^2, and preferably from 3.0×10^3 to 5.0×10^4 dye/cm^2.

If the shearing elastic coefficient (G) is lower than 2.0×10^3 dyn/cm^2, the cohesive force is insufficient and the pressure-sensitive adhesive layer is liable to be broken and even if the layer is not broken, the adhesion feeling becomes greatly poor. If the shearing elastic coefficient (G) is higher than 6.0×10^4 dyn/cm^2, the dispersion of stress at releasing the pressure-sensitive adhesive layer is insufficient to cause a physical stimulation, and since the amount of keratin released become large, whereby the objects of the present invention cannot be sufficiently attained and a delicate balance between the skin stimulative property and the skin adhesion is difficult to obtain.

On the other hand, it is necessary to control the retarding time (τ) to shorter than 30 seconds, and preferably shorter than 25 seconds. If the retarding time is longer than 30 seconds, a sufficient stress dispersion is not obtained as same as in the case of the G value and the effect aimed by the present invention cannot be sufficiently exhibited.

Furthermore, in the case of the tape preparation of the present invention containing percutaneous absorption-type drugs in the pressure-sensitive adhesive layer, when the drugs are

contained in the pressure-sensitive adhesive layer in a crystal state, a filling effect causes, whereby the lower limit of the shearing elastic coefficient (G) becomes high a little and the G value becomes about 3.5×10^3 dyn/cm^2 or higher.

Since the medical adhesive tape and the tape preparation of the present invention are designed such that the creep characteristics of the pressure-sensitive adhesive layer are adjusted to become lower than the specific initial shear modulus and also the permanent shearing strain formed after adding a shearing stress becomes lower than the specific value, the pressure-sensitive adhesive layer has a good skin adhesion and also can decrease the skin stimulation and a pain at releasing the pressure-sensitive adhesive layer from a skin surface. Thus, the medical adhesive tape and the tape preparation giving a soft feeling to a skin at adhering and releasing are obtained. In particular, when the pressure-sensitive adhesive layer is crosslinked and the pressure-sensitive adhesive layer coincides with the sinple Voigt model, the pressure-sensitive adhesive layer has the specific shearing modulus and retarding time, becomes excellent in the stress moderating property and the stress dispersing property, can decrease the skin stimulation and pain, and can keep a delicate balance between the skin adhesion and the skin stimulative property.

The present invention is explained in more detail by the following examples, wherein all parts and %, unless otherwise indicated, are by weight.

EXAMPLES 1 TO 10 AND COMPARATIVE EXAMPLES 1 TO 9

Each pressure-sensitive adhesive layer (thickness 60 μm) formed using each composition for pressure-sensitive adhesive layer shown in Table 1 and Table 2 was formed on the surface of a nonwoven fabric of a support (a laminate film composed of a polyester nonwoven fabric having a weight per unit area of 12 g/m^2 and a polyester film having a thickness of 2 μm) to obtain each medical adhesive tape or tape preparation.

In the Tables, % for the monomer shows the compounding ratio of each monomer, % for the crosslinking agent shows the proportion to solid components of the pressure-sensitive adhesive, and % for the plasticizer and the drug shows the proportion to the whole pressure-sensitive adhesive layer.

TABLE 1

Example	Monomer (%)	Crosslinking Agent (%)	Plasticizer	Drug
1	2-EHA/AA (95/5)	Coronate™ HL (0.15)	IPM (40%)	-
2	"	" (")	" (50%)	-
3	"	" (")	" (60%)	-
4	"	" (")	OP (40%)	-
5	"	" (")	IPM (40%)	ISDN (20%)
6	"	ATAA (0.25)	" (")	" (")
7	2-EHA/VP/AA (75/22/3)	Coronate™ HL (0.50)	" (50%)	-
8	"	" (0.50)	" (")	ES (3%)
9	"	" (0.60)	IPM/SC (45/5%)	-
10	"	" (0.50)	IPM/OA (40/10%)	-

Notes):

2-EHA = 2-Ethylhexyl acrylate

AA = Acrylic acid

VP = N-vinyl-2-pyrrolidone

IPM = Isopropyl myristate

OP = Octyl palmitate

ATAA = Aluminum triacetyl acetonate

SC = Sorbitan monocaprylate

OA = Oleic acid

Colonate HL = Trifunctional isocyanate (trade name, made by Nippon Polyurethane Co.)

ISDN = Isosorbid dinitrate

ES = Estradiol

TABLE 2

Comparative Example	Monomer (%)	Crosslinking Agent (%)	Plasticizer	Drug
1	2-EHA/AA (95/5)	-	IPM (50%)	-
2	"	Colonate HL (0.15)	-	-
3	"	-	-	ISDN (20%)
4	"	Colonate HL (0.03)	IPM (50%)	-
5	"	" (0.15)	" (10%)	-
6	"	" (")	" (90%)	-
7	"	-	" (40%)	ISDN (20%)
8	2-EHA/VP/AA (75/22/3)	-	-	-
9	"	ATAA (0.50)	OP (90%)	-

Notes):

2-EHA = 2-Ethylhexyl acrylate

AA = acrylic acid

VP = N-Vinyl-2-pyrrolidone

IPM = Isopropyl myristate

OP = Octyl palmitate

ATAA = Aluminum triacetyl acetonate

Colonate HL = Trifunctional isocyanate

ISDN = Isosorbid dinitrate

On the medical adhesive tapes and the tape preparations obtained, the following characteristic evaluations were made. The results obtained are shown in Table 3 and Table 4.

[Shear modulus]

As shown in Fig. 1, each of the medical adhesive tapes or the tape preparations of the present invention was adhered to a bakelite plate such that the adhered area became 1 cm^2, and the adhered sample was closely adhered by reciprocating once a roller of 2 kg on the sample thus adhered.

After adhering the sample, from the shearing strain at applying a load of 50 g/cm^2 to the shearing direction for 30 seconds, the initial shear modulus was calculated according to the following formula.

$$E = W \cdot g/S \times d/X$$

E: Shear modulus (dyn/cm^2)

W: Weight (g) of the load

g: Acceleration of gravity (cm/sec^2)

S: Adhered area (cm^2)

d: Thickness (μm) of the pressure-sensitive layer

X: Shearing strain (μm).

[Permanent shearing strain]

The shear moved distance at applying the load for 30 minutes as described above was measured by a laser feed monitor (manufactured by Keyence Co.).

The proportion of the permanent shearing strain to the shearing strain at removing the load obtained above was calculated.

[Adhesive force]

Each strip sample cut into a width of 12 mm was adhered to a bakelite plate. After adhering the sample by reciprocating once a roller at a load of 850 g, the sample was peeled in the direction of 180° at a speed of 300 mm/minute, and the peeling force was measured.

[Skin stimulative property]

Each sample cut into a size of 5 cm^2 was applied to the inside of a brachium of each of 5 volunteers. After 8 hours since then, the sample was peeled. The skin stimulative property at peeling was obtained according to the following evaluation standard, and the average value thereof was calculated.

1: No skin stimulation

2: Slight skin stimulation

3: Small skin stimulation

4: Skin stimulation

5: Strong skin stimulation

[Adhering property]

In the above skin stimulative property test, the skin adhered state at peeling the sample was visually evaluated. In addition, the case that a rise on a considerable area was observed was evaluated as 1, the case that the sample was completely adhered was evaluated as 5, and the adhering property was evaluated by 5 stages.

[Adhesive remaining]

In the skin stimulative property test described above, after peeling each sample from the skin surface, the residue of the pressure-sensitive adhesive remained on the skin surface was visually observed. The case that the residue of the pressure-sensitive adhesive was observed on the whole adhered surface was evaluated as 1, the case that no residue of the pressure-sensitive adhesive was observed on the skin surface and no tackiness was observed was evaluated as 5, and the remaining state of the pressure-sensitive adhesive after peeling the sample was evaluated in 5 stages.

TABLE 3

Example	(A) (dyn/cm^2)	(B) (%)	(C) (g/12mm)	(D)	(E)	(F)
1	1.44×10^4	9.3	43	1.4	4.6	5.0
2	7.17×10^3	12.3	40	1.0	5.0	5.0
3	4.61×10^3	22.1	25	1.0	5.0	5.0
4	2.43×10^4	7.8	39	1.4	4.6	5.0
5	2.85×10^4	11.3	34	1.0	5.0	5.0
6	3.30×10^4	8.3	31	1.2	5.0	5.0
7	2.06×10^4	20.3	85	1.0	5.0	5.0
8	6.25×10^4	12.0	82	1.0	5.0	5.0
9	2.33×10^4	17.6	80	1.0	5.0	5.0
10	1.86×10^4	19.3	88	1.0	5.0	5.0

(A): Shear modulus

(B): Permanent strain

(C): Adhesive force

(D): Skin stimulative property

(E): Adhering property

(F): Adhesive remaining

TABLE 4

Comparative Example		(A) (dyn/cm^2)	(B) (%)	(C) (g/12mm)	(D)	(E)	(F)
	1	-	-	-	-	-	-
	2	1.97×10^5	45.5	344	3.8	4.2	5.0
5	3	1.47×10^5	52.8	327	4.4	4.6	5.0
	4	1.46×10^3	46.2	21	1.0	5.0	1.4
	5	1.24×10^5	40.1	160	2.8	4.4	5.0
	6	-	-	-	-	-	-
	7	-	-	-	-	-	-
10	8	1.84×10^5	42.3	438	4.8	4.0	5.0
	9	-	-	-	-	-	-

(A), (B), (C), (D), (E), and (F) are same as in Table 3.

15 EXAMPLES 11 TO 18 AND COMPARATIVE EXAMPLES 10 TO 16

Each pressure-sensitive adhesive layer (thickness 55 μm) formed by using each composition for the pressure-sensitive adhesive layer shown in Table 5 was formed on the nonwoven fabric surface of a support (laminate film composed of a 20 polyester nonwoven fabric having a weight per unit area of 12 g/m^2 and a polyester film having a thickness of 2 μm) to obtain each of medical adhesive tapes and tape preparations. The units shown in Table 5 are the same as in Table 1 and Table 2.

TABLE 5

Run No.	Monomer (%)	Crosslinking Agent (%)	Plasticizer	Drug
1	2-EHA/AA (95/5)	-	-	-
2	2-EHA/AA (95/5)	Colonate HL (0.063)	-	-
3	2-EHA/AA (95/5)	" (0.125)	-	-
4	2-EHA/AA (95/5)	" (0.125)	IPN (10%)	-
5	2-EHA/AA (95/5)	" (0.125)	IPM (20%)	-
6	2-EHA/AA (95/5)	" (0.125)	IPM (40%)	-
7	2-EHA/AA (95/5)	" (0.125)	IPM (60%)	-
8	2-EHA/AA (95/5)	-	IPM (50%)	-
9	2-EHA/AA (95/5)	Colonate HL (0.063)	IPM (50%)	-
10	2-EHA/AA (95/5)	" (0.125)	IPM (50%)	-
11	2-EHA/AA (95/5)	" (0.188)	IPM (50%)	-
12	2-EHA/AA (95/5)	" (0.125)	IPM (40%)	ISDN (17%)
13	2-EFA/AA (95/5)	" (0.125)	OP (40%)	TNG (10%)
14	2-EHA/VP/AA (72/25/3)	" (0.500)	IPM (50%)	ES (3%)
15	2-EHA/VP/AA (72/25/3)	ATAA (1.000)	IPM (40%)	MP (10%)

Notes):

2-EHA = 2-Ethylhexyl acetylate

AA = Acrylic acid

VP = N-Vinyl-2-pyrrolidone

IPM = Isopropyl Myristate

OP = Octyl palmitate

ATAA = Aluminum triacetyl acetate

Colonate HL = Trifunctional isocyanate (trade name, made by Nippon Polyurethane Co.)

ISDN = Isosorbid Dinitrate

TNG = Trinitroglycerol

ES = Estradiol

MP = Metoprorol•free form

Run Nos. 1 to 5 = Comparative Examples 10 to 14.

Run Nos. 6 and 7 = Examples 11 and 12.

Run Nos. 8 and 9 = Comparative Examples 15 and 16.

Run Nos. 10 to 15 = Examples 13 to 18.

On each of the medical adhesive tapes or the tape preparations obtained, the following characteristic evaluations were made. The results obtained are shown in Tables 6 to 9.

[Viscoelastic characteristics]

Each sample was adhered to a bakelite plate with an adhered area of 1 cm × 1 cm and after closely adhering the sample by reciprocating once a roller of 2 kg, the assembly was allowed to stand for 30 minutes. By applying a shearing stress of a load of 50 g to the sample, the deformation amount of the

sample to the stress was measured at a time interval of 5 seconds using a laser feed monitor. By calculating the measured result according to the calculation methods described above, $\varepsilon(t=1000)$, $\varepsilon(t=1000)x(1-e^{-1})$, the G value, and the τ value were obtained.

[Adhesive force]

Each strip sample cut into a width of 12 mm was adhered to a bakelite plate, after closely adhering the sample by reciprocating a roller of 300 g, the sample was peeled in the direction of 180° at a speed of 300 mm/minute, and the peeling force was measured.

[Keratin released amount]

Each disk sample cut into a diameter of 16 mm was adhered to the inside of the brachium of each of 3 volunteers for 2 hours, after peeling the sample, the sample was immersed in a dye solution (Gentian violet 1%, Brilliant green 0.5%, distilled water 98.5%) for 3 minutes, and the sample was then washed with water and the keratin cell attached to the sample surface was dyed.

The sample was immersed in a 5% aqueous solution of sodium dodecylsulfate a whole day and night to extract the dyed solution and by measuring the absorbance (595 nm) of the extract, the number of the keratin cells released from the skin surface was compared. That is, it could be judged that as the absorbance was larger, the amount of the keratin released was larger.

In addition, between the number of the released keratin cells counted by a microscope and the above absorbance, a good correlation was confirmed.

[Pain]

Each sample was adhered to the inside of the brachium of each of 5 volunteers, after 2 hours since then, the sample was peeled, and the pain at peeling was measured. The pain was evaluated in 5 stages and the case of the smallest pain was defined as 1 and the average value was obtained. In addition, Sample No. 1 was defined 5 as the standard for the evaluation.

TABLE 6

Time t (sec)	Deformed Amount d (μm) of Pressure-Sensitive Adhesive Layer							
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8
0	0	0	0	0	0	0	0	0
5	13	17	17	17	39	137	584	321
10	20	"	19	20	43	189	655	1260
15	"	"	20	23	46	208	678	2315
20	23	21	"	"	48	221	691	5612
25	"	"	"	26	51	229	701	broken
30	"	24	21	"	52	235	707	
35	"	"	23	"	56	241	714	
40	26	"	"	28	59	247	717	
45	"	"	"	"	"	"	721	
50	"	27	"	"	62	254	726	
55	"	"	"	29	"	"	727	
60	"	"	"	"	"	257	729	
65	30	"	"	30	65	260	730	
70	"	"	"	32	66	261	731	
75	"	"	"	33	"	264	"	
80	"	"	"	"	69	267	"	
85	"	28	"	"	70	"	"	
90	"	"	"	"	72	"	"	
95	"	"	"	"	74	270	"	
100	33	"	"	34	76	"	732	
105	"	"	"	"	77	"	731	
110	"	"	"	"	"	273	"	
115	"	"	"	"	78	"	"	
120	"	29	"	35	79	"	"	
125	"	30	24	"	80	277	"	
130	"	"	"	37	82	"	"	
150	34	"	"	38	"	280	"	
200	35	"	25	40	86	285	"	
250	36	34	26	43	87	286	732	
500	39	40	32	49	"	285	731	
750	44	47	33	50	"	"	"	
1000	48	"	"	49	"	"	"	

TABLE 7

Time t (sec)	Deformed Amount d (μm) of Pressure-Sensitive Adhesive Layer						
	No. 9	No. 10	No. 11	No. 12	No. 13	No. 14	No. 15
0	0	0	0	0	0	0	0
5	449	222	173	87	26	40	52
10	933	359	221	100	537	52	55
15	1105	401	234	108	572	"	58
20	1199	424	241	113	585	"	"
25	1261	437	245	116	592	"	"
30	1310	449	251	119	595	"	"
35	1346	456	254	122	602	"	59
40	1376	463	"	126	605	"	"
45	1401	469	257	"	607	"	"
50	1421	476	260	"	608	53	"
55	1440	479	"	128	611	56	60
60	1456	482	"	129	613	55	"
65	1472	485	263	132	615	56	"
70	1486	489.	264	"	"	"	"
75	1499	492	"	135	618	"	"
80	1508	494	"	"	"	"	62
85	1518	498	"	"	"	"	"
90	1528	502	267	"	621	"	"
95	1538	"	"	139	"	"	"
100	1544	505	"	"	"	"	64
105	1554	508	270	"	"	"	"
110	1560	509	"	"	624	57	"
115	1570	511	"	140	"	"	"
120	1573	515	"	"	"	58	67
125	1583	518	271	141	"	"	"
130	1595	520	"	"	"	59	"
150	1621	528	"	142	628	"	69
200	1680	546	272	144	631	62	71
250	1697	553	271	"	634	66	73
500	1698	"	"	"	"	69	74
750	1697	"	"	"	"	"	"
1000	"	"	"	"	"	"	"

TABLE 8

	Sample No.							
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8
ε(t=1000) (μm)	-	47	33	49	87	285	731	-
ε(t=1000)x $(1-e^{-1})$ (μm)	-	30	209	31	55	180	462	-
G (dyn/cm^2)	-	5.73 $\times 10^4$	8.17 $\times 10^4$	5.50 $\times 10^4$	3.10 $\times 10^4$	9.49 $\times 10^3$	3.69 $\times 10^3$	-
τ (sec)	-	120-125	25-30	65-70	30-35	5-10	0-5	-
Adhesive force (g/12mm)	351	362	361	415	114	92	70	-
Released amount of keratin (Abs.)	1.40	1.54	1.51	1.31	0.52	0.39	0.41	-
Pain	5	5	5	5	3	1	1	-

TABLE 9

	Sample No.						
	No. 9	No. 10	No. 11	No. 12	No. 13	No. 14	No. 15
ε(t=1000) (μm)	1697	553	271	144	634	69	74
ε(t=1000)x $(1-e^{-1})$ (μm)	1073	349	171	91	401	44	47
G (dyn/cm^2)	1.59 $\times10^3$	4.87 $\times10^3$	9.94 $\times10^3$	1.87 $\times10^4$	4.25 $\times10^3$	3.91 $\times10^4$	3.97 $\times10^4$
τ (sec)	10-15	5-10	0-5	5-10	5-10	5-10	0-5
Adhesive force (g/12mm)	67	69	74	68	61	95	68
Released amount of keratin (Abs.)	0.34	0.30	0.29	0.36	0.25	0.60	0.42
Pain	2	1	1	1	1	2	1

In the results shown in Table 8 and Table 9 above, in the medical adhesive tape of Sample No. 1 (Comparative Example 10). the deformation was not finished and hence the value G and the value τ could not be obtained.

Further, in the medical adhesive tape of Sample No. 8 (Comparative Example 15), the cohesive failure occurred and sample could not be tested.

Furthermore, in the medical adhesive tape of Sample No. 8 (Comparative Example 16), the sample showed excellent values in the adhesive force, the released amount of the keratin, and

the pain, and also the cohesive failure did not occur but the sample showed a tacky feeling, had a feeling of requiring a care for falling off of the sample, the actual tacky feeling was bad, and the sample was unsuitable for a practical use.

The G values and the τ values of the medical adhesive tapes of Sample Nos. 6, 7, 10 and 11 and the tape preparations of Sample Nos. 12 to 15 were within the present invention (Examples 11 to 18) and these samples were excellent for practical use.

The medical adhesive tape of Sample No. 5 (Comparative Example 14) could be practically used but the sample gave some pain at peeling and hence was not particularly excellent one.

While the invention has been described in detail and with reference to specific embodiments thereof, it will be apparent to one skilled in the art that various changes and modifications can be made therein without departing from the spirit and scope thereof.

WHAT IS CLAIMED IS:

1. A medical adhesive tape comprising a flexible support having formed on at least one surface thereof a hydrophobic pressure-sensitive adhesive layer, wherein when the pressure-sensitive adhesive layer is adhered to a bakelite plate, an initial shear modulus at applying a load of 50 g/cm^2 to a shearing direction is 1x10^5 dyn/cm^2 or less and the permanent shearing strain occurring in the pressure-sensitive adhesive layer at removing the load after adding the load for 30 minutes is 30% or less of the shearing strain at removing the load, and wherein said pressure-sensitive layer comprises a (meth)acrylic acid alkyl ester polymer obtained by polymerizing a (meth)acrylic acid alkyl ester.

2. A medical adhesive tape of claim 1, wherein the pressure-sensitive adhesive layer comprises a copolymer obtained by copolymerizing a (meth)acrylic acid alkyl ester having an alkyl group having an average carbon atom number of from 4 to 18 as the main component monomer.

3. A medical adhesive tape of claim 1, wherein the pressure-sensitive adhesive layer contains an organic liquid material which is in a liquid state at room temperature and is compatible with the pressure-sensitive adhesive layer,

and wherein the organic liquid material is from 15 to 75% by weight.

4. A medical adhesive tape of claim 3, wherein the organic liquid material is at least one liquid material selected from the group of consisting of fatty acid esters, fatty acids, and surface active agents.

5. A medical adhesive tape of claim 1, wherein the pressure-sensitive adhesive layer is a crosslinked structural material.

6. A medical adhesive tape of claim 5, wherein the deformation strain of the pressure-sensitive adhesive layer at adding a shearing stress to the layer has a shearing elastic coefficient (G) and a retarding time (τ) satisfying the following values in the case of applying it to a simple Voigt model;

$$6.0\times10^{4} > G > 2.0\times10^{3} \ (dyn/cm^{2})$$

$$30 > \tau \ (sec.)$$

7. A tape preparation comprising a flexible support having formed on at least one surface thereof a hydrophobic pressure-sensitive adhesive layer, wherein when the pressure-sensitive adhesive layer is adhered to a bakelite plate, the initial shear modulus at applying a load of 50 g/cm^{2} to the shearing direction for 30 seconds is 1×10^{5} dyn/cm^{2} or less, the permanent shearing strain occurring in

the pressure-sensitive layer at removing the load after adding the load for 30 minutes is 30% or less of the shearing strain at removing the load, and the pressure-sensitive adhesive layer contains percutaneous absorption-type drugs from 1 to 40% by weight, and wherein said pressure-sensitive adhesive layer comprises a (meth)acrylic acid alkyl ester polymer obtained by polymerizing a (meth)acrylic acid alkyl ester.

Fig. 1

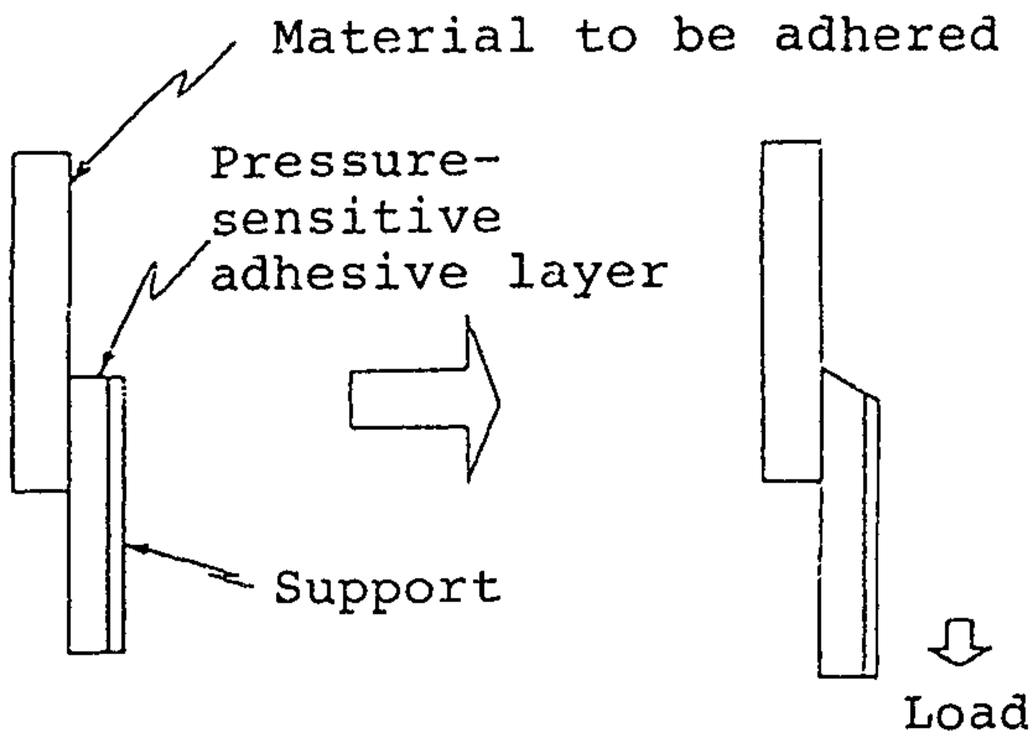


Fig. 2

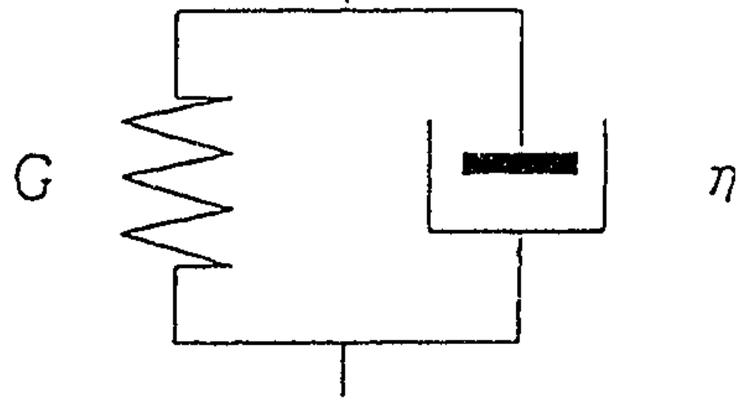
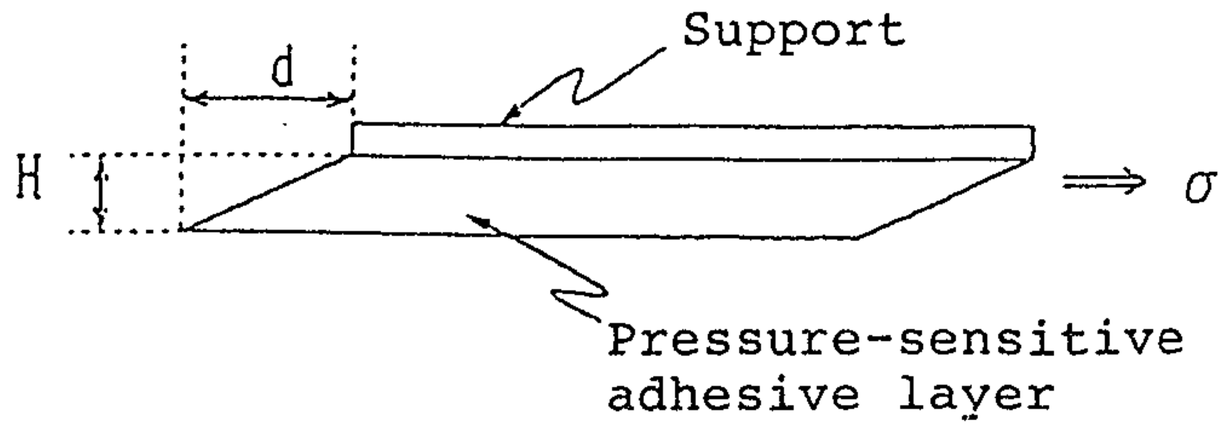
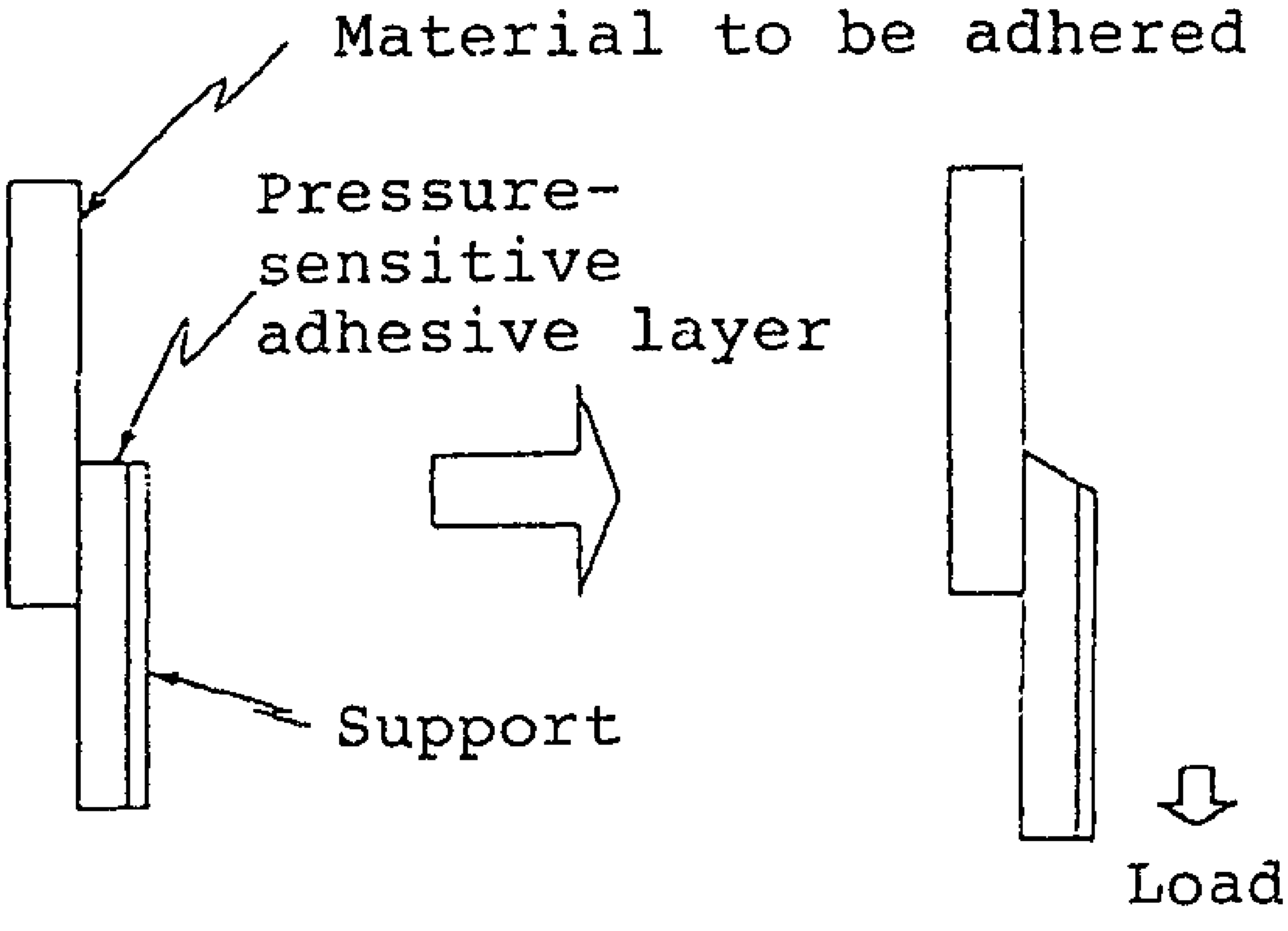


Fig. 3

Fig. 4




Material to be adhered
Pressure-
sensitive
adhesive layer
Support
Load