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(57) Abstract: Preformed film (1) comprising a carrier member (2) and a polymeric member (3) attached to the carrier member (2), wherein the polymeric member (3) includes at least one shape memory polymer and wherein the polymeric member (3) has a flatness index of less than 0.02.



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Preformed film

FIELD OF THE INVENTION

The present invention relates to a preformed film comprising a carrier member and a polymeric member attached to the carrier member. The polymeric member could be curable elastomer compositions and also deformable thermoplastic compositions which are reshapable subsequent to cure or solidification. A possible application among others is the usage of the film for the handling and/or treatment of a semiconductor wafer for e.g. the thinning of the wafer. Furthermore the present invention relates to a manufacturing process for such a preformed film comprising a carrier member and a polymeric member attached to the carrier member.

BRIEF DESCRIPTION OF RELATED TECHNOLOGY

The US7,226,812B2 discloses a film comprising a carrier in form of a wafer support substrate with a wafer support adhesive wherein an additional sacrificial polymeric layer is used for a method for handling and treating a wafer. The disadvantage of the used film is that the sacrificial polymeric layer has to be spray coated onto the wafer bumps in an additional procedural step. Furthermore after the treatment of the wafer, the wafer is exposed to heat to thermally decompose the sacrificial polymer into gases so that the sacrificial layer couldn't be used again.

To overcome these disadvantages a further film is disclosed with the US2006/0046433A1 comprising a carrier in form of a fixture, which is covered with a shape memory polymer with openings formed therein.

Disclosed prior art films requires the application of shearing, wedging, and/or peeling forces in order to separate the film from the component to be handled, e.g. a thinned wafer surface. Because the prior art temporary adhesives like a polymeric layer or a SMP retain a relatively high degree of residual adhesion they tend to cause a damaging of the component e.g. a cracking of thinned wafers as mechanical force is applied during shearing, wedging, and/or peeling debonding process steps.

An object for the present invention is to provide an advanced preformed film comprising a carrier member and a polymeric member to provide an improved application.

SUMMARY OF THE INVENTION

The invention overcomes the identified disadvantages and solves the mentioned object by providing a preformed film comprising a carrier member and a polymeric member attached to the carrier member, wherein the polymeric member includes at least one shape memory polymer and wherein the polymeric member has an average film thickness of 10 to 1200 μm and wherein the polymeric

member has a flatness index of less than 0.02 wherein the flatness index is defined as the ratio of roughness of the exterior surface of the polymeric member to the thickness of the polymeric member.

The said exterior surface of the polymeric member could be defined as this outer side of the polymeric member which is arranged at the opposing side to the area of contact of the carrier member for the polymeric member.

The flatness index, as used in the present invention, is defined as the ratio of roughness of the exterior surface of the polymeric member to the average film thickness of the polymeric member.

The flatness index can be determined as shown in Fig. 1 to 3. The term roughness, as used in the present invention, means the roughness average, which is defined as the arithmetic average of peak P_n and valley V_n distances D_n .

The term peak P_n , as used in the present invention, refers to any protruding area of the exterior surface, whereas the term valley V_n , as used in the present invention, refers to any recess between protruding areas of the exterior surface of the polymeric member.

The term distance D_n , as used in the present invention, means the difference in height of a peak P_n and neighbored valley V_n measured in a substantially orthogonal direction to the outer surface of the carrier member which is the contact surface for the attached polymeric member.

In other words the distance D_n is defined as the distance, measured in a substantially orthogonal to the outer surface of the carrier member, of two straight lines extending substantially parallel to the said outer surface, wherein one straight line subtends a peak P_n and the other straight line subtends a neighbored valley V_n .

The roughness can be measured, for example, along a line of usually 0.08 cm on the exterior surface of the polymeric member. Preferably the roughness, as used in the present invention, is the arithmetic average of 15 different measurements at 15 different positions on the exterior surface of the polymeric member. The roughness can be determined at a measurement speed of 0.5 mm/s by using a Solarius non-contacting Laser Profilometer equipped with an AF2000 autofocus sensor. The obtained data can be analyzed by using solar map universal 3.1.10 image analysis software (Gaussian filter 0.8 mm), wherein a microroughness filtering is used, with a cutoff of 2.5 μm .

The average film thickness T of the shape memory polymer film can be determined as shown in Fig. 3. The average film thickness T is the arithmetic average of a multitude of film thickness values T_n , wherein each film thickness value T_n is measured in a substantially orthogonal direction to the contact

surface for the attached polymeric member, between two opposing points, wherein one point is located on the said contact surface, and the corresponding point is located on the opposing exterior surface of the polymeric member.

The term multitude, as used above, can refer, for example, to at least 10 different measuring points at 10 different positions along a profile section of the polymeric member.

The average film thickness T can be determined, for example, by using a section of the support structure (1 cm×1 cm in size) divided into 5 equal strips (each 2 mm) and in each case the average film thickness T of the polymeric member is determined along the profile. The average film thickness T along the profile can be determined by scanning electron microscopy (SEM) preferably using a scanning electron microscope JEOL JSM-6060 SEM.

It is also possible to use a longitudinal extension of the preformed film as a plane of reference for the orthogonality of the measurements of the thickness values T_n for the determination of the thickness T and the measurements of the distances D_n for the determination of the roughness instead of the said outer surface of the carrier member. The term longitudinal extension, as used in the present invention, refers to a plane extending substantially parallel to the exterior surfaces of the polymeric member, wherein the asperity of the surfaces of the polymeric member is not taken into account.

Such a preformed film could in particular be used for handling and treating any product or component like e.g. a wafer. The preformed film provides a fixing possibility to hold the wafer or any other product during processing e.g. for a thinning process step. The polymeric member guarantees a secure adherence of e.g. the wafer also in case the wafer contains protrusions e.g. in form of bumps. To guarantee a safe handling and/or a secure adherence it is possible to provide recesses within the surface of the polymeric member so that any protrusion of the product to be handled will fit into these recesses.

In this context, it is advantageous to use preformed films having a polymeric member with an exterior surface which exhibits a flatness index (FI) of less than 0.02, because the flat nature of said surface allows the removal of the preformed films or rather the polymeric member in a very efficient way. Polymeric members having an exterior surface which exhibits a flatness index (FI) of less than 0.02 can be removed substantially completely from e.g. a wafer surface in a stress-free process by applying a low peel force.

Preferably the preformed film or rather the polymeric member is removed by exposing it to a temperature of at least 10°C, more preferably to a temperature of at least 20°C, and particularly

preferably to a temperature of at least 30°C above the glass transition temperature of the shape memory polymer.

By applying an appropriate temperature, the preformed film with the polymeric member of the present invention can be removed substantially completely from e.g. a wafer surface in short time periods, preferably in less than 15 minutes, more preferably in less than 10 minutes, and particularly preferably in less than 5 minutes.

The term “substantially completely” as used in the present invention preferably means, that less than 5 wt.-%, preferably less than 1 wt.-%, more preferably less than 0.5 wt.-%, and particularly preferably less than 0.1 wt.-%, based on the total weight of the polymeric member, remain on the components surface after the preformed film with the polymeric member is removed from the components surface, e.g. a wafer surface.

The term “peel force” as used in the present invention preferably refers to the 90° peel force needed for peeling the adhered surfaces (exterior surface of the polymeric member and components surface) apart. Said 90° peel force can be determined at 23°C according to ASTM D6862-04 test method using a TXT plus tensile tester (available from Stable Micro Systems, Surrey UK) using 5 Kg load cell and a crosshead speed of 25 mm/min.

As used in the present invention a peel force, such as the 90° peel force, is regarded as being low, if the peel force, such as the 90° peel force, needed to separate the preformed film or rather the polymeric member and the component at 23°C is less than 0.01 N/mm, preferably less than 0.005 N/mm, more preferably less than 0.002 N/mm, and particularly preferably less than 0.001 N/mm.

It is desirable that the flatness index (FI) of the exterior surface of the polymeric member of the present invention is less than 0.01, more preferably less than 0.005, and particularly less than 0.001, because the very flat nature of said surface allows the substantially completely removal of the preformed film or rather the polymeric member from the components surface in a stress-free process by applying a very low peel force, such as a 90° peel force of less than 0.005 N/mm.

As noted above, the exterior surface the polymeric member of the present invention is formed by or comprises at least one shape memory polymer film.

The term “shape memory polymer” as used in the present invention refers to polymeric materials that are stimuli-responsive. Upon application of an external stimulus they have the ability to change their shape. A change in shape initiated by a change in temperature can be referred to as a thermally induced shape memory effect.

The at least one shape memory polymer of the present invention preferably has a glass transition temperature, as determined by DSC (Differential Scanning Calorimetry), of between 40 and 200°C, preferably between 50 and 150°C and more preferably between 100 and 120°C.

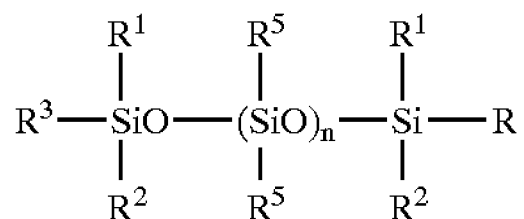
In certain embodiments of the present invention the shape memory polymer is a reaction product formed by curing a curable composition, comprising

- i) at least one crosslinkable component which forms an elastomer when cured; and
- ii) distributed within said crosslinkable component in a shape-holding amount a polymeric powder which remains discrete in the cured elastomer and has a melt temperature below the degradation temperature of the cured elastomer.

The at least one crosslinkable component of the present invention is preferably selected from curable silicone compositions. Various types of curable silicone compositions may be employed. For example, heat curing silicone compositions, moisture curing silicone compositions and photocuring silicone compositions may be employed. Polymodal curing silicone compositions, for example photo and moisture dual curing compositions or heat and moisture dual curing silicone compositions are also useful.

Desirably, the curable silicone compositions are heat cure compositions. In particular, such heat cure silicone compositions include reactive polyorganosiloxanes containing reactive functional groups such as vinyl or allyl groups, or (meth)acrylate groups. In addition to the reactive polyorganosiloxanes, such heat curing compositions also include a silicon hydride cross-linker and an organo-metallic hydrosilation catalyst.

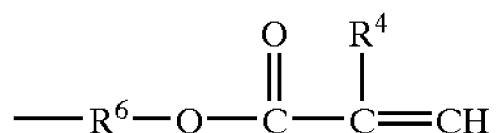
Examples of useful reactive polyorganosiloxanes which may be employed in heat curing silicone compositions include those which conform to formula (I) below:



formula (I)

where R¹, R², R³ and R⁵ can be the same or different and are substituted or unsubstituted hydrocarbon or hydrocarboxy radicals from C1-20, provided that at least two of these R groups, and desirably more than two, are reactive functional groups such as olefinic groups, including vinyl,

(meth)acrylate, maleate and cinamate groups. For example, when one or more of the aforementioned R groups (R1, R2, R3 and R 5) is not one of the required reactive functional groups, they can be chosen from alkyl radicals such as methyl, propyl, butyl and pentyl; alkenyl radicals such as vinyl and allyl; cycloalkyl radicals such as cyclohexyl and cycloheptyl; aryl radicals such as phenyl; arylalkyl radicals such as betaphenylethyl; alkylaryl radicals; and hydrocarbonoxy radicals such as alkoxy, aryloxy, alkaryloxy, aryalkoxy, and desirably methoxy, ethoxy or hydroxy, and the like. Any of the foregoing radicals having some or all of the hydrogen atoms replaced, for example, by a halogen such as fluorine or chlorine, are also useful. One or more of the aforementioned R groups can also be hydrogen, provided the required reactive functional group is present as indicated and the presence of the hydrogen does not deleteriously interfere with the ability of the polyorganosiloxane to perform in the present invention. R3 in the above formula desirably is:



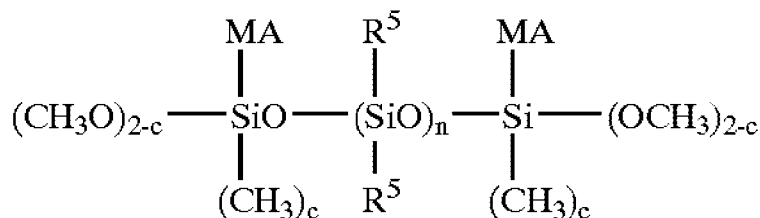
where R6 is a substituted or unsubstituted hydrocarbon radical C1-20 and desirably is an alkyl group such as propyl; and R4 is H or CH3.

The number of repeating units in the reactive polyorganosiloxanes can be varied to achieve specific molecular weights, viscosities and other chemical or physical properties. Generally n is an integer such that the viscosity is from about 25 cps to about 2,500,000 cps at 25°C, such as when n is from 1 to 1200 and desirably from 10 to 1000.

The reactive polyorganosiloxanes of the present invention may include as part of their backbone one or more divalent substituted or unsubstituted C 1-20 aliphatic, cycloaliphatic or aromatic hydrocarbon radicals, which may be interrupted with a heteroatom-containing linkage. The heteroatom may include N, O or S. Among the useful divalent hydrocarbon radicals include alkylenes, polyolefins, polyethers, polyesters, polyurethanes and combinations thereof.

Desirably the crosslinkable component includes a compound (reactive polyorganosiloxane) having the formula (II):

- 7 -

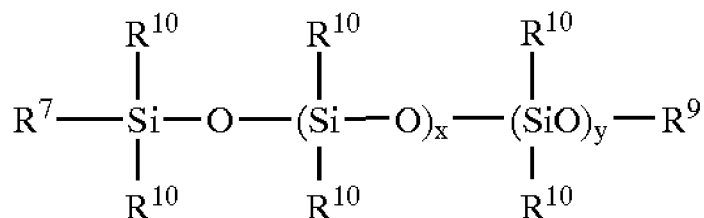


formula (II)

wherein MA is a methacryloxypropyl group, n is from 1 to 1200 and c is 0 or 1; and R⁵ is a substituted or unsubstituted C1-20 hydrocarbon or C1-20 hydrocarbonoxy radical.

The reactive polyorganosiloxanes should be present in amounts of about 50 to about 95%, and desirably in amounts of about 60 to about 80% by weight, based on the total amount of the curable composition.

Silicon hydride crosslinker compounds may also be incorporated, and are particularly useful in heat curing compositions. These materials may be selected from a wide variety of compounds, although the crosslinker desirably conforms to formula (III) below:



formula (III)

where at least two of R⁷, R⁹ and R¹⁰ are H; otherwise R⁷, R⁹ and R¹⁰ can be the same or different and can be substituted or unsubstituted hydrocarbon radical from C₁₋₂₀ such hydrocarbon radicals including those as previously defined for formula I above, thus, the SiH group can be terminal, pendent or both; R¹⁰ can also be a substituted or unsubstituted hydrocarbon radical from C₁₋₂₀ such hydrocarbon radicals including those as previously defined for formula I above, and desirably is an alkyl group such as methyl; x is an integer from 10 to 1000; and y is an integer from 1 to 20. Desirably R groups which are not H are methyl. The silicon hydride crosslinker should be present in amounts sufficient to achieve the desired amount of crosslinking and desirably in amounts of about 1 to about 10 wt.-% of the curable composition.

Useful organo-metallic hydrosilation catalyst may be selected from any precious metal or precious metal-containing catalyst effective for initiating a thermal hydrosilation cure reaction. Especially useful

are the platinum and rhodium catalysts which are effective for catalyzing the addition reaction between silicone-bonded hydrogen atoms and silicone-bonded olefinic groups.

Other classes of catalysts useful in the present invention include organo rhodium and platinum alcoholates. Complexes of ruthenium, palladium, osmium and iridium are also contemplated. The organo metallic hydrosilation catalyst may be used in any effective amount to effectuate thermal curing. Desirably the catalyst is present in amounts of 0.025% to about 1.0% by weight, based on the total amount of the curable composition. Combinations of catalysts are contemplated.

Desirably, the at least one crosslinkable component of the present invention is present in amounts of 20 to 80% and more desirably in amounts of 40 to 60% by weight, based on the total amount of the curable composition.

The curing (vulcanization) reaction can be defined as any treatment that increases the viscosity of the elastomers, increases the tensile strength and modulus, and strain-to-failure. This process can be described as a crosslinking reaction between polymer molecules, which also includes chain extension as well as crosslinking. Included among the useful silicone polymers are liquid vinyl containing esters or ethers.

The polymeric particles of the present invention remain discrete in the cured elastomer and have a melt temperature below the degradation temperature of the cured elastomer.

As used in the present invention the term "melt temperature" of the polymeric particles preferably refers to the temperature at which the polymeric particles undergo a change of state from a solid to liquid. The melt temperature can be determined by DSC where the melt temperature is defined as the inflection point of a DSC curve.

As used in the present invention the term "degradation temperature" of the cured elastomer refers to the temperature at which the elastomer undergoes a weight loss of more than 10 wt.-%, preferably more than 20 wt.-%. The degradation temperature can be determined by TGA (Thermogravimetric Analysis).

Among the useful polymeric particles, such as polymeric powders, are polyolefins or copolyolefins such as polyethylene, polypropylene, polyethylene-co-propylene, polybutadiene (72% cis, 28% trans), polycaprolactone, isotactic poly(1-butene), syndiotactic polypropylene, poly(1-decene), poly(ethylene-co-1-butene), poly(ethylene-co-vinylacetate), polybutylene adipic acid), poly(α -methyl styrene-co-methylstyrene), polyethylene oxide, trans 1,4-polybutadiene or trans 1,4-polyisoprene. The particle size of the polymeric particles of the present invention may vary widely from 50 nm, up to about 100 microns. Desirably, the polymeric particles have a size range of about 5 to about 10 μ m.

The particle size can be determined by laser diffraction using a Mastersizer 2000 (produced by Malvern instruments Ltd, calculation according to Mie).

The term "particle size" as used in the present invention refers to the d50 particle diameter. D50 represents a particle diameter defining that 50% of the particles are greater than this, and another 50% of the particles are smaller than this.

It is desirable that the polymeric particles are distributed within the crosslinkable component in a shape-holding amount, preferably in an amount of 1 to 80 wt.-%, more preferably in an amount of 20 to 60 wt.-%, and more preferably in an amount of 30 to 50 wt.-%, based on the total amount of the curable composition.

The shape memory polymers of the present invention can be prepared according to any method. A particular preferred method to prepare the shape memory polymers of the present invention is described in US patent application No. 2004/0266940 A1, which is expressly incorporated herein by reference.

In a further embodiment of the present invention, the shape memory polymer is a shape memory epoxy polymer. Preferred shape memory epoxy polymers are selected from reaction products formed by curing a curable composition, comprising an aromatic diepoxide (rigid epoxy), an aliphatic diepoxide (flexible epoxy), and a diamine curing agent.

Suitable aromatic diepoxides include the diglycidyl ether of bisphenol A epoxy monomer, which is commercially available under the tradename EPON 826 from Hexion Speciality Chemicals; suitable aliphatic diepoxides include neopentyl glycol diglycidyl ether (NGDE), which is commercially available from TCI America; suitable diamine curing agents include poly(propylene glycol)bis(2-aminopropyl)ether, which is commercially available under the tradename Jeffamine D-230 from Huntsman.

A particular preferred method to prepare the shape memory epoxy polymers of the present invention is described in US patent application No. 2008/0262188 A1, which is expressly incorporated herein by reference.

In a preferred embodiment of the present invention the polymeric member used as a support structure and rather the shape memory polymer used as the polymeric member is a film, preferably having an average film thickness of 10 to 1200 μm . Polymeric members comprising shape memory polymer films can for example be used to support components like wafers during backside grind. The shape memory polymer film protects the protrusions, such as bumps, on the surface of the wafer during the backside grinding process, wherein the thickness of the shape memory polymer film is typically at

least two times larger than the height (maximum length in any direction of space) of the protrusions, such as bumps, in order ensure an effective protection of the protrusions and other extruding structures on the front side of the wafer

It has been found that, particularly in the range of an average film thickness of 10 to 1200 μm , more preferably in the range of 15 to 500 μm , and particularly preferably in the range of 30 to 300 μm , the protrusions of wafer surface are effectively protected during the grinding process and that the support structure can be substantially completely removed from the wafer surface in a stress-free process by applying a low 90° peel force of less than 0.005 N/mm.

Additionally, the preformed film of the present invention comprises at least one carrier member, which is attached to the inner surface of the polymeric member comprising the shape memory polymer.

It is advantageous to use a preformed film comprising at least one carrier member in the method of the present invention, because the carrier member reduces the peel force needed to remove the polymeric member from the wafer surface. Additionally, the carrier member imparts structural integrity and/or stiffness to the support structure and/or ensures the reusability of the support structure.

The at least one carrier film of the present invention may be UV transparent and/or may comprise at least one polymer selected from polyethylenes, polypropylenes, polycarbonates, polyesters, polyethyleneterephthalates, polyvinylchlorides, copolymers of ethylene and vinyl acetate and/or combinations thereof. The carrier film can comprise or consist of one, two or more than two different layers, wherein each layer can comprise or consist of at least one of the aforementioned polymers.

It is desirable that the average thickness of the carrier member is in the range of 50 to 200 μm , preferably in the range of 70 to 175 μm , and more preferable in the range of 90 to 140 μm .

The average film thickness of the carrier member is defined as the arithmetic average of a multitude of film thickness values, wherein each film thickness value is measured in a substantially orthogonal direction to the said outer surface of the carrier member or to the said longitudinal extension of the carrier member between two opposing points, wherein one point is located on the inner surface of the carrier member, and the corresponding point is located on the opposing outer surface of the carrier member.

The term multitude, as used above, can refer, for example, to at least 10 different measuring points at 10 different positions along a profile section of the preformed film.

The average film thickness of the carrier member can be determined, for example, by using a section of the support structure (1 cm×1 cm in size) divided into 5 equal strips (each 2 mm) and in each case the average film thickness of the carrier film is determined along the profile. The average film thickness of the carrier film along the profile can be determined by scanning electron microscopy (SEM) preferably using a scanning electron microscope JEOL JSM-6060 SEM.

It is advantageous to use a transparent carrier member, preferably transparent for ultraviolet radiation. With such a carrier member the substance or alloy used as the later polymeric member can be attached to the carrier member as a monomer. Via ultraviolet radiation through the transparent carrier film a polymerization of this monomer could be provided.

A further advantage is the use of a laminar carrier film as a carrier member, wherein the polymeric member is laminarily attached to the carrier member. This embodiment provides the possibility to use a preformed film in form of a plane or e.g. a stripe of any size. Afterwards the plane or stripe could be cut into pieces suitable for the application. It is also possible to provide a preformed film spooled as a coil.

It is furthermore advantageous that the carrier member or carrier film, henceforth simply called carrier member, has at least partly an adhesive promoted surface. The polymeric member is attached to the carrier member; therefore the equipment of the carrier member with an adhesive promoted surface is advantageously to give a prepared surface for a sufficient adhesion for the polymeric member so that the polymeric member could not be peeled away accidentally and/or easily.

A further advantage is the equipment of the polymeric member with a preformed microstructure. The said flatness index flatness index of less than 0.02 is in case of using a preformed film with a preformed microstructure provided by the residual exterior surface of the polymeric member, surrounding the microstructure or in which the microstructure is set. The microstructure could be provided in the form of openings in this said residual exterior surface, which correspond generally to the horizontal dimensions of features or parts, which will be handled by the preformed film, e.g. bumps of wafers. Initially, the openings may be slightly larger than the features in order to allow a feature to be inserted into an opening. Advantageously these openings do not go from the surface of the polymeric member to the carrier member. It is preferred that the polymeric member or that the depth of the openings are designed in such a manner that a layer of the polymeric material remains on the ground of the openings so that the openings do not end at the surface of the carrier member. The preformed microstructure is of course not restricted to openings and can in fact show a different structure with e.g. protrusions or recesses in a different form.

It is furthermore object of the present invention to present a method for providing a preformed film comprising the following steps:

- providing a carrier member;
- applying a supporting material onto the carrier member;
- providing stamping means comprising a rotatable and substantially cylindrical application reel with a contact surface equipped with a releasing agent and a corresponding substantially cylindrical counter surface reel;
- spreading the supporting material onto the carrier member with the stamping means, by feeding the carrier member with the supporting material through the application reel and the corresponding counter surface reel wherein the supporting material gets laminary in contact with the contact surface equipped with the releasing agent over a section of the lateral surface of the cylindrical application reel and wherein the flow rate for the application of the supporting material, the tension exerted on the carrier member and the distance between the application reel and the counter surface reel is adjusted in that the supporting material of the film leaving the stamping means surface has a flatness index of less than 0.02.

This flatness index as used in the present invention could be defined as said before. In a preferred embodiment of the present invention the polymeric member used as a support structure and rather the shape memory polymer used as the polymeric member is a film, preferably having an average film thickness of 10 to 1200 μm .

In an advantageous embodiment a laminar carrier member is used which is preferably spooled as a coil which is unrolled for the further processing. The supporting material could be attached to the unrolled carrier member by e.g. an applicator nozzle. The inventive flatness index of less than 0.02 of the polymeric member is guaranteed in particular by the stamping means. The surface of the substantially cylindrical application reel of the stamping means is equipped with a releasing agent in particular to avoid an adhesion of the supporting material at the surface of the application reel.

The carrier member, i.e. in particular the film after leaving the stamping means is tensioned to be fed through the stamping means. This tension exerted on the carrier member or rather the film is also essential in particular for the flatness or rather the flatness index of the supporting material and the spreading of the supporting material on the surface of the film. The supporting material gets laminary in contact with the contact surface equipped with the releasing agent over a section of the lateral surface of the cylindrical application reel. Therefore a higher tension exerted on the carrier member or rather the film itself results in a closer adaptation of the carrier member with the supporting material to the contact surface equipped with the releasing agent over a section of the lateral surface of the cylindrical application reel. The tension depends in particular on the characteristics of the carrier

member and also of the supporting material as well as on the desired thickness and the desired spreading of the supporting material onto the carrier member.

Furthermore the distance between the application reel and the counter surface reel is essential to provide an inventive preformed film. This distance depends in particular on the thickness of the used carrier member as well as on the desired thickness and the desired spreading of the supporting material onto the carrier member. These parameters could be adjusted by an expert to the characteristics of the used components so that the surface of the supporting material of the film leaving the stamping means has a flatness index of less than 0.02.

For example it could be advantageous to provide a preformed film with a thickness in the range of 200 μm to 300 μm , wherein a laminar carrier member made of a polyethylene with a width in the range of 100 mm to 150 mm and a thickness in the range of 103 μm to 140 μm is used and wherein the supporting material is dispensed onto the carrier member with a flow rate in the range of 0,4 l/h to 0,6 l/h. The tension which is exerted on the carrier or rather the film is preferably in the range of 3 kg to 18 kg, more preferably in the range of 5 kg to 15 kg and wherein the carrier member or rather the film is pulled with a speed in the range of 0,03 m/min to 0,05m/min. The distance between the application reel and the corresponding counter surface reel is adjusted in the range of 0,9 mm to 1,1 mm. As a releasing agent a dry-film lubricant is used, e.g. Polytetrafluorethylen, preferably sprayed onto the contact surface of the application reel.

It could be advantageous to use heating means to heat up the supporting material to improve the adhesion of the supporting material to the carrier member. The heating means preferably let the supporting material to become softer e.g. by allowing a filler of the supporting material to melt. In a preferred embodiment the stamping means or a part of the stamping means is used as heating means and therefore the stamping means itself is heated. It is also possible to use an additional heating member which heats the supporting material wherein the additional heating member is separated from the stamping means.

In an advantageous embodiment a polymeric material is applied onto the carrier member as the supporting material including at least one shape memory polymer. To apply the polymeric member onto the carrier it has to be heated up at least up to the glass temperature. It is also possible to only apply a shape memory polymer as a polymeric member, e.g. a shape memory polymer as described above.

It could also be advantageous to provide a monomeric material onto the carrier member as supporting material and to polymerize this monomer in a later step to provide a polymeric member onto the carrier member. The aforementioned use of a polymeric member to provide a preformed film expressly

comprises such an embodiment wherein at first a monomer is provided which is later polymerized. This monomer could preferably be polymerized to a shape memory polymer, e.g. like a shape memory polymer as described above. It is also possible to apply an intermixture of monomeric materials which are polymerized in several, preferably different polymerization treatments, wherein one of the polymeric materials is a shape memory polymer as described above.

Preferably when using a monomeric material as described above a film is used as carrier member, wherein the film is transparent for ultraviolet radiation so that the monomeric material could be polymerized via ultraviolet radiation through the carrier member in form of a transparent film. Preferably a ultraviolet radiation is used with a irradiation dose of 3 W/cm^2 to 5 W/cm^2 , preferably 4 W/cm^2 , wherein the carrier member or rather the film is pulled with a speed in a range of $0,01 \text{ m/min}$ to $0,1 \text{ m/min}$, preferably in the range of $0,03 \text{ m/min}$ to $0,05 \text{ m/min}$ to guarantee a polymerization of the monomeric material.

A further advantage is the use of a rotatable application reel and a rotatable counter surface reel, which are rotated or driven by the carrier with the supporting material fed through the stamping means, i.e. the rotatable application reel and the rotatable counter surface reel. The advantage of this embodiment is the possibility to waive a separate drive for the reels and to guarantee the right rotational speed which is adjusted to the feeding speed of the carrier member with the supporting material.

A further advantage is the use of a non-stick coating of the stamping means as a releasing agent to avoid the adhesion of the supporting material to the stamping means. Preferably the rotatable application reel is equipped with such a non-stick coating. In a preferred embodiment an electroless nickel plating is used as a non-stick coating for the stamping means. The electroless nickel plating has preferably a thickness between $1 \text{ }\mu\text{m}$ and $5 \text{ }\mu\text{m}$. A further advantage is to use a carrier member with an adhesion promoted surface to increase the adhesion of the supporting material onto the carrier member and to avoid or minimize the adhesion of the supporting material to the stamping means.

It is furthermore advantageously to use a flow rate for the application of the supporting material within the range of $0,2 \text{ l/h}$ – $0,8 \text{ l/h}$, preferably a flow rate of $0,5 \text{ l/h}$, wherein the carrier member or rather the film is pulled with a speed in a range of $0,01 \text{ m/min}$ to $0,1 \text{ m/min}$, preferably $0,04 \text{ m/min}$ and wherein the carrier member has a width in a range of 50 mm to 200 mm , preferably in a range of 100 mm to 150 mm .

A further advantage is the use of a microstructuring means with a microstructured stamping area is used to provide the polymeric member with a preformed microstructure. This microstructuring means could be provided by the stamping means itself or as an additional component. The microstructured

stamping area of the microstructuring means contains preferably a plurality of preferably regularly arranged protrusions. A further advantage is to use a microstructured stamping area with an interlocking pattern. Preferably a roll or reel is used as said stamping means to provide a continuous treatment of the carrier member and the supporting material. It could also be advantageous to use a roll a microstructuring means. It is furthermore advantageously to provide the microstructured stamping area of the microstructuring means at least partly over the outer roll shell, even if the microstructuring means is provided by the stamping means itself. A further advantage when using a roll as a microstructuring means is given by providing the microstructured stamping area over the whole circumference of the roll shell and at least partly in an axial extension. A further advantage is to provide a plurality of protrusions regularly arranged in rows over the whole circumference of the roll shell as a microstructured area of the roll.

Therefore a further advantage is the equipment of the supporting material with a preformed microstructure. The said flatness index flatness index of less than 0.02 is in case of using a preformed film with a preformed microstructure provided by the residual exterior surface of the supporting material, surrounding the microstructure or in which the microstructure is set. The microstructure could provided in the form of openings in this said residual exterior surface, which correspond generally to the horizontal dimensions of features or parts, which will be handled by the preformed film, e.g. bumps of wafers. Initially, the openings may be slightly larger than the features in order to allow a feature to be inserted into an opening. Advantageously these openings do not go from the surface of the supporting material to the carrier member. It is preferred that the supporting material or that the depth of the openings are designed in such a manner that a layer of the supporting material remains on the ground of the openings so that the openings do not end at the surface of the carrier member. The preformed microstructure is of course not restricted to openings and can in fact show a different structure with e.g. protrusions or recesses in a different form.

Preferred embodiments of the invention are described with the figures.

Figure 1 shows a sectional view of a preformed film according to the invention.

Figure 2 shows an enlarged sectional view of a part of the preformed film shown in figure 1.

Figure 3 shows an additional enlarged sectional view of a part of the preformed film 1 shown in figure 1.

Figure 4 shows a perspective view of the preformed film with a microstructure.

Figure 5 shows a sectional view through the intersecting line A-A of the film shown in figure 4

Figure 6 shows a schematic side view of a device for manufacturing a preformed film.

Figure 7 shows a schematic side view of an alternative device for manufacturing a preformed film comprising a microstructure.

Fig. 1 shows a sectional view of a preformed film 1 according to the invention comprising a transparent laminar carrier member 2 made of Polyethylene and a polymeric member 3, more precisely a shape memory polymer as a supporting material which has a thickness within a range of 10 μm to 1200 μm , wherein the polymeric member 3 has a flatness index of less than 0.02. The used carrier member 3 is in the shown embodiment a laminar carrier film and the polymeric member 3 is laminary attached to the carrier member 2, wherein the carrier member 2 provides a contact surface 8 for the polymeric member 2, which is built as an adhesive promoted surface 5 to increase the adhesion of the polymeric member 3 on the carrier member 2. With figure 2 an enlarged sectional view of a part of the preformed film 1 shown in figure 1 is depicted. The polymeric member 3 has a flatness index of less than 0.02, wherein the flatness index is defined as the ratio of roughness of the exterior surface 7 of the polymeric member 3 to the average film thickness of the polymeric member 3.

The said exterior surface 7 of the polymeric member 3 is defined in this embodiment as this outer side of the polymeric member 3 which is arranged at the opposing side to the area of contact or contact surface 8 of the carrier member 2 for the polymeric member 3. The thickness of the polymeric member 3 could therefore be defined as the average film thickness T , which is the arithmetic average of a multitude of film thickness values T_n exemplary shown in figure 2 as thickness values T_1 , T_2 , T_3 , T_4 between the contact surface 8 facing the polymeric member 3 and the said exterior surface 7 of the polymeric member 3 measured in a substantially orthogonal direction to the said contact surface 8 of the carrier member 2. It is also possible to define a longitudinal extension 9 of the preformed film 1 and to use this longitudinal extension 9 as a reference line or reference plane for the orthogonality when determining the thickness values T_1 , T_2 , T_3 , T_4 .

The term multitude, as used above, can refer, for example, to at least 10 different measuring points at 10 different positions along a profile section of the polymeric member 3.

The average film thickness T can be determined, for example, by using a section of the support structure (1 cm $\times$ 1 cm in size) divided into 5 equal strips (each 2 mm) and in each case the average film thickness T of the polymeric member 3 is determined along the profile. The average film thickness T along the profile can be determined by scanning electron microscopy (SEM) preferably using a scanning electron microscope JEOL JSM-6060 SEM.

Figure 3 shows an enlarged sectional view of a part of the preformed film 1 shown in figure 1 with an indication of the roughness of the polymeric member 3. The exterior surface 7 is of course not flat and shows a special asperity. The asperity of the surface of the polymeric member 3 is reflected in sections of the polymeric member 3 having a more or less minor variable thickness. This variable

thickness is reflected in the sectional view of the preformed film 1 shown in fig. 3 in the form of peaks P1, P2, P3 and valleys V1, V2, V3, V4 in the exterior surface 7 of the polymeric member 3. The peaks P1, P2, P3 are any protruding areas of the exterior surface, whereas each of the valleys V1, V2, V3, V4 are recesses between or next to the peaks or protruding areas P1, P2, P3 of the exterior surface 7 of the polymeric member 3.

The term roughness means the roughness average, which is defined as the arithmetic average of peak P_n and valley V_n distances D_n . The distance D_n , means the difference in height of a peak P_n and a neighbored valley V_n measured in a substantially orthogonal direction to the outer surface of the carrier member 2 which is the contact surface 8 for the attached polymeric member 3. It is also possible to use the said longitudinal extension 9 of the preformed film 1 as a reference line or reference plane for the orthogonality when determining the distances D_n exemplary shown in figure 3 with distance values D_1 , D_2 .

The roughness is measured along a line of usually 0.08 cm on the exterior surface 7 of the polymeric member 3. Preferably the roughness is the arithmetic average of 15 different measurements at 15 different positions on the exterior surface 7 of the polymeric member 3. The roughness can be determined at a measurement speed of 0.5 mm/s by using a Solarius non-contacting Laser Profilometer equipped with an AF2000 autofocus sensor. The obtained data can be analyzed by using solar map universal 3.1.10 image analysis software (Gaussian filter 0.8 mm), wherein a microroughness filtering is used, with a cutoff of 2.5 μm .

It turned out to be advantageous, when using a preformed film 1 comprising a polymeric member 3 with a thickness within a range of 10 μm to 1200 μm , to have polymeric member 3 with a flatness index of less than 0.02, wherein the flatness index is defined as the ratio of said roughness of the exterior surface 7 to the said thickness of the polymeric member 3.

The shown preformed film 1 is used for handling and treating a wafer. The preformed film 1 provides a fixing possibility to hold the wafer for a thinning process step. The polymeric member 3 guarantees a secure adherence of the wafer also in case the wafer contains protrusions e.g. in form of bumps. The flatness index of less than 0,2 guarantees that the preformed film 1 can be removed from the surface of the wafer. Subsequent to processing, such as thinning the wafer, it is possible to remove the preformed film 1 with a polymeric member 3 used as a support structure substantially completely from the wafers surface in a stress-free process by applying a low peel force. The preformed film 1 with a polymeric member 3 used as a support structure is therefore reusable, which reduces waste and overall cost.

Figure 4 shows a perspective view of the preformed film with the features of the film shown with figures 1 and 2, wherein the polymeric member 3 has a preformed microstructure. The microstructure guarantees a safe handling of a wafer with protruding bumps. Therefore the microstructure is shaped in the form of openings 4 or recesses within the surface of the polymeric member 3 so that any protruding bump of the wafer to be handled will fit into these openings 4. The said flatness index of less than 0.02 is provided by the residual exterior surface of the polymeric member 3, surrounding the openings 4.

Figure 5 shows a sectional view through the intersecting line A-A of the film 1 shown in figure 4. The openings 4 are shaped in a way corresponding generally to the horizontal dimensions of the bumps of the wafer. Initially, the openings 4 are slightly larger than the bumps in order to allow a feature to be inserted into an opening. In the shown embodiment these openings 4 do not go from the surface 7 of the polymeric member 3 to the surface of the carrier member 2. It is preferred that the thickness of the polymeric member 3 or that the depth of the openings 4 are designed in such a manner that a layer of the polymeric material remains on the ground of the openings 4 so that the openings 4 do not end at the surface of the carrier member 2.

Figure 6 shows a schematic side view of a device for manufacturing a preformed film 1 as shown with figures 1 to 3 according to the invention and especially according to the inventive method. A laminar carrier member 2 which is transparent at least for ultraviolet radiation made of preferably polyethylene with an adhesive promoted surface 5 is used, which is spooled as a coil and which is unrolled in a direction of rotation 112 from a take of reel 100 for further processing. To unroll the carrier member 2 a tension exerted on the carrier member 2 is used so that the speed of the forward motion of the carrier member 2 could be adjusted. In the shown embodiment the tension is exerted on the carrier member 2 or rather the preformed film 1 itself at the other end of the device, namely via a take up reel 109 for the preformed film 1.

After passing several guide rollers 101 a monomer is applied as a supporting material to the carrier member 2 which will be polymerized to become a polymeric member 3 in a further process step. The monomer is extruded via an applicator 7 onto the side of the carrier member 2 with the adhesive promoted surface 5. Afterwards the carrier member 2 with the monomer is guided through stamping means 102, 103 which is provided by an application roller 103 and a feed roller 102, the last one as a counterpart surface reel of the application roller 103. The application roller 103 is a cylindrical reel made of steel which is provided with a dry-film lubricant, e.g. Polytetrafluorethylen, which is sprayed onto the contact surface of the application roller 103 as a non-stick coating 108. The feed roller 102 is a cylindrical reel made of rubber or rubber-like material or with a rubber-like surface. The rotatable application roller 103 and the rotatable feed roller 102 are rotated by the carrier member 2 with the monomer fed through the stamping means 102, 103 and do not have an additional drive. The monomer

is spread via the stamping means 103, 102 at a stamping area between the application roller 103 and the feed roller 102 over the desired width of the carrier member 2.

A counter surface reel 110 is provided on the other side of the application roller 103 with regard to the stamping area in a way so that the carrier 2 with the monomer is turned partly round the outer surface of the application roller 103 and the monomer gets laminary in contact with the contact surface equipped with the releasing agent 108 over a section of the lateral surface of the cylindrical application roller 103. This means for shown embodiment that the carrier approaches towards the contact section of the lateral surface of the cylindrical application roller 103 more and more, the higher the tension is adjusted, which is exerted on the carrier member 2 or rather the film 1 itself. Therefore the said tension has to be considered and adjusted for the wished thickness and spreading of the polymeric member 3.

Furthermore a UV lamp 113 is provided in the area of the application roller 103 in a way so that the monomer applied onto the carrier member 2 and spread by the stamping means 103, 102 could be polymerized by the radiation of the UV lamp 113 through the transparent carrier member 2. In the shown embodiment the polymerized monomer, i.e. the polymeric member 3, which is a shape memory polymer, gets also laminary in contact with the contact surface equipped with the non-stick coating 108 over a section of the lateral surface of the cylindrical application roller 103. The preformed film 1 leaving the stamping means 102, 103 and the area of polymerization via the UV-lamp 113 has a flatness index of less than 0.02. This inventive flatness index of less than 0.02 of the polymeric member 3 is guaranteed in particular by the stamping means 102, 103 and several other parameters. To provide a preformed film 1 as shown in the embodiment with a thickness in the range of thickness within a range of 10 μm to 1200 μm , more preferably within a range of 200 μm to 300 μm , a laminar carrier member 2 made of a polyethylene with a width in a range of 100 mm to 150 mm and a thickness in the range of 103 μm to 140 μm is used. The monomer is dispensed onto the carrier member 2 with a flow rate in the range of approximately 0.5l/h. The tension which is exerted on the carrier member 2 or rather the preformed film 1 via the take up reel 109 is approximately 13 kg and the carrier member 2 or rather the film 1 is pulled with a speed of approximately 0,04m/min. The distance between the application reel and the corresponding counter surface reel is adjusted in the range of approximately 1mm. As a non-stick coating 108 or releasing agent a dry-film lubricant is used, e.g. Polytetrafluorethylen, preferably sprayed onto the contact surface of the application roller 103.

After the treatment of the carrier member 2 and the monomer or the polymeric member 3 respectively, the preformed film passes further guide rollers 101 and is coiled by the take up reel 109.

Figure 7 shows a schematic side view of a similar device for manufacturing a preformed film 1 as shown with figures 4 and 5 comprising a microstructure 6 according to the invention and especially

according to the inventive method. The principle assembly and functionality of the shown device is similar to the device shown in figure 5. The carrier member 2 is provided with a monomer which is spread by stamping means 102, 103 so that the monomer is polymerized to become the polymeric member 3, which is a shape memory polymer. The only difference in the shown device is that the application roller 103 is heated via a heating so that the polymeric member 3 gets softer by allowing a filler to melt. Furthermore the counter surface reel 110 next to the application roller 103 acts as a counter surface for a microstructuring roller 105 comprising a microstructuring area. The preformed film 1 comprising the carrier member 2 and the polymeric member 3 is pulled through the counter surface reel 110 and the microstructuring roller 105 in a way that the microstructuring area 106 provides the polymeric member 3 with a microstructure 6 in the form of openings shown in figure 3 and 4. The preformed film 1 comprising the polymeric member 3 with a microstructure 6 is coiled by the take up reel 109 rotating in the direction of movement 112.

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1	Preformed film	100	Take of reel
2	Carrier member	101	Guide roller
3	Polymeric member	102	Feed roller
4	Openings	103	Application roller
5	Adhesive promoted surface	104	Heating
6	Microstructure	105	Microstructuring roller
7	Exterior surface	106	Microsturcturing area
8	Contact surface	107	Applicator
9	Longitudinal extension	108	Non-stick coating
P _{1-n}	Peaks	109	Take up reel
V _{1-n}	Valley	110	Counter surface reel
T _{1-n}	Thickness values	112	Direction of rotation
D _{1-n}	Distances	113	UV lamp

CLAIMS

1. Preformed film (1) comprising a carrier member (2) and a polymeric member (3) attached to the carrier member (2), wherein the polymeric member (3) includes at least one shape memory polymer and wherein the polymeric member (3) attached to the carrier member (2) has a thickness within a range of 10 μm to 1200 μm and wherein the polymeric member (3) has a flatness index of less than 0.02
2. Preformed film (1) according to claim 1, characterized in that the carrier member (2) is a laminar carrier film and the polymeric member (3) is laminary attached to the carrier member (2).
3. Preformed film (1) according to one of claims 1 or 2, characterized in that the carrier member (2) has at least partly an adhesive promoted surface (5).
4. Preformed film (1) according to one of the aforementioned claims, characterized in that the polymeric member (3) has a preformed microstructure (6).
5. Method for providing a preformed film (1) comprising the following steps:
 - providing a carrier member (2);
 - applying a supporting material (3) onto the carrier member (2);
 - providing stamping means (102, 103) comprising a rotatable and substantially cylindrical application reel (103) with a contact surface equipped with a releasing agent (108) and a corresponding substantially cylindrical counter surface reel (102);
 - spreading the supporting material (3) onto the carrier member (2) with the stamping means (102, 103), by feeding the carrier member (2) with the supporting material (3) through the application reel (103) and the corresponding counter surface reel (103) wherein the supporting material (3) gets in contact with the contact surface equipped with the releasing agent (108) over a section of the lateral surface of the cylindrical application reel (103) and wherein the flow rate for the application of the supporting material (3), the tension exerted on the carrier member (2) and the distance between the application reel (103) and the counter surface reel (101) is adjusted in that the supporting material (3) of the film (1) leaving the stamping means (103, 103) surface has a flatness index (FI) of less than 0.02.
6. Method according to claim 5, characterized in that a polymeric material (3) is applied onto the carrier member (2) as the supporting material including at least one shape memory polymer.

7. Method according to claim 5, characterized in that a monomeric material (3) is applied onto the carrier member (2) as the supporting material and that the monomeric material (3) is treated to become a polymeric material (3) including at least one shape memory polymer.

8. Method according to claim 7, characterized in that the carrier member (2) is a film, which is transparent for ultraviolet radiation and that the monomeric material (3) is polymerized via ultraviolet radiation through the carrier member (2).

9. Method according to one of claims 5 to 8, wherein the rotatable application reel (103) and the rotatable counter surface reel (102) are rotated by carrier (2) with the supporting material (3) fed through the stamping means (102, 103).

10. Method according to one of claims 5 to 9, characterized in that the releasing agent (108) is a non-stick coating (108) of the stamping means (103) to avoid the adhesion of the supporting material (3) to the stamping means (103).

11. Method according to one of claims 5 to 10, characterized in that the flow rate for the application of the supporting material (3) is within the range of 0,2 l/h – 0,8 l/h.

12. Method according to one of claims 5 to 11, characterized in that the supporting material (3) is applied to the carrier member (2) with a flow rate within the range of 0,2 l/h – 0,8 l/h, wherein the carrier member (2) is pulled with a speed in a range of 0,01m/min to 0,1m/min through the stamping means (102, 103) and wherein the carrier member (2) has a width in a range of 50 mm to 200 mm.

13. Method according to one of claims 5 to 12, characterized in that the distance between the application reel (103) and the counter surface reel (101) is within the range of 0,9mm to 1,1mm.

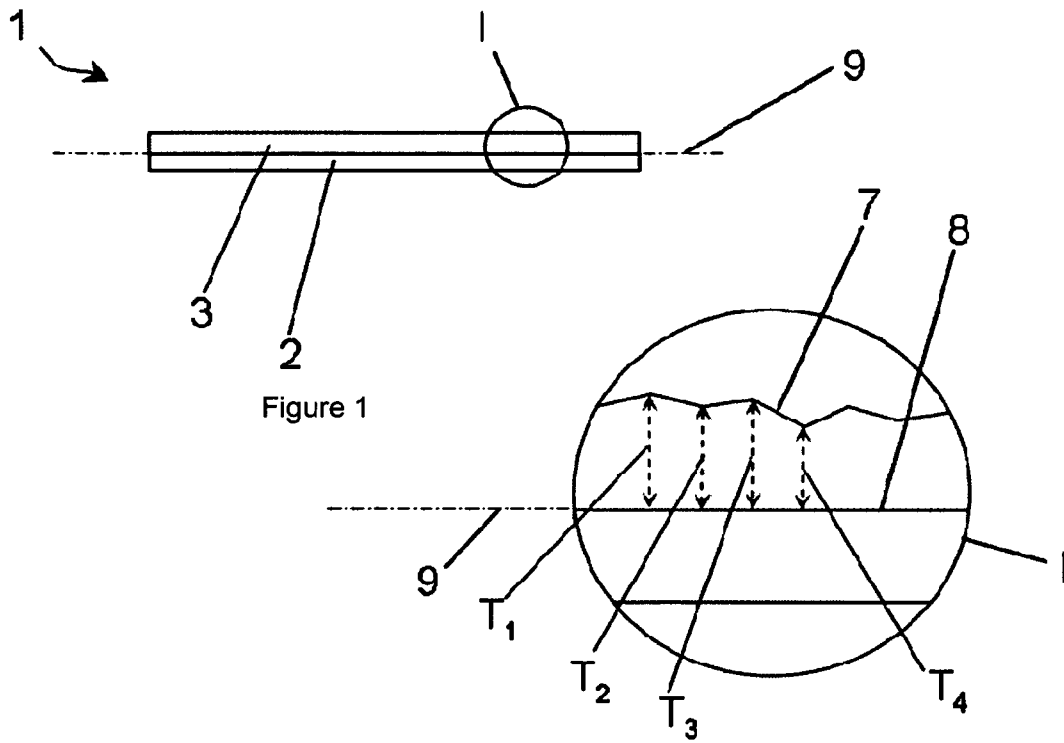


Figure 2

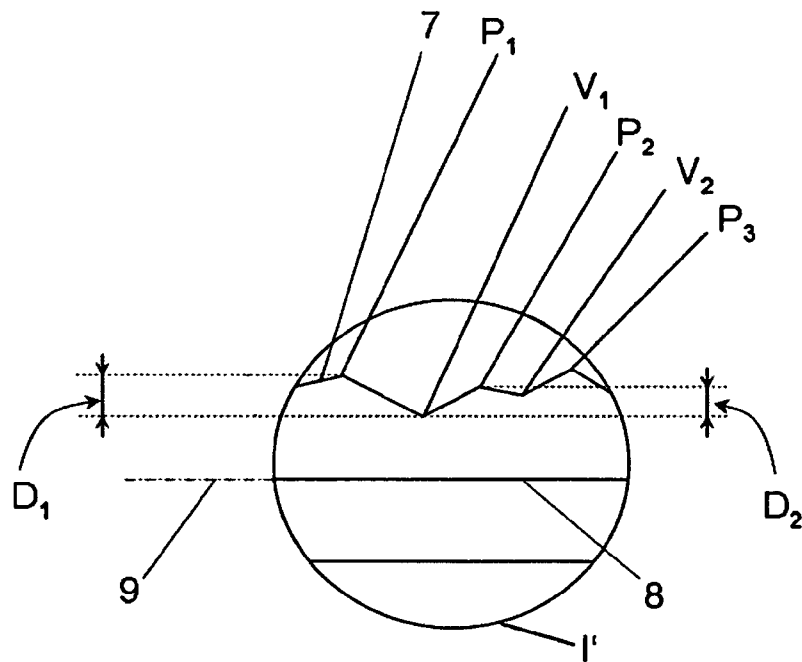


Figure 3

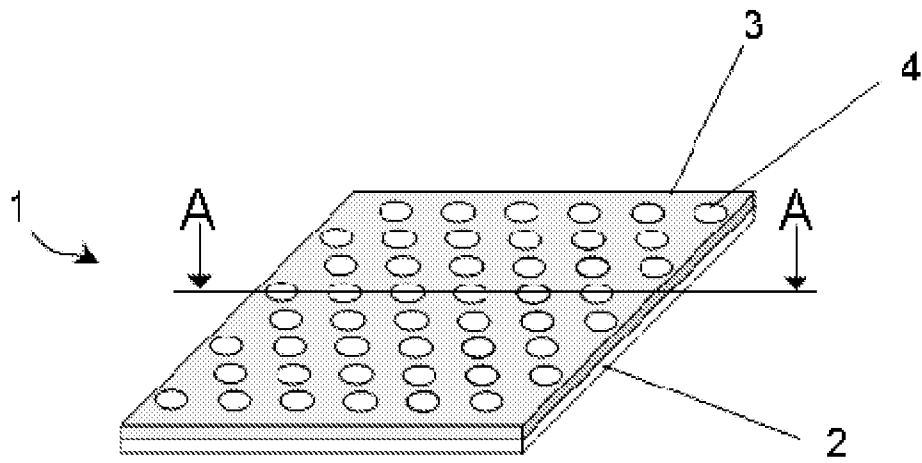


Figure 4

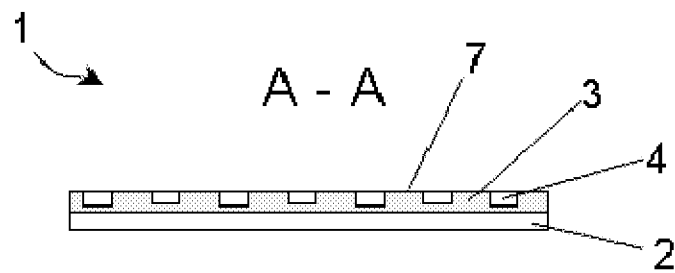


Figure 5

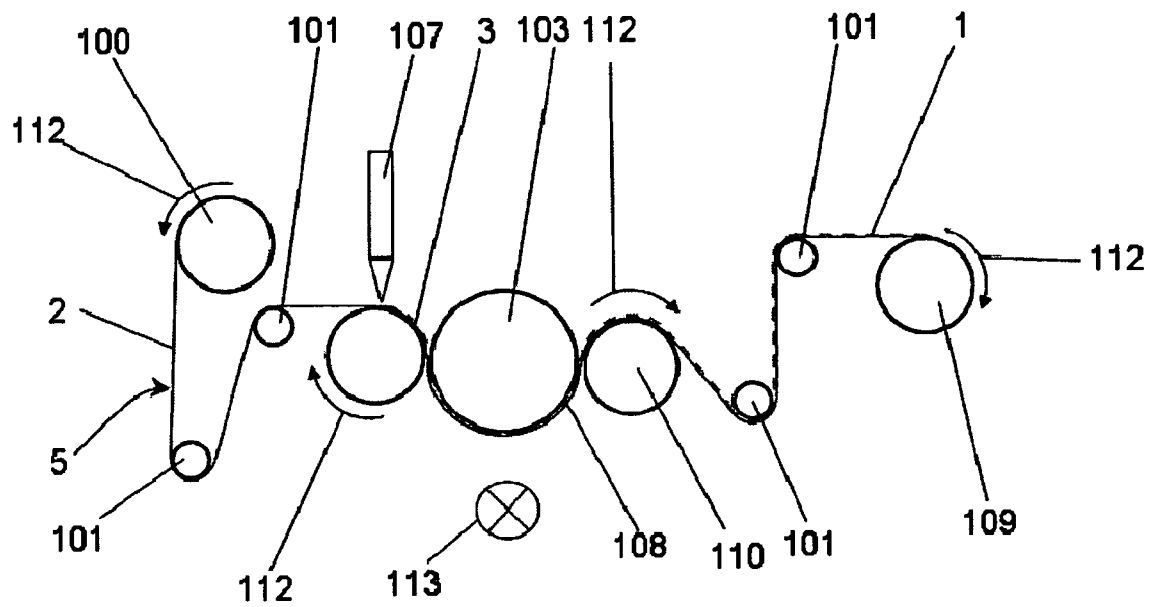


Figure 6

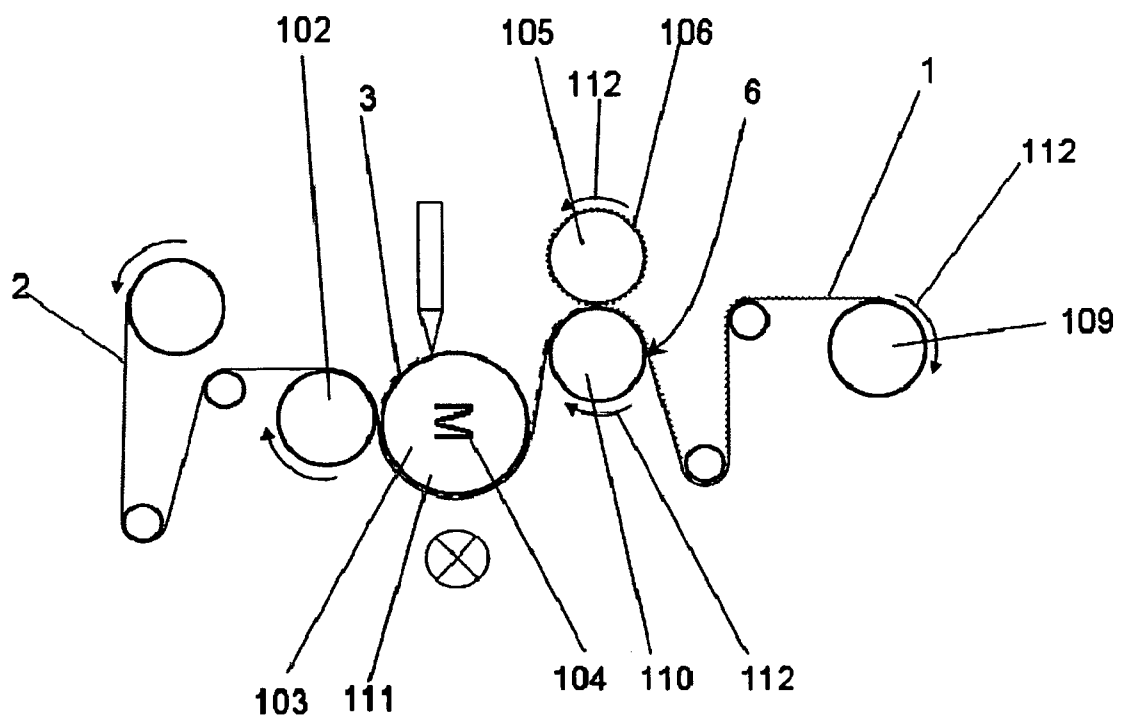


Figure 7