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(54) Heat-sensitive stencil sheet

(57) Provided is a heat-sensitive stencil sheet which is inhibited from deterioration of the resulting printed images caused by heat shrinkage or creasing upon perforation or winding around a printing drum even using an original of high printing ratio, and gives printed images of high quality. This heat-sensitive stencil sheet comprises a laminate of a thermoplastic resin film and a porous substrate mainly composed of thermoplastic fibers, in which said porous substrate has a heat shrinkage percentage of 3.5% or lower at 140°C in at least one direction thereof, as measured in accordance with thermal mechanical analysis (TMA) under measurement conditions of a load of 1.0 gf and a heating rate of 10°C/min. Said film is preferably a polyester film and said thermoplastic fibers are preferably polyester fibers, and these may be hot fusion bonded without using adhesives. Printed images of high quality can be obtained by carrying out perforation and printing with carrying the heat-sensitive stencil sheet in the direction of the heat shrinkage percentage being 3.5% or lower.

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Description

[0001] The present invention relates to a heat-sensitive stencil sheet which is perforated by flash irradiation with halogen lamp, xenon lamp, flash bulb or the like, infrared irradiation, pulse irradiation with laser beams, or by thermal head, and excellent in printing characteristics, especially, free from formation of creases at the time of perforation and at the time of winding around a printing drum.

[0002] Hitherto, as heat-sensitive stencil sheets used for stencil printing, there are known those which comprise a thermoplastic resin film such as polyester film, polyvinylidene chloride film or polypropylene film and a porous substrate comprising a thin paper, nonwoven fabric, or gauze made of natural fibers, synthetic fibers or a mixture thereof, the film and the substrate being laminated to each other with an adhesive.

[0003] However, printed images obtained using these conventional heat-sensitive stencil sheets are not necessarily satisfactory in sharpness, especially, in uniformity of solid portions. Various reasons are considered for the lack of sharpness of the printed images. When a thin paper comprising natural fibers is used as a porous substrate, permeation of ink is apt to become uneven because of relatively thick and uneven fiber diameter. Moreover, smoothness of the surface of the laminated film is deteriorated due to the thick fibers to cause insufficient contact with a thermal head in perforation of the stencil sheet, resulting in deficient perforations. As a result, the resulting images become faded, or voids are generated in the solid portions. Furthermore, since foreign matters coming from natural fibers cannot sufficiently be removed at the production step of the substrates, they hinder passing of ink, causing voids in the printed images. Even when a thin paper made from a mixture of natural fibers and synthetic fibers is used as a porous substrate, improvement is still not sufficient See, for example, JP-A-59-2896, JP-A-59-16793, and JP-A-2-67197.

[0004] Furthermore, a heat-sensitive stencil sheet comprising a film laminated to a nonwoven fabric made of synthetic fibers has been proposed. See, for example, JP-A-2-67197 and JP-A-5-309967. However, uneven density so-called "fibrous texture" is produced and besides sufficient strength of the sheet cannot be assured. Thus, this has not yet been put to practical use.

[0005] Moreover, there has been proposed a heat-sensitive stencil sheet prepared by hot press-bonding a porous substrate comprising unstretched thermoplastic resin fibers to an unstretched thermoplastic resin film, followed by biaxial stretching to laminate them without using adhesives. It has been further proposed to use a porous substrate having a specific pore area ratio and a specific pore average diameter to improve sharpness of printed images and offset of ink. See, for example, JP-A-7-205564. However, in the case of the porous substrate containing a thermoplastic resin component, when this is used for perforation based on an original of high printing ratio, the substrate heat-shrinks and this causes not only dimensional change of the stencil sheet, but also creases at the time of perforating the stencil sheet or winding around the printing drum so that quality of printed images is deteriorated.

[0006] The object of the present invention is to solve the above problems on conventional techniques, and to provide a heat-sensitive stencil sheet which is inhibited from deterioration of printed images due to heat shrinkage or creasing at the time of perforation or winding around the printing drum even in perforation based on an original of high printing ratio and which gives printed images of high quality.

[0007] In order to attain the above object, the inventors have conducted an intensive research on the mechanism of heat shrinkage of the porous substrate caused by perforation. As a result, it has been found that heat shrinkage of the stencil sheet at the time of perforation is inhibited by specifying a shrinkage percentage at a specific temperature in thermal mechanical analysis (TMA) of the porous substrate. Thus, the stencil sheet is prevented from creasing when it is perforated or wound around the printing drum, and prints of high quality is provided.

[0008] According to the present invention, there is provided a heat-sensitive stencil sheet comprising a laminate of a thermoplastic resin film and a porous substrate mainly composed of thermoplastic fibers, in which said porous substrate has a heat shrinkage percentage of 3.5% or lower at 140°C in at least one direction thereof, as measured in accordance with thermal mechanical analysis (TMA) under measurement conditions of a load of 1.0 gf and a heating rate of 10°C/min.

[0009] In general, when a heat-sensitive stencil sheet is perforated to make a master, it is necessary to heat the thermoplastic resin film to at least the melting point thereof. The melting starting temperature of the film varies depending on the kind of films, but in the case of the heating means such as thermal head, the stencil sheet is usually heated to 200-400°C at the time of perforation. Simultaneously, the heat is also conducted to a part of the fibers of the substrate in the vicinity of the film to damage the fibers. Consequently, as a whole of the stencil sheet, there are portions which shrink to less than the desired size. When the stencil sheet with distortions due to the shrinkage is carried, even if it is stretched to correct the distortions, sometimes the correction cannot be performed depending on the degree of shrinkage. The present invention is characterized in that the damage of the substrate is minimized by controlling the heat shrinkage percentage of the substrate to lower than a specific value.

[0010] The inventors have found that the heat shrinkage percentage at 140°C in thermal mechanical analysis (TMA) under the measurement conditions of a load of 1.0 gf and a heating rate of 10°C/min well represents the quantity of heat applied to the porous substrate of the stencil sheet at actual thermal perforation. That is, when the heat shrinkage percentage of the porous substrate of the stencil sheet in at least one direction is 3.5% or lower, heat shrinkage of the sheet at the time of perforation is inhibited, and creasing at the time of perforation and winding can also be inhibited. Therefore, by carrying out perforation and printing with the stencil sheet being carried in the direction that satisfies a heat shrinkage percentage of 3.5% or lower, prints of high quality free from uneven density caused by creasing at the time of perforation and winding around the printing drum can be provided.

[0011] Thus, according to another aspect of the present invention, there is provided a method for perforating the above-mentioned heat-sensitive stencil sheet, in which said stencil sheet is perforated by heat whilst it is carried in a direction that satisfies 3.5% or lower of the heat shrinkage percentage.

[0012] According to still another aspect of the present invention, there is provided a method for stencil printing using the above-mentioned heat-sensitive stencil sheet in a rotary stencil printing apparatus having a cylindrical printing drum, in which said stencil sheet is perforated by heat and wound around an outer circumferential surface of said cylindrical printing drum to perform stencil printing whilst said stencil sheet is carried in a direction that satisfies 3.5% or lower of the heat shrinkage percentage.

[0013] The stencil sheet of the present invention comprises a laminate of a thermoplastic resin film and a porous substrate mainly composed of thermoplastic fibers.

[0014] As the thermoplastic resin film in the present invention, mention may be made of known films such as of polyester, polyamide, polypropylene, polyethylene, polyvinyl chloride, polyvinylidene chloride and copolymers thereof, and preferred is a polyester film from the point of perforation sensitivity.

[0015] As the polyesters constituting the polyester film in the present invention, mention may be made of polyethylene terephthalate, polyethylene naphthalate, polybutylene terephthalate, a copolymer of ethylene terephthalate and ethylene isophthalate, polyethylene-2,6-naphthalate, polyhexamethylene terephthalate, a copolymer of hexamethylene terephthalate and 1,4-cyclohexanedimethylene terephthalate, etc.

[0016] The thermoplastic resin film in the present invention is preferably stretched, especially preferably biaxially stretched. Such stretched film can be produced, for example, by known T-die extrusion method and inflation method. For example, an unstretched film is prepared by extruding a polymer on a casting drum using the T-die extrusion method, and then stretching the unstretched film in lengthwise direction by a group of heating rolls, and, if necessary, stretching it in crosswise direction by feeding to a tenter and the like. An unstretched film of the desired thickness can be prepared by adjusting the slit width of head, the discharging amount of polymer, and the number of revolution of the casting drum. Furthermore, the stretching can be performed at the desired stretch ratio by adjusting the revolution speed of the heating rolls or changing the set width of the tenter.

[0017] In the present invention, thickness of the thermoplastic resin film is optionally determined depending on the required sensitivity and the like, but is usually 0.1-10 μm, preferably 0.1-5 μm, more preferably 0.1-3 μm. If the thickness exceeds 10 μm, the perforation properties sometimes deteriorate, and if it is thinner than 0.1 μm, film-forming stability is sometimes inferior.

[0018] If necessary, the thermoplastic resin film may contain flame retardants, heat stabilizers, antioxidants, ultraviolet absorbers, antistatic agents, pigments, dyes, organic lubricants such as fatty acid esters and waxes, and foaming agents such as polysiloxane.

[0019] As the thermoplastic fibers constituting the porous substrate in the present invention, mention may be made of known fibers such as of polyester, polyamide, polyphenylene sulfide, polyacrylonitrile, polypropylene, polyethylene, and copolymers thereof. These thermoplastic fibers may be used each alone or in combination of two or more, and, besides, may contain natural fibers such as hemp fibers, wood fibers, or regenerated fibers. Preferred are polyester fibers from the point of heat stability in perforation of the stencil sheet, and the thermoplastic fibers preferably comprise at least 60% of polyester fibers.

[0020] As the polyesters constituting the thermoplastic fibers, mention may be made of polyethylene terephthalate, polyethylene naphthalate, polybutylene terephthalate, a copolymer of ethylene terephthalate and ethylene isophthalate, polyethylene-2,6-naphthalate, polyhexamethylene terephthalate, a copolymer of hexamethylene terephthalate and 1,4-cyclohexanedimethylene terephthalate, etc.

[0021] If necessary, the thermoplastic fibers may contain flame retardants, heat stabilizers, antioxidants, ultraviolet absorbers, antistatic agents, pigments, dyes, organic lubricants such as fatty acid esters and waxes, and foaming agents such as polysiloxane.

[0022] The porous substrate in the present invention may be a paper, a nonwoven fabric or a woven fabric made from short fibers comprising the above thermoplastic fibers, or may be a screen gauze. The nonwoven fabric is preferred from the point of production cost.

[0023] Average fiber diameter of the porous substrate is preferably 2-10 μm. If the average fiber diameter is less than 2 μm, the stencil sheet is apt to crease to cause failure of perforation, resulting in unperforated portions. If it exceeds 10 μm, passing of ink becomes uneven.

[0024] Basis weight of the porous substrate is preferably 1-30 g/m^2, more preferably 2-20 g/m^2, especially preferably 3-16 g/m^2.

[0025] The nonwoven fabric used as the porous substrate in the present invention can be produced by direct melt spinning methods such as known melt blow method and spun bond method. According to the melt blow method, the nonwoven fabric is produced by discharging a molten polymer from a spinneret under blowing of a hot air against the polymer from the circumference of the spinneret, thereby making the discharged polymer into fine fibers, then blowing the fibers onto a net conveyor disposed at a given position to collect the fibers, and forming them into a web. The resulting web is sucked together with the hot air by a sucking device provided at the net conveyor, and, hence, the fibers are collected before individual fibers are completely solidified. That is, the fibers of the web are collected in the state of being fusion bonded to each other. The degree of fusion bonding of the fibers can be adjusted by suitably adjusting the collecting distance between the spinneret and the conveyor. Furthermore, the basis weight of the web and the diameter of single fibers can be optionally set by suitably adjusting the discharging amount of the polymer, the hot air temperature, the hot air flow rate, and the conveyor moving speed. The fibers spun by the melt blow method are made fine by the pressure of the hot air and solidified in the non-oriented or low-oriented state, so that thickness of the fibers is not uniform. Thus, the web is formed in the state of thick fibers and thin fibers being properly dispersed. Moreover, the polymer discharged from the spinneret is rapidly cooled from the molten state to room or ambient temperature, and, therefore, is solidified in the state of low-crystallization close to an amorphous state.

[0026] The nonwoven fabric constituting the porous substrate of the present invention is preferably stretched and oriented, and birefringence (Δn) of the individual fibers is preferably 0.1 or higher, more preferably 0.12 or higher, especially preferably 0.14 or higher. Crystallinity of the fibers is preferably 15% or higher, more preferably 20% or higher, especially preferably 25% or higher.

[0027] In the present invention, the thermoplastic resin film and the porous substrate may be laminated using adhesives under the condition of not lowering the perforation sensitivity of the film, but preferably they are laminated by heat fusion bonding without using adhesives from the point of obtaining sharpness of prints. In the stencil sheet of the present invention, it is preferred that the melting point (Tm_1) of the thermoplastic resin film and the melting point (Tm_2) of the porous substrate satisfy the relation $Tm_1 \leqq Tm_2$. Peeling strength between the film and the substrate is preferably 3 g/cm or more, more preferably 5 g/cm or more, especially preferably 10 g/cm or more.

[0028] The heat fusion bonding can be attained, for example, by obtaining an unstretched film by extrusion casting, and before subjecting it to the longitudinal stretching step, hot pressing it with an unstretched nonwoven fabric by use of heating rolls. Fusion bonding temperature is preferably between the glass transition temperature (Tg) and the melting point (Tm) of the thermoplastic resin film, and more preferably between the glass transition temperature (Tg) and the cold crystallizing temperature (Tcc). In the case of a polyester film, it is preferably in the range of Tg+10°C - Tg+50°C.

[0029] In the present invention, it is especially preferred that the present stencil sheet is produced by carrying out co-stretching after the heat fusion bonding of the unstretched thermoplastic film and the nonwoven fabric. When co-stretching is carried out in the heat fusion bonded state, the film and the nonwoven fabric are integrated so as not to be separated, and thus suitable stretching can be performed. In this case, the fibers of the nonwoven fabric are fusion bonded at interlocking points or contact points to form a reticulation having contact points.

[0030] The polyester nonwoven fabric used for heat fusion bonding is most preferably unstretched, and even if it is stretched, it is preferred that the stretching ratio is low and the degree of orientation is low. In this state, the birefringence (Δn) of the fibers of the nonwoven fabric is preferably 0.03 or lower, more preferably 0.02 or lower, especially preferably 0.01 or lower. Crystallinity of the fibers is preferably 20% or lower, more preferably 15% or lower, especially preferably 10% or lower.

[0031] The method of co-stretching is not limited, and preferred is biaxial stretching and this may be either sequential biaxial stretching or simultaneous biaxial stretching. In the case of the sequential biaxial stretching, generally, first the stretching in lengthwise direction is carried out and then the stretching in crosswise direction is carried out, but the sequence of stretching may be reversed. The stretching temperature is preferably between the glass transition temperature (Tg) and the cold crystallizing temperature (Tcc) of the thermoplastic resin film. The stretching ratio is not limited, and is optionally determined depending on the kind of polymer constituting the thermoplastic resin film and the sensitivity required for the stencil sheet. Generally, it is preferably 2-8 times, more preferably 3-8 times in longitudinal and width directions.

[0032] It is preferred to further subject the stencil sheet to a heat treatment after the co-stretching. Usually, the heat treatment is carried out at about 80-260°C for about 0.5-60 seconds.

[0033] In the present invention, two or more nonwoven fabrics which are the same or different in fiber diameter and basis weight may be stretched in superposed state.

[0034] In the present invention, the stencil sheet can be perforated by any methods as far as perforations corresponding to the image to be printed can be formed by melting the thermoplastic resin film. For example, perforation can be performed by flash irradiation with halogen lamp, xenon lamp, flash bulb, etc., infrared irradiation, pulse irradiation with laser beams, and by heating means such as a thermal head, etc.

[0035] Typically, the stencil sheet of the present invention is perforated by a thermal head, and in this case numerous fine openings corresponding to the image to be printed are formed in the thermoplastic resin film, and opening ratio of the stencil sheet in perforated part for black solid original of 100% in printing ratio is usually 20-50%. Such opening ratio can be attained, for example, by optionally selecting a size of elements of the thermal head, a pitch between the elements, and a temperature or an heated area that depends upon the energy introduced. If the opening ratio is less than 20%, since there are many unperforated portions, there are very many portions through which ink does not pass to cause formation of voids in prints, irrespective of the state of the substrate being dense or rough, the state of dispersion of fibers, and the density and thickness of the substrate. On the other hand, if the opening ratio is more than 50%, excess ink is apt to pass through the sheet to result in offset in prints, irrespective of the state of the substrate being dense or rough, the state of dispersion of fibers, and the density and thickness.

[0036] Preferably, a release layer is provided on the side of the thermoplastic resin film opposite to the side of the porous substrate for inhibition of sticking to a perforation means such as a thermal head. The release layer may be coated at any stage before or after stretching of the film, but preferably coated before stretching in order to highly develop the effects of the present invention. Releasing agents such as silicone oil, silicone resin, fluorocarbon resin, surface active agent or the like may be used. The release layer can be formed by coating a coating agent containing the releasing agent by coating means such as roll coater, gravure coater, reverse coater, and bar coater. The coating agent may contain various additives such as dispersing aid, surface active agent, preservative, and anti-foaming agent for the purpose of improving dispersibility of the releasing agent in a medium such as water. Thickness of the release layer is preferably 0.005-0.4 μm, more preferably 0.01-0.4 μm. When the thickness of the release layer is 0.4 μm or less, running property during perforation is satisfactory and the thermal head is hardly stained.

[0037] Furthermore, as far as the effects of the present invention are not damaged, the stencil sheet of the present invention may contain various additives such as antistatic agents, heat resisting agents, antioxidants, organic particles, inorganic particles, and pigments.

[0038] The stencil sheet of the present invention can be used for stencil printing with various known stencil printing inks. Typical stencil printing inks are water-in-oil (W/O) emulsion inks. The W/O emulsion inks comprise, for example, about 10-70% by weight of an oil phase and about 90-30% by weight of a water phase. Furthermore, a colorant is contained in the oil phase or water phase, and amount of the colorant is preferably 1-30% by weight, more preferably 3-10% by weight of the total amount of the emulsion ink. Average particle size of the colorant is preferably in the range of 0.1-12 μm. If the particle size is less than 0.1 μm, even if the ink passes through the sheet, the colorant readily penetrates into the inside of the printing paper, and no sufficient printing density can be obtained. If it is more than 12 μm, the colorant is apt to cause clogging between fibers of the substrate, resulting in occurrence of white points on the prints.

Examples

[0039] The present invention will be explained in more detail by the following examples. However, it should be construed that the present invention is not limited to the examples. First, methods for measurement and evaluation of the properties of the stencil sheet which are employed in the examples will be explained.

(1) Measurement of heat shrinkage percentage by thermal mechanical analysis (TMA):

[0040] A stencil sheet obtained by co-stretching was separated into the film and the nonwoven fabric. Then, the nonwoven fabric was cut to a size of 4 mm in width and 25 mm in length (machine direction (MD)). This was chucked by a thermal mechanical analyzer TMA/SS6100 manufactured by Seiko Instruments Co., Ltd. in such a manner that the sample length was set to 15 mm, and the heat shrinkage percentage of the sample was measured by heating the sample from 20°C at a heating rate of 10°C/min with application of a constant load of 1.0 gf to obtain a heat shrinkage percentage at a sample temperature of 140°C. As for the stencil sheet comprising the film and the substrate laminated with adhesives, the substrate alone was subjected to the measurement before lamination into an integral state.

(2) Measurement of average fiber diameter of the substrate:

[0041] Optional 10 portions of the nonwoven fabric layer of the stencil sheet were photographed by an electron microscope, and diameters of optional 15 fibers in each photograph were measured. Thus, diameters of 150 fibers in total in the 10 portions were measured and the average value thereof was obtained.

(3) Measurement of basis weight of substrate:

[0042] The stencil sheet was cut to 210 × 297 mm, and weight thereof was measured and converted to a weight per m^2. The weight of the film was deducted from the resulting weight of the sheet to obtain the basis weight.

(4) Measurement of thickness of stencil sheet:

[0043] Ten stencil sheets were stacked and the thickness thereof was measured by PEACOCK (DIAL THICKNESS GAUGE manufactured by Ozaki Seisakusho Co., Ltd.). Thickness per one sheet was calculated.

(5) Evaluation of heat shrinkage upon perforation:

[0044] The stencil sheet was subjected to perforation by a rotary stencil printing machine RISOGRAPH TR153 (trade mark) manufactured by Riso Kagaku Corporation with carrying the sheet in machine direction so that a region of printing paper corresponding to A4 size was printed at a printing ratio of 100%. Thereafter, degree of shrinkage was visually evaluated by observing the surface of the stencil sheet.

(6) Evaluation of occurrence of creasing:

[0045] The stencil sheet was subjected to perforation and printing by a rotary stencil printing machine RISOGRAPH TR153 (trade mark) manufactured by Riso Kagaku Corporation with carrying the sheet in machine direction so that a region of printing paper corresponding to A4 size was printed at a printing ratio of 100%. Creasing reflected on the prints was visually evaluated. Occurrence of creasing upon perforation was judged by presence of voids on the prints, and occurrence of creasing upon winding around the drum was judged by presence of portions of higher printing density on the prints.

Example 1

[0046] Polyethylene terephthalate (η=0.60, Tm=254°C) was spun using a rectangular spinneret having 80 holes of 0.35 mm in diameter at a spinneret temperature of 285°C by melt blow method, and the fibers were dispersed and collected on a conveyor to prepare a nonwoven fabric having an average fiber diameter of 8.2 μm and a basis weight of 120 g/m^2.

[0047] Then, a copolymer polyester resin (η=0.65, Tm=225°C) comprising 85 mol% of polyethylene terephthalate and 15 mol% of polyethylene isophthalate was extruded using an extruder of 40 mm in screw diameter at a T-die head temperature of 275°C, and cast on a cooling drum to prepare an unstretched film. The above-obtained nonwoven fabric was superposed on the unstretched film, and these were fed to heating rolls to perform hot fusion bonding of them at a roll temperature of 80°C to obtain a laminate sheet.

[0048] The laminate sheet was stretched threefold between the heating rolls in machine direction, and then fed into a tenter type stretching machine to stretch the sheet threefold in crosswise direction, and, furthermore, heat treated at 140°C in the tenter to obtain a stencil sheet.

[0049] In the resulting stencil sheet, thickness of the film was 1.51 μm, average fiber diameter of the substrate was 4.1 μm, and basis weight of the substrate was 10.3 g/m^2, and the stencil sheet had a thickness of 72 μm. Moreover, in order to impart releasability from thermal head, a silicone oil was coated on the stencil sheet at a thickness of 0.01 μm by a roll coater.

[0050] This stencil sheet was subjected to the above-mentioned measurement and evaluation. The results are shown in Table 1.

Example 2

[0051] A stencil sheet was prepared in the same manner as in Example 1, except that the nonwoven fabric used had an average fiber diameter of 10.5 μm and a basis weight of 110 g/m^2 before stretching, and the hot fusion bonding by the heating rolls was carried out twice, and, in addition, the temperature in the tenter at the time of co-stretching was 100°C.

[0052] In the resulting stencil sheet, thickness of the film was 1.51 μm, average fiber diameter of the substrate was 5.3 μm, and basis weight of the substrate was 10.1 g/m^2, and the stencil sheet had a thickness of 55 μm.

[0053] This stencil sheet was subjected to the above-mentioned measurement and evaluation. The results are shown in Table 1.

Example 3

[0054] A stencil sheet was prepared in the same manner as in Example 1, except that the nonwoven fabric used was made of a copolymer polyester resin (Tm=225°C) comprising 85 mol% of polyethylene terephthalate and 15 mol% of polyethylene isophthalate and had an average fiber diameter of 8.5 μm and a basis weight of 120 g/m^2, the film used was made of a copolymer polyester resin (Tm=190°C) comprising 75 mol% of polyethylene terephthalate and 25 mol% of polyethylene isophthalate, the hot fusion bonding by the heating rolls was carried out twice, and, in addition, the temperature in the tenter at the time of co-stretching was 100°C.

[0055] In the resulting stencil sheet, thickness of the film was 1.69 μm, average fiber diameter of the substrate was 4.3 μm, and basis weight of the substrate was 10.1 g/m^2, and the stencil sheet had a thickness of 58 μm.

[0056] This stencil sheet was subjected to the above-mentioned measurement and evaluation. The results are shown in Table 1.

Example 4

[0057] A stencil sheet was prepared in the same manner as in Example 1, except that the nonwoven fabric used had an average fiber diameter of 6.8 μm and a basis weight of 103 g/m^2 before stretching.

[0058] In the resulting stencil sheet, thickness of the film was 1.57 μm, average fiber diameter of the substrate was 3.4 μm, and basis weight of the substrate was 8.6 g/m^2, and the stencil sheet had a thickness of 60 μm.

[0059] This stencil sheet was subjected to the above-mentioned measurement and evaluation. The results are shown in Table 1.

Example 5

[0060] A stencil sheet was prepared in the same manner as in Example 1, except that the nonwoven fabric used had an average fiber diameter of 7.8 μm and a basis weight of 120 g/m^2 before stretching.

[0061] In the resulting stencil sheet, thickness of the film was 1.63 μm, average fiber diameter of the substrate was 3.9 μm, and basis weight of the substrate was 10.4 g/m^2, and the stencil sheet had a thickness of 82 μm.

[0062] This stencil sheet was subjected to the above-mentioned measurement and evaluation. The results are shown in Table 1.

Example 6

[0063] A film was previously prepared by carrying out stretching of the film alone in the stretching procedure of Example 1, so as to give a film thickness of 1.7 μm. This film was adhered with an adhesive to a porous substrate having a basis weight of 11.4 g/m^2 made from admixture of hemp fibers having an average fiber diameter of 15.0 μm and polyester fibers having an average fiber diameter of 5.0 μm to obtain a stencil sheet. This sheet had a thickness of 57 μm.

[0064] This stencil sheet was subjected to the above-mentioned measurement and evaluation. The results are shown in Table 1.

Example 7

[0065] A film was previously prepared by carrying out stretching of the film alone in the stretching procedure of Example 1, so as to give a film thickness of 1.5 μm. This film was adhered with an adhesive to a porous substrate having a basis weight of 8.0 g/m^2 made from admixture of polyester fibers having an average fiber diameter of 5.5 μm and polyester fibers having an average fiber diameter of 12.0 μm to obtain a stencil sheet. This sheet had a thickness of 40 μm.

[0066] This stencil sheet was subjected to the above-mentioned measurement and evaluation. The results are shown in Table 1.

Comparative Example 1

[0067] A stencil sheet was prepared in the same manner as in Example 1, except that the nonwoven fabric used had an average fiber diameter of 7.4 μm and a basis weight of 103 g/m^2 before stretching.

[0068] In the resulting stencil sheet, thickness of the film was 1.64 μm, average fiber diameter of the substrate was 3.7 μm, and basis weight of the substrate was 8.3 g/m^2, and the stencil sheet had a thickness of 62 μm.

[0069] This stencil sheet was subjected to the above-mentioned measurement and evaluation. The results are shown in Table 1. As shown in Table 1, heat shrinkage upon perforation was seen, and both the creasing upon perforation and the creasing upon winding around the drum were reflected on the prints. Thus, satisfactory printed images were not obtained.

Comparative Example 2

[0070] A stencil sheet was prepared in the same manner as in Example 1, except that the nonwoven fabric used had an average fiber diameter of 8.0 μm and a basis weight of 120 g/m^2 before stretching.

[0071] In the resulting stencil sheet, thickness of the film was 1.63 μm, average fiber diameter of the substrate was 4.0 μm, and basis weight of the substrate was 10.3 g/m^2, and the stencil sheet had a thickness of 90 μm.

[0072] This stencil sheet was subjected to the above-mentioned measurement and evaluation. The results are shown in Table 1. As shown in Table 1, heat shrinkage upon perforation was seen, and both the creasing upon perforation and the creasing upon winding around the drum were reflected on the prints. Thus, satisfactory printed images were not obtained.

Table 1

	Film thickness µm	Average fiber diameter of substrate µm	Basis weight of substrate g/m²	Thickness of stencil sheet µm	Heat shrinkage percentage in TMA % (MD)	Heat shrinkage by perforation	Creasing due to perforation	Creasing upon winding around drum	Overall evaluation on printed images
Example 1	1.51	4.1	10.3	72	2.1	◎	○	○	○
Example 2	1.51	5.3	10.1	55	2.5	○	○	○	○
Example 3	1.69	4.3	10.1	58	2.5	○	○	○	○
Example 4	1.57	3.4	8.6	60	2.6	○	○	○	○
Example 5	1.63	3.9	10.4	82	3.3	△	○	○	○
Example 6	1.7	Hemp 15.0 PET 5.0	11.4	57	0.1	○	○	○	○
Example 7	1.5	PET 5.5 PET 12.0	8.0	40	0.8	○	○	○	○
Comparative Example 1	1.64	3.7	8.3	62	4.4	×	△	×	×
Comparative Example 2	1.63	4.0	10.3	90	5.8	×	×	×	×

Criteria of evaluation:

◎: Very good

○: Good

△: Practically acceptable

×: Practically unacceptable

[0073] As can be seen from Table 1, when heat shrinkage percentage of the porous substrate of the stencil sheet according to thermal mechanical analysis (TMA) at 140°C is 3.5% or lower in lengthwise direction (MD, namely, carrying direction of the stencil sheet upon perforation and printing), the stencil sheet is inhibited from heat shrinkage at the perforation stage and shows no deterioration in quality of the resulting prints without any creasing at the perforation stage and the drum winding stage. Thus, it is an excellent stencil sheet.

[0074] According to the present invention, since a porous substrate having a specific heat shrinkage percentage is used in the stencil sheet, heat shrinkage of the stencil sheet is inhibited even when it is perforated to yield a master for an original of high printing ratio. Also, no creasing is made when it is perforated or wound around the drum, and thus images are not caused to deteriorate. Thus, good printed images can be provided.

Claims

1. A heat-sensitive stencil sheet comprising a laminate of a thermoplastic resin film and a porous substrate mainly composed of thermoplastic fibers, in which said porous substrate has a heat shrinkage percentage of 3.5% or lower at 140°C in at least one direction thereof as measured in accordance with thermal mechanical analysis (TMA) under measurement conditions of a load of 1.0 gf and a heating rate of 10°C/mm.

2. A heat-sensitive stencil sheet according to claim 1, in which said thermoplastic resin film is a polyester film.

3. A heat-sensitive stencil sheet according to claim 1, in which said thermoplastic fibers comprise polyester fibers.

4. A heat-sensitive stencil sheet according to claim 1, in which said thermoplastic film and said porous substrate are laminated by fusion bonding without using adhesives, said film being a polyester film, and said porous substrate being mainly composed of polyester fibers.

5. A method for perforating the heat-sensitive stencil sheet of claim 1, in which said stencil sheet is perforated by heat whilst it is carried in a direction that satisfies 3.5% or lower of the heat shrinkage percentage.

6. A method for stencil printing using the heat-sensitive stencil sheet of claim 1 in a rotary stencil printing apparatus having a cylindrical printing drum, in which said stencil sheet is perforated by heat and wound around an outer circumferential surface of said cylindrical printing drum to perform stencil printing whilst said stencil sheet is carried in a direction that satisfies 3.5% or lower of the heat shrinkage percentage.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 11 7650

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	EP 0 451 269 A (ASAHI CHEMICAL IND) 16 October 1991 (1991-10-16) * examples; table 3 *	1-3,5,6	B41N1/24
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A	EP 0 617 087 A (DIAFOIL HOECHST CO LTD) 28 September 1994 (1994-09-28) * the whole document *	1-6	TECHNICAL FIELDS SEARCHED (Int.Cl.7) B41N B41C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 November 1999	Martins Lopes, L

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 99 11 7650

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