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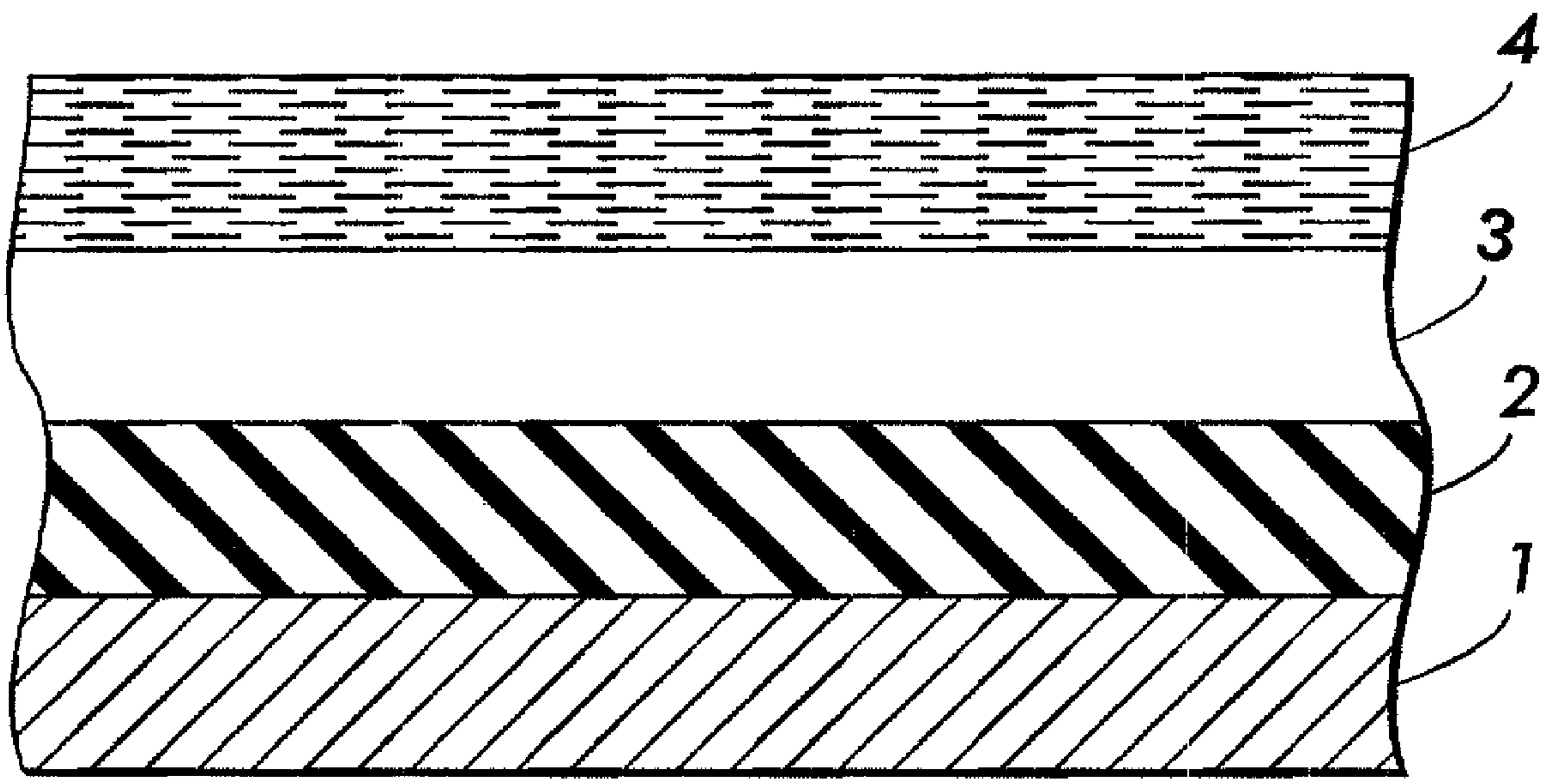
(54) Titre : MELANGE CONTENANT UN AGENT DE DEMOULAGE A BASE DE FLUOROSILICONE, POUR LA PRODUCTION D'ELEMENTS DE FIXATION A BASE DE SILICONE
(54) Title: BLENDED FLUOROSILICONE RELEASE AGENT FOR SILICONE FUSER MEMBERS



(57) Abrégé/Abstract:
A fuser member having a substrate, an outer silicone rubber layer; and a release agent having a combination of fluorosilicone release agent and a non-functional release agent.

ABSTRACT

A fuser member having a substrate, an outer silicone rubber layer; and a release agent having a combination of fluorosilicone release agent and a non-functional release agent.

BLENDED FLUOROSILICONE RELEASE AGENT FOR SILICONE FUSER MEMBERS

BACKGROUND OF THE INVENTION

The present invention relates to fuser members useful in electrostatographic reproducing apparatuses, including digital, image on image, and contact electrostatic printing apparatuses. The present fuser members can be used as fuser members, pressure members, transfuse or transfix members, and the like. In an embodiment, the fuser members comprise an outer layer comprising a silicone rubber material. In embodiments, the release agent is a blended fluorosilicone release agent. In embodiments, the blended fluorosilicone release agent comprises a fluorosilicone release agent having pendant fluorocarbon groups blended with a non-functional release agent.

In a typical electrostatographic reproducing apparatus, a light image of an original to be copied is recorded in the form of an electrostatic latent image upon a photosensitive member, and the latent image is subsequently rendered visible by the application of electroscopic thermoplastic resin particles and pigment particles, or toner. The visible toner image is then in a loose powdered form and can be easily disturbed or destroyed. The toner image is usually fixed or fused upon a support, which may be the photosensitive member itself, or other support sheet such as plain paper.

The use of thermal energy for fixing toner images onto a support member is well known. To fuse electroscopic toner material onto a support surface permanently by heat, it is usually necessary to elevate the temperature of the toner material to a point at which the constituents of the toner material coalesce and become tacky. This heating causes the toner to flow to some extent into the fibers or pores of the support member.

Thereafter, as the toner material cools, solidification of the toner material causes the toner material to be firmly bonded to the support.

Typically, the thermoplastic resin particles are fused to the substrate by heating to a temperature of between about 90° C to about 200° C or higher depending upon the softening range of the particular resin used in the toner. It may be undesirable; however, to increase the temperature of the substrate substantially higher than about 250° C because of the tendency of the substrate to discolor or convert into fire at such elevated temperatures, particularly when the substrate is paper.

Several approaches to thermal fusing of electroscopic toner images have been described. These methods include providing the application of heat and pressure substantially concurrently by various means, a roll pair maintained in pressure contact, a belt member in pressure contact with a roll, a belt member in pressure contact with a heater, and the like. Heat may be applied by heating one or both of the rolls, plate members, or belt members. The fusing of the toner particles takes place when the proper combinations of heat, pressure and contact time are provided. The balancing of these parameters to bring about the fusing of the toner particles is well known in the art, and can be adjusted to suit particular machines or process conditions.

During operation of a fusing system in which heat is applied to cause thermal fusing of the toner particles onto a support, both the toner image and the support are passed through a nip formed between the roll pair, or plate or belt members. The concurrent transfer of heat and the application of pressure in the nip affect the fusing of the toner image onto the support. It is important in the fusing process that no offset of the toner particles from the support to the fuser member takes place during normal operations. Toner particles offset onto the fuser member may subsequently transfer to other parts of the machine or onto the support in subsequent copying cycles, thus increasing the background or interfering with the material being copied there. The referred to "hot offset" occurs when the temperature of the toner is increased to a point where the toner particles liquefy and a splitting of the molten toner takes place during the fusing operation with a portion remaining on the fuser member. The hot offset temperature or degradation of the hot offset temperature is a measure of the release property of the fuser roll, and accordingly it is desired to provide a fusing surface, which has a low surface energy to provide the necessary release. To ensure and maintain good release properties of the fuser roll, it has become customary to apply release agents to the fuser roll during the fusing operation. Typically, these materials are applied as thin films of, for example, non-functional silicone oils or mercapto- or amino-functional silicone oils, to prevent toner offset.

U.S. Patent 4,257,699 to Lentz discloses a fuser member comprising at least one outer layer of an elastomer containing a metal-containing filler and use of a polymeric release agent.

U.S. Patent 4,264,181 to Lentz et al. discloses a fuser member having an elastomer surface layer containing metal-containing filler therein and use of a polymeric release agent.

U.S. Patent 4,272,179 to Seanor discloses a fuser member having an elastomer surface with a metal-containing filler therein and use of a mercapto-functional polyorganosiloxane release agent.

U.S. Patent 5,401,570 to Heeks et al. discloses a fuser member comprised of a substrate and thereover a silicone rubber surface layer containing a filler component, wherein the filler component is reacted with a silicone hydride release oil.

U.S. Patent 4,515,884 to Field et al. discloses a fuser member having a silicone elastomer-fusing surface, which is coated with a toner release agent, which includes an unblended polydimethyl siloxane.

U.S. Patent 5,512,409 to Henry et al. teaches a method of fusing thermoplastic resin toner images to a substrate using amino-functional silicone oil over a hydrofluoroelastomer fuser member.

U.S. Patent 5,516,361 to Chow et al. teaches a fusing member having a thermally stable FKM hydrofluoroelastomer surface and having a polyorgano T-type amino-functional oil release agent. The oil has predominantly monoamino functionality per active molecule to interact with the hydrofluoroelastomer surface.

U.S. Patent 6,253,055 to Badesha et al. discloses a fuser member coated with a hydride release oil.

U.S. Patent 5,991,590 to Chang et al. discloses a fuser member having a low surface energy release agent outermost layer.

U.S. Patent 6,377,774 B1 to Maul et al. discloses an oil web system.

U.S. Patent 6,197,989 B1 to Furukawa et al. discloses a fluorine-containing organic silicone compound represented by a formula. In addition, the reference mentions that fluorosilicone oils can be mixed with functional oils.

U.S. Patent 5,757,214 to Kato et al. discloses a method for forming color images by applying a compound, which contains a fluorine atoms and/or silicon atom to the surface of electrophotographic light-sensitive elements.

U.S. Patent 5,716,747 to Uneme et al. discloses a fluororesin coated fixing device with a coating of a fluorine containing silicone oil.

U.S. Patent 5,698,320 to Ebisu et al. discloses a fixing device coated with a fluororesin, and having a fluorosilicone polymer release agent. In addition, the reference teaches that fluorosilicone oils can be mixed with conventional silicone oils.

U.S. Patent 5,641,603 to Yamazaki et al. discloses a fixing method using a silicone oil coated on the surface of a heat member.

U.S. Patent 5,636,012 to Uneme et al. discloses a fixing device having a fluororesin layer surface, and using a fluorine-containing silicone oil as a repellant oil.

U.S. Patent 5,627,000 to Yamazaki et al. discloses a fixing method having a silicone oil coated on the surface of the heat member, wherein the silicone oil is a fluorine-containing silicone oil and has a specific formula.

U.S. Patent 5,624,780 to Nishimori et al. discloses a fixing member having a fluorine-containing silicone oil coated thereon, wherein the silicone oil has a specific formula.

U.S. Patent 5,568,239 to Furukawa et al. discloses a stainproofing oil for heat fixing, wherein the fluorine-containing oil has a specific formula.

U.S. Patent 5,463,009 to Okada et al. discloses a fluorine-modified silicone compound having a specific formula, wherein the compound can be used for oil-repellency in cosmetics.

U.S. Patent 4,968,766 to Kendziorski discloses a fluorosilicone polymer for coating compositions for longer bath life.

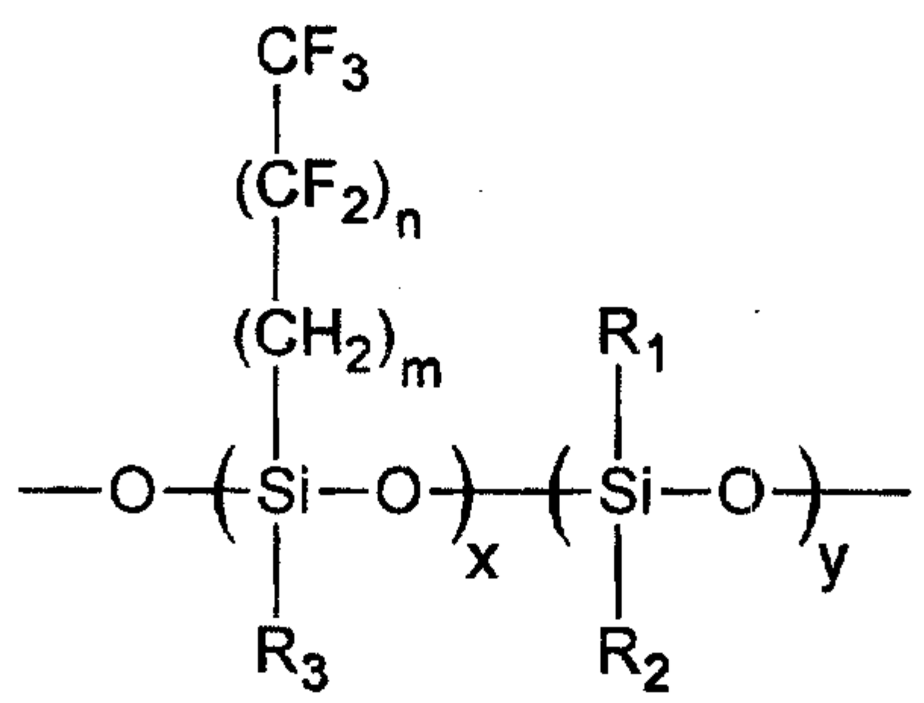
The use of polymeric release agents having functional groups, which interact with a fuser member to form a thermally stable, renewable self-cleaning layer having good release properties for electroscopic thermoplastic resin toners, is described in U.S. Patent Nos. 4,029,827; 4,101,686; and 4,185,140. Disclosed in U.S. Patent 4,029,827 is the use of polyorganosiloxanes having mercapto functionality as release agents. U.S. Patent Nos. 4,101,686 and 4,185,140 are directed to polymeric release agents having functional groups such as carboxy, hydroxy, epoxy, amino, isocyanate, thioether and mercapto groups as release fluids. U.S. Patent 5,716,747 discloses the use of fluorine-containing silicone oils for use on fixing rollers with outermost layers of ethylene tetrafluoride perfluoro alkoxyethylene copolymer, polytetrafluoroethylene and polyfluoroethylenepropylene copolymer. U.S. Patent 5,698,320 discloses the use of fluorosilicone polymers for use on fixing rollers with outermost layers of perfluoroalkoxy and tetrafluoroethylene resins.

The selection of release agents is based partly on the fuser member surface being used, so as to maximize the interaction between the fluid and the fuser member surface. For example, fluoroelastomer fuser members have used amino-functional polydimethylsiloxane (PDMS) release agents, whereas fluoroelastomer fuser members filled with copper oxide have used mercapto-functional PDMS. TEFLON®-like fuser members have used non-functional PDMS, and silicone fuser members have used high molecular weight PDMS to avoid outer layer swelling. Particularly for color and high-speed products, these fluids often do not meet desired release life requirements because of premature toner offset to the fuser member surface. Fluorinated silicones have shown promise in improving release performance on TEFLON®-like overcoated fuser members, but the cost for the fluid with TEFLON® has been shown to be relatively high. Particularly for RAM systems requiring application of large volumes of release agent, such as the Xerox DocuTech and DocuColor machines, the use of fluorinated release oils has been shown to be prohibitively expensive.

Therefore, it is desired to provide a release agent that has superior wetting and spreading capability, and reduces swelling. It is further desired to provide a fuser member release agent, which has little or no interaction with copy substrates such as paper, so that the release agent does not interfere with adhesives and POST-IT® notes (by 3M) adhering to the copy substrate such as paper. It is known that amino-functional oils interfere with adhesion on the copy substrate. It is further desired that the oil not prevent ink adhesion to the final copy substrate. In addition, it is desired that the release agent does not react with components of the toner nor promote fuser fluid gelation. It is also desired to provide a release agent that enhances roll life, and reduces fuser contamination.

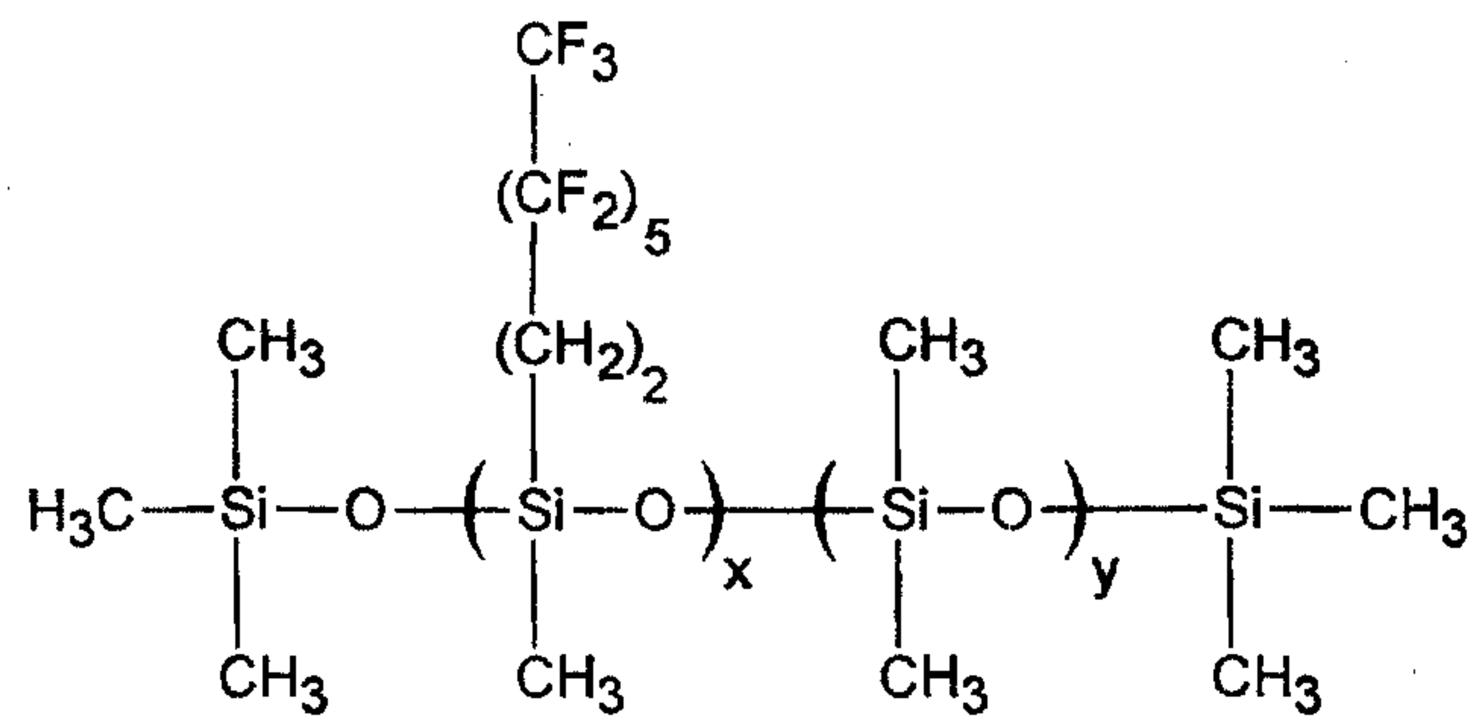
SUMMARY OF THE INVENTION

Embodiments of the present invention include: a fuser member comprising a substrate; an outer layer comprising a silicone rubber material; and a release agent material coating on the outer silicone rubber layer, wherein the release agent material coating comprises a) a non-functional release agent, and b) a fluorinated silicone release agent having the following Formula I:



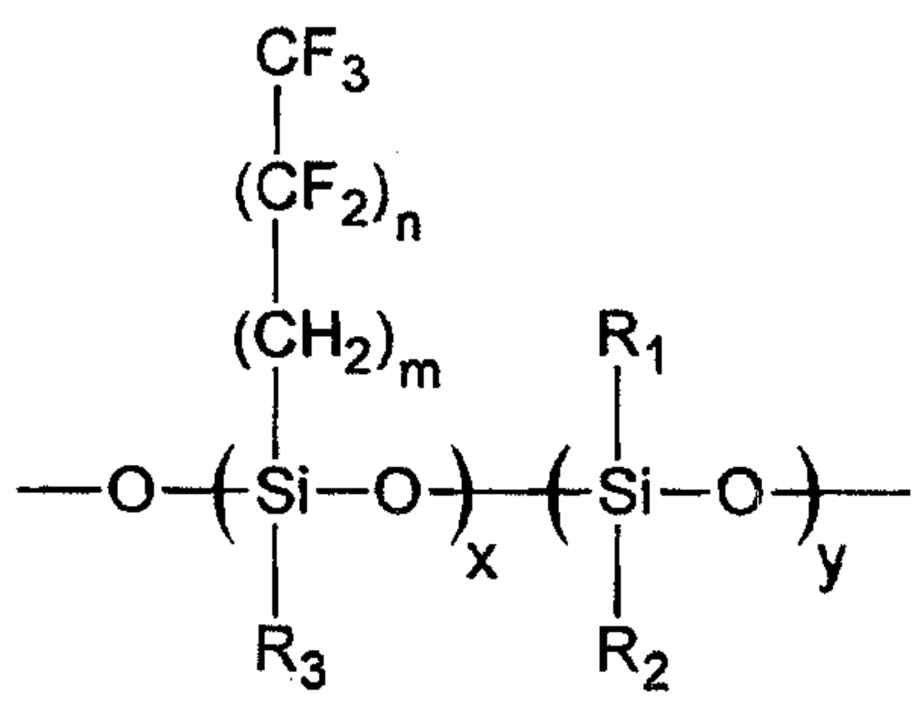
wherein m is a number of from about 0 to about 25 and n is a number of from about 1 to about 25; x/(x + y) is from about 1 percent to about 100 percent; R_1 and R_2 are selected from the group consisting of alkyl, arylalkyl, amino, and alkylamino groups; and R_3 is selected from the group consisting of alkyl, arylalkyl, polyorganosiloxane chain, and a fluoro-chain of the formula $-(CH_2)_o-(CF_2)_p-CF_3$ wherein o is a number of from about 0 to about 25 and p is a number of from about 1 to about 25.

Embodiments also include: a fuser member comprising a substrate; an outer layer comprising a silicone rubber material; and a release agent material coating on the outer silicone rubber layer, wherein the release agent material coating comprises a) a non-functional release agent, and b) a fluorinated silicone release agent having the following Formula III:



wherein x/(x + y) is about 2.4 percent.

Embodiments further include: an image forming apparatus for forming images on a recording medium comprising: a charge-retentive surface to receive an electrostatic latent image thereon; a development component to apply a developer material to the charge-retentive surface to develop the electrostatic latent image to form a developed image on the charge retentive surface; a transfer component to transfer the developed image from the charge retentive surface to a copy substrate; and a fuser member component to fuse the transferred developed image to the copy substrate, wherein the fuser member comprises a) a substrate; b) an outer layer comprising a silicone rubber material; and c) a release agent material coating on the outer silicone rubber layer, wherein the release agent material coating comprises i) a non-functional release agent, and ii) a fluorinated silicone release agent having the following Formula I:



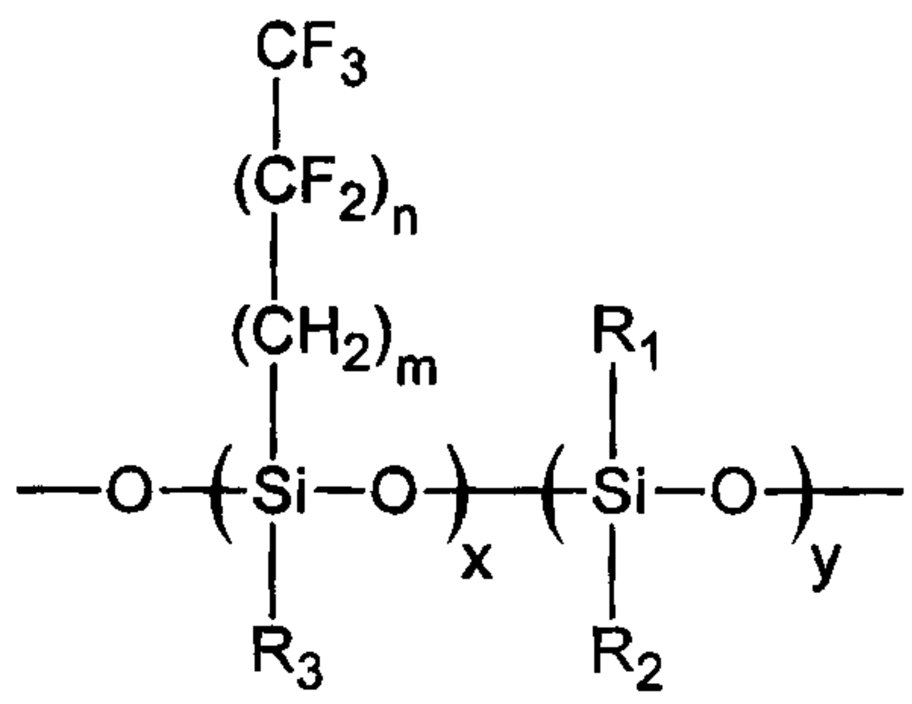
wherein m is a number of from about 0 to about 25 and n is a number of from about 1 to about 25; x/(x + y) is from about 1 percent to about 100 percent; R_1 and R_2 are selected from the group consisting of alkyl, arylalkyl, amino and alkylamino groups; and R_3 is selected from the group consisting of alkyl, arylalkyl, polyorganosiloxane chain, and a fluoro-chain of the formula $–(CH_2)_o-(CF_2)_p-CF_3$ wherein o is a number of from about 0 to about 25 and p is a number of from about 1 to about 25.

According to an aspect of the present invention, there is provided a fuser member comprising

a substrate;

an outer layer comprising a silicone rubber material; and

a release agent material coating on the outer silicone rubber layer, wherein the release agent material coating comprises a) a non-functional release agent, and b) a fluorinated silicone release agent having the following Formula I:



wherein m is a number of from about 0 to about 25 and n is a number of from about 1 to about 25; x/(x + y) is from about 1 percent to less than about 100 percent; R_1 and R_2 are selected from the group consisting of alkyl, arylalkyl, amino and alkylamino groups; and R_3 is selected from the group consisting of alkyl, arylalkyl, polyorganosiloxane chain, and a fluoro-chain of the formula $–(CH_2)_o-(CF_2)_p-CF_3$ wherein o is a number of from about 0 to about 25 and p is a number of from about 1 to about 25.

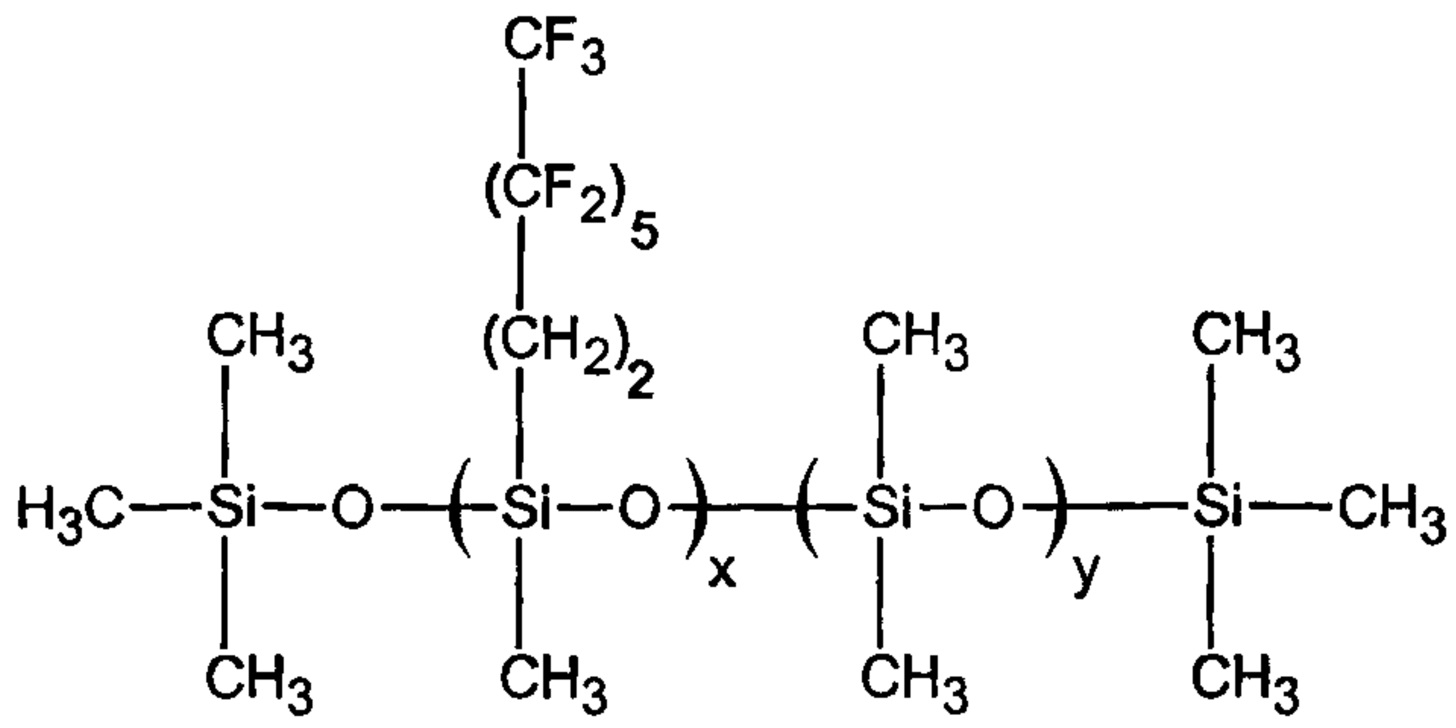
According to another aspect of the present invention, there is provided a fuser member comprising

a substrate;

an outer layer comprising a silicone rubber material; and

a release agent material coating on the outer silicone rubber layer, wherein the release agent material coating comprises a) a non-functional release agent, and b) a fluorinated silicone release agent having the following

Formula III:



wherein x/(x + y) is about 2.4 percent.

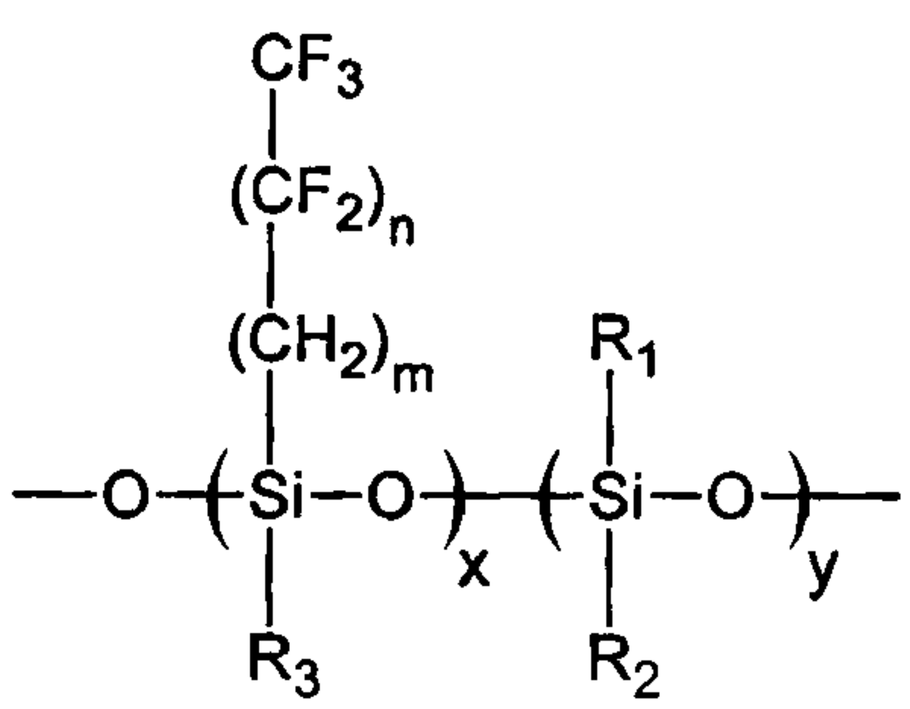
According to a further aspect of the present invention, there is provided an image forming apparatus for forming images on a recording medium comprising:

a charge-retentive surface to receive an electrostatic latent image thereon;

a development component to apply a developer material to the charge-retentive surface to develop the electrostatic latent image to form a developed image on the charge retentive surface;

a transfer component to transfer the developed image from the charge retentive surface to a copy substrate; and

a fuser member component to fuse the transferred developed image to the copy substrate, wherein the fuser member comprises a) a substrate; b) an outer layer comprising a silicone rubber material; and c) a release agent material coating on the outer silicone rubber layer, wherein the release agent material coating comprises i) a non-functional release agent, and ii) a fluorinated silicone release agent having the following Formula I:



wherein m is a number of from about 0 to about 25 and n is a number of from about 1 to about 25; x/(x + y) is from about 1 percent to less than about 100 percent; R_1 and R_2 are selected from the group consisting of alkyl, arylalkyl, amino, and alkylamino groups; and R_3 is selected from the group consisting of alkyl, arylalkyl, polyorganosiloxane chain, and a fluoro-chain of the formula $-(CH_2)_o-(CF_2)_p-CF_3$ wherein o is a number of from about 0 to about 25 and p is a number of from about 1 to about 25.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention, reference may be had to the accompanying figures.

Figure 1 is a schematic illustration of an image apparatus in accordance with the present invention.

Figure 2 is an enlarged, side view of an embodiment of a fuser member, showing a fuser member with a substrate, intermediate layer, outer layer, and release agent coating layer.

Figure 3 is a graph of fluid uptake versus time in hours testing the swelling of silicone rubber of various functional oils and a non-functional oil against a fluorosilicone oil.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

The present invention relates to fuser members having a release agent in combination therewith. The fuser member has an outer layer comprising silicone rubber. The outer layer is in combination with a release agent comprising a non-functional release agent and a fluorosilicone release agent. The combination, in embodiments, allows for sufficient wetting of the fuser member, and decreases swelling. The release agent, in embodiments, provides little or no interaction with copy substrates such as paper, so that the release agent does not interfere with adhesives and POST-IT® notes (by 3M) and like tabs, adhering to the copy substrate such as paper. The release agent combination, in embodiments, enables increase in life of the fuser member by improved spreading of the release agent. The release agent combination, in embodiments, further provides a release agent that provides little or no interaction with toner constituents, and does not promote fuser fluid gelation, thus increasing fuser member life. In addition, the release agent combination, in embodiments, reduces or eliminates fuser contamination.

When used on TEFLON®-like fuser member surfaces, such as polytetrafluoroethylene (PTFE), perfluoroalkoxy resin (PFA) or fluorinated ethylene propylene resin (FEP), fluorosilicone fluids demonstrate much faster surface wetting and thus provide more thorough surface coverage than non-functional fluids. The result is that a significant reduction in stripper finger marks with the use of fluorosilicone fluids in place of non-functional can occur.

In addition, when used as a release fluid on an image drum for image transfer to an intermediate transfer belt in ink jet printers, unlike non-functional oils, the fluorofluid does not extract wax from the toner, thus reducing contamination and providing superior performance.

When used with an outer polymeric surface, the fluorosilicone fuser fluid spreads more rapidly and thus provides more complete surface coverage then does the non-functional, amino-functional, or mercapto-functional fluids. (See Figure 3).

When used in combination with a silicone fuser roll surface, the fluorosilicone release agent provides much less swelling of the surface than does non-functional, amino-functional, or mercapto-functional fluids. (See Figure 3).

By combining a fluorosilicone fluid having the above advantages, with a non-functional release agent, the benefits of both fluids can be obtained. For example, fluorosilicones have good on-print characteristics similar to those of non-functional fluids. Therefore, a combination of fluorosilicones with non-functional fluids provide excellent on-print characteristics. In addition, non-functional fuser oils are very inexpensive. On the other hand, fluorosilicone oils are quite expensive. Therefore, the combination of non-functional fuser oil and fluorosilicone oil is used as a cost down measure. A non-functional fluid component in a blend with fluorinated fluid does not compromise the added benefit of reduced interaction gained by using a fluorinated fluid. In addition, the blend, in embodiments, results in more uniform application of fuser fluid, and a higher viscosity fluorofluid.

Referring to Figure 1, in a typical electrostatographic reproducing apparatus, a light image of an original to be copied is recorded in the form of an electrostatic latent image upon a photosensitive member and the latent image is subsequently rendered visible by the application of electroscopic thermoplastic resin particles which are commonly referred to as toner. Specifically, photoreceptor 10 is charged on its surface by means of a charger 12 to which a voltage has been supplied from power supply 11. The photoreceptor is then imagewise exposed to light from an optical system or an image input apparatus 13, such as a laser and light emitting diode, to form an electrostatic latent image thereon. Generally, the electrostatic latent image is developed by bringing a developer mixture from developer station 14 into contact therewith. Development can be effected by use of a magnetic brush, powder cloud, or other known development process. A dry developer mixture usually comprises carrier granules having toner particles adhering triboelectrically thereto. Toner particles are attracted from the carrier granules to the latent image forming a toner powder image thereon. Alternatively, a liquid developer material may be employed, which includes a liquid carrier having toner particles dispersed therein. The liquid developer material is advanced into contact with the electrostatic latent image and the toner particles are deposited thereon in image configuration.

After the toner particles have been deposited on the photoconductive surface, in image configuration, they are transferred to a copy sheet 16 by transfer means 15, which can be pressure transfer or electrostatic transfer. Alternatively, the developed image can be transferred to an intermediate transfer member, or bias transfer member, and subsequently transferred to a copy sheet. Examples of copy substrates include paper, transparency material such as polyester, polycarbonate, or the like, cloth, wood, or any other desired material upon which the finished image will be situated.

After the transfer of the developed image is completed, copy sheet 16 advances to fusing station 19, depicted in Figure 1 as fuser roll 20 and pressure roll 21 (although any other fusing components such as fuser belt in contact with a pressure roll, fuser roll in contact with pressure belt, and the like, are suitable for use with the present apparatus), wherein the developed image is fused to copy sheet 16 by passing copy sheet 16 between the fusing and pressure members, thereby forming a permanent image. Alternatively, transfer and fusing can be effected by a transfix application.

Photoreceptor 10, subsequent to transfer, advances to cleaning station 17, wherein any toner left on photoreceptor 10 is cleaned therefrom by use of a blade (as shown in Figure 1), brush, or other cleaning apparatus.

Figure 2 is an enlarged schematic view of an embodiment of a fuser member, demonstrating the various possible layers. As shown in Figure 2, substrate 1 has intermediate layer 2 thereon. Intermediate layer 2 can be, for example, a rubber such as silicone rubber or other suitable rubber material. On intermediate layer 2 is positioned outer layer 3 comprising a silicone rubber as described below. Positioned on outer silicone rubber layer 3 is outermost liquid combination fluorosilicone and non-functional release layer 4.

Examples of the outer surface of the fuser system members include silicone rubbers, such as room temperature vulcanization (RTV) silicone rubbers; high temperature vulcanization (HTV) silicone rubbers; and low temperature vulcanization (LTV) silicone rubbers. These rubbers are known and readily available commercially such as SILASTIC® 735 black RTV and SILASTIC® 732 RTV, both from Dow Corning; and 106 RTV

Silicone Rubber and 90 RTV Silicone Rubber, both from General Electric. Other suitable silicone materials include the siloxanes (such as polydimethylsiloxanes); fluorosilicones such as Silicone Rubber 552, available from Sampson Coatings, Richmond, Virginia; liquid silicone rubbers such as vinyl crosslinked heat curable rubbers or silanol room temperature crosslinked materials; and the like. Another specific example is Dow Corning Sylgard 182.

The amount of silicone rubber material in solution in the outer layer solutions, in weight percent total solids, is from about 10 to about 25 percent, or from about 16 to about 22 percent by weight of total solids. Total solids as used herein include the amount of silicone rubber, additives, and fillers, including metal oxide fillers.

An inorganic particulate filler may be used in connection with the silicone rubber outer layer. Examples of suitable fillers include a metal-containing filler, such as a metal, metal alloy, metal oxide, metal salt or other metal compound. The general classes of metals which are applicable to the present invention include those metals of Groups 1b, 2a, 2b, 3a, 3b, 4a, 4b, 5a, 5b, 6b, 7b, 8 and the rare earth elements of the Periodic Table. The filler can be an oxide of aluminum, copper, tin, zinc, lead, iron, platinum, gold, silver, antimony, bismuth, zinc, iridium, ruthenium, tungsten, manganese, cadmium, mercury, vanadium, chromium, magnesium, nickel and alloys thereof. Other specific examples include inorganic particulate fillers are aluminum oxide and cupric oxide. Other examples include reinforcing and non-reinforcing calcined alumina and tabular alumina respectively.

The thickness of the outer silicone rubber surface layer of the fuser member herein is from about 10 to about 250 micrometers, or from about 15 to about 100 micrometers.

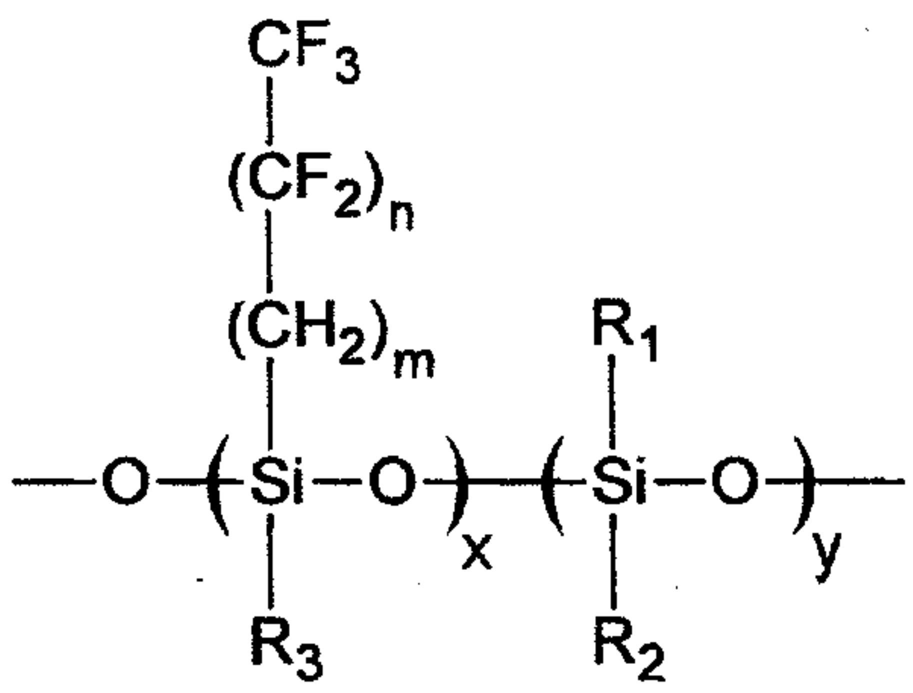
Optional intermediate adhesive layers and/or intermediate polymer or elastomer layers may be applied to achieve desired properties and performance objectives of the present invention. The intermediate layer may be present between the substrate and the outer surface. An adhesive intermediate layer may be selected from, for example, epoxy resins and polysiloxanes. Examples of suitable intermediate layers include silicone rubbers such as those described above for the outer layer, and other elastomer layers.

There may be provided an adhesive layer between the substrate and the intermediate layer. There may also be an adhesive layer between the intermediate layer and the outer layer. In the absence of an intermediate layer, the silicone rubber layer may be bonded to the substrate via an adhesive layer.

The thickness of the intermediate layer is from about 0.5 to about 20 mm, or from about 1 to about 5 mm.

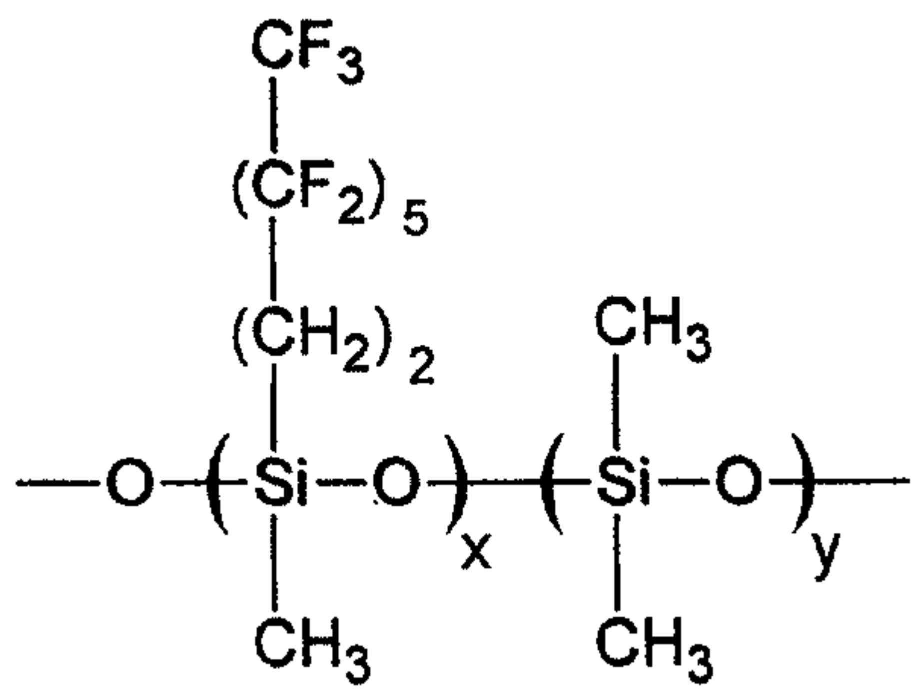
The release agents or fusing oils described herein are provided onto the outer layer of the fuser member via a delivery mechanism such as a delivery roll. The delivery roll is partially immersed in a sump, which houses the fuser oil or release agent. The fluorosilicone and non-functional oil is renewable in that the release oil is housed in a holding sump and provided to the fuser roll when needed, optionally by way of a release agent donor roll in an amount of from about 0.1 to about 20 mg/copy, or from about 1 to about 12 mg/copy. The system by which fuser oil is provided to the fuser roll via a holding sump and optional donor roll is well known. The release oil may be present on the fuser member in a continuous or semicontinuous phase. The fuser oil in the form of a film is in a continuous phase and continuously covers the fuser member.

Examples of suitable fluorosilicone release agents include those having pendant fluorinated groups, such as $CF_3(CF_2)_n(CH_2)_m$-, wherein "n" and "m" are numbers representing repeating units. In embodiments, examples of fluorosilicone release agents include those having the following Formula I:



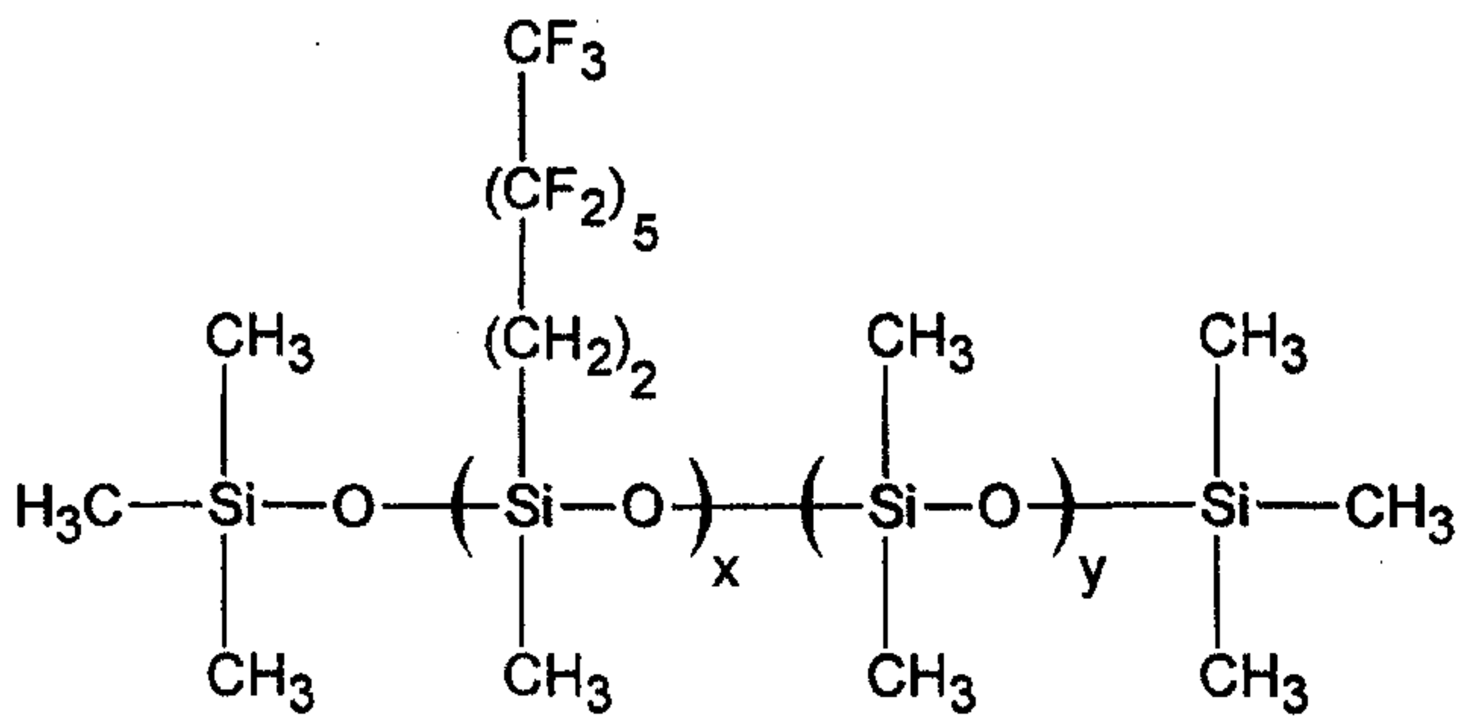
wherein m and n are the same or different and m is from about 0 to about 25 or from about 1 to about 10, or from about 2 to about 7, or 5 and n is from about 1 to about 25, or from about 2 to about 12, or from about 3 to about 7, or 5. The extent of incorporation of the pendant fluorocarbon chains, defined as $x/(x + y)$ is from about 1 percent to about 100 percent or from about 4 percent to about 20 percent or from about 5 percent to about 10 percent. The groups, R_1 and R_2 can be the same or different and are selected from the group consisting of alkyl and arylalkyl groups such as those having from about 1 to about 18 carbon atoms, such as methyl, ethyl, propyl, butyl and the like, or methylphenyl, ethylphenyl, propylphenyl, butylphenyl and the like, amino and alkylamino groups such as those having from about 1 to about 18 carbons, such as methylamino, ethylamino, propylamino, butylamino and the like, and wherein R_3 is selected from the group consisting of alkyl and arylalkyl groups such as those just listed, a polyorganosiloxane chain such as those having from about 1 to about 300 repeat units, and a fluoro-chain of the formula $-(CH_2)_o-(CF_2)_p-CF_3$ where o and p have the same ranges as m and n, respectively, but may be the same or different than m and n.

A specific example of a pendant fluorosilicone group in the fluorosilicone release agent is one having the following Formula II:



wherein x/(x + y) is about 2.4 percent (0.024) and the total length of the polymer chain, x+y, is that which corresponds to a viscosity of 226 cS.

A specific example of a fluorosilicone release agent is one having the following formula III:



In the above formula, x/(x + y) can be about 2.4 percent (0.024) and the total length of the polymer chain, x + y, can be that which corresponds to a viscosity of 226 cS.

In embodiments, the siloxane polymer containing pendant fluorinated groups of Formulas I, II, or III can be present with a non-functional release agent. In embodiments, the siloxane polymer containing pendant fluorinated groups as in Formulas I through III above, may be present in the release agent in amounts of from about 1 to about 100 percent, 5 to about 30 percent, or from about 7 to about 20 percent, or about 8.5 percent.

In embodiments, the fluorinated silicone release agent has a viscosity of from about 75 to about 1,500 cS, or from about 200 to about 1,000 cS.

Examples of non-functional release agents that can be used in combination with the fluorosilicone release agent include polydialkylsiloxanes, such as polydimethylsiloxanes, polydiethylsiloxanes, and the like.

In embodiments, a high molecular weight non-functional oil is used in combination with the fluorosilicone oil. However, a low molecular weight non-functional oil can be used. In embodiments, the molecular weight of the non-functional oil can be from about 35,000 to about 67,500, or from about 49,500 to about 67,500, or from about 62,700 to about 65,000.

In embodiments, the non-functional oil has a viscosity of from about 10,000 to about 20,000 cS, of from 13,000 to about 15,000 cS.

A non-functional oil, as used herein, refers to a release agent having no functional groups, which would chemically react with the fillers present on the surface of the fuser member.

The non-functional release agent is used in an amount of from about 99 to about 60, or from about 90 to about 70 percent, or from about 80 to about 75 percent by weight in combination with the fluorosilicone fluid. Similarly, the fluorosilicone fluid is used in amounts of from about 1 to about 40 percent, or from about 10 to about 30 percent, or from about 20 to about 25 percent by weight in combination with the non-functional fluid.

The combination of fluorosilicone and non-functional fuser oil shows little interaction of the fluorinated substituents to the copy substrate, such as paper. In this manner, the release agents do not prevent adhesives and POST IT® notes and other tabs from adhering adequately to copies or prints fused with these fluorinated release agents. In addition, the release agents spread better than known release agents on silicone rubber surfaces, and prevent swelling, which is a common problem.

Moreover, the use of fluorosilicone oils with non-functional oils reduces costs.

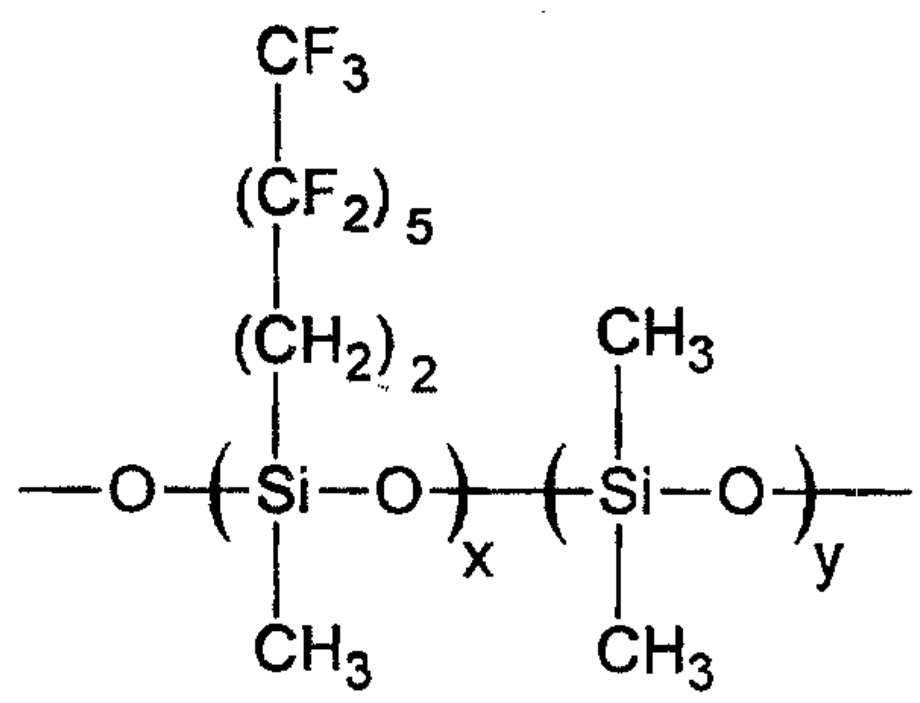
The following Examples further define and describe embodiments of the present invention. Unless otherwise indicated, all parts and percentages are by weight.

EXAMPLES

Example I

Fluorinated Silicone Release Agent

A fluorinated silicone release agent or fuser oil fluid with about 2.4 percent pendant fluorinated chains (or, x/(x+y)=0.024 or 2.4 percent) having the following formula:



was provided by Wacker Chemical Corporation, Adrian, MI. The sample was designated as SLM-50330 CS-137. The viscosity of the fluid was 226 cS at room temperature.

Example II

Testing of Swelling of Non-functional and Fluorosilicone Combination

Four fluids were tested to determine the swelling differences between functional and non-functional silicone fluids, and fluorosilicone fluids. The four fluids tested were as follows: a functional amino fluid, a functional mercapto fluid, a non-functional fluid, and a fluorosilicone fluid. The fluids were tested on a silicone rubber surface. As shown in Figure 3, the fluorosilicone fluid exhibited superior swelling behavior than the other fluids. Therefore it is reasonable to assume that with a blended fluid, the swelling would be less than with a purely non-functional fluid.

Example III

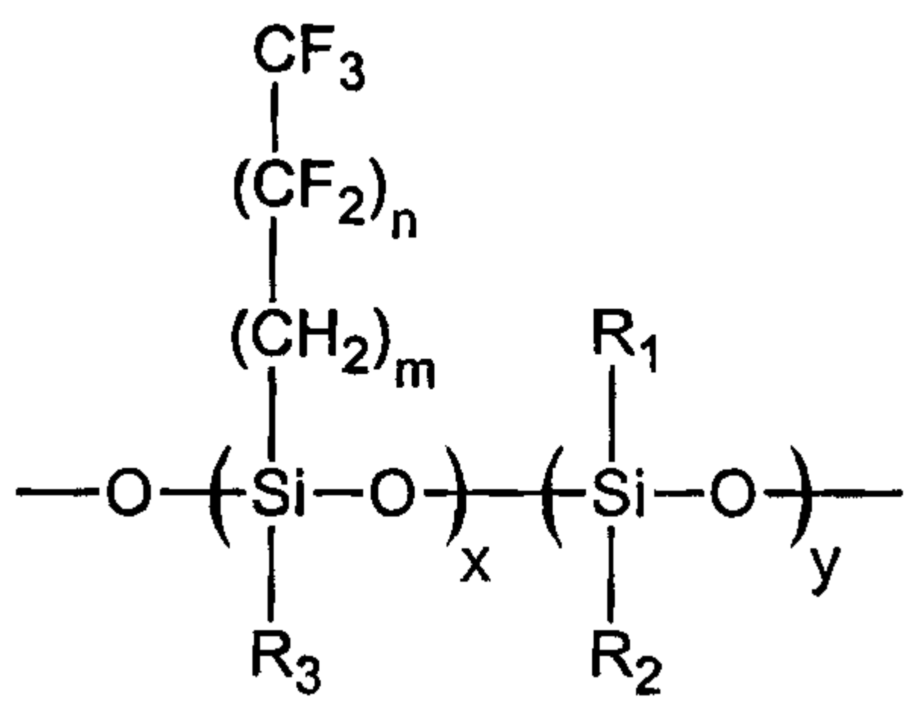
Testing of Safety of Fluorofluids

The fluorosilicone oil of Example 1 was tested for safety by heating to 180°C. The fluorosilicone oil was found to not give off any detectable (by GC/MS) fluorinated species. It is believed that the long fluorochains of this fluid does not have the safety problem of known fluorofluids.

While the invention has been described in detail with reference to specific and preferred embodiments, it will be appreciated that various modifications and variations will be apparent to the artisan. All such modifications and embodiments as may readily occur to one skilled in the art are intended to be within the scope of the appended claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A fuser member comprising
a substrate;
an outer layer comprising a silicone rubber material; and
a release agent material coating on the outer silicone rubber layer, wherein the release agent material coating comprises a) a non-functional release agent, and b) a fluorinated silicone release agent having the following Formula I:



wherein m is a number of from about 0 to about 25 and n is a number of from about 1 to about 25; x/(x + y) is from about 1 percent to less than about 100 percent; R_1 and R_2 are selected from the group consisting of alkyl, arylalkyl, amino and alkylamino groups; and R_3 is selected from the group consisting of alkyl, arylalkyl, polyorganosiloxane chain, and a fluoro-chain of the formula $-(CH_2)_o-(CF_2)_p-CF_3$ wherein o is a number of from about 0 to about 25 and p is a number of from about 1 to about 25.

2. A fuser member in accordance with claim 1, wherein said non-functional release agent is a polydialkylsiloxane release agent.

3. A fuser member in accordance with claim 2, wherein said polydialkylsiloxane is a polydimethylsiloxane.

4. A fuser member in accordance with claim 1, wherein said non-functional release agent has a molecular weight of from about 35,000 to about 67,500.

5. A fuser member in accordance with claim 4, wherein said non-functional release agent has a molecular weight of from about 49,500 to about 67,500.

6. A fuser member in accordance with claim 1, wherein m is a number of from about 1 to about 10.

7. A fuser member in accordance with claim 1, wherein n is a number of from about 2 to about 12.

8. A fuser member in accordance with claim 1, wherein $x/(x + y)$ is from about 4 percent to about 20 percent.

9. A fuser member in accordance with claim 8, wherein $x/(x + y)$ is from about 5 percent to about 10 percent.

10. A fuser member in accordance with claim 1, wherein o is a number of from about 1 to about 10.

11. A fuser member in accordance with claim 1, wherein p is a number of from about 2 to about 12.

12. A fuser member in accordance with claim 1, wherein fluorinated silicone release agent is present in the release agent material coating in an amount of from about 1 to about 40 percent by weight.

13. A fuser member in accordance with claim 12, wherein the amount is from about 10 to about 30 percent by weight.

14. A fuser member in accordance with claim 13, wherein the amount is from about 20 to about 25 percent by weight.

15. A fuser member in accordance with claim 1, wherein said non-functional polydimethylsiloxane release agent has a viscosity of from about 10,000 to about 20,000 cS.

16. A fuser member in accordance with claim 15, wherein said viscosity is from about 13,000 to about 15,000 cS.

17. A fuser member in accordance with claim 1, wherein the fluorinated silicone release agent has a viscosity of from about 75 to about 1,500 cS.

18. A fuser member in accordance with claim 17, wherein the fluorinated silicone release agent has a viscosity of from about 200 to about 1,000 cS.

19. A fuser member in accordance with claim 1, wherein said silicone rubber outer layer has a thickness of from about 10 to about 250 micrometers.

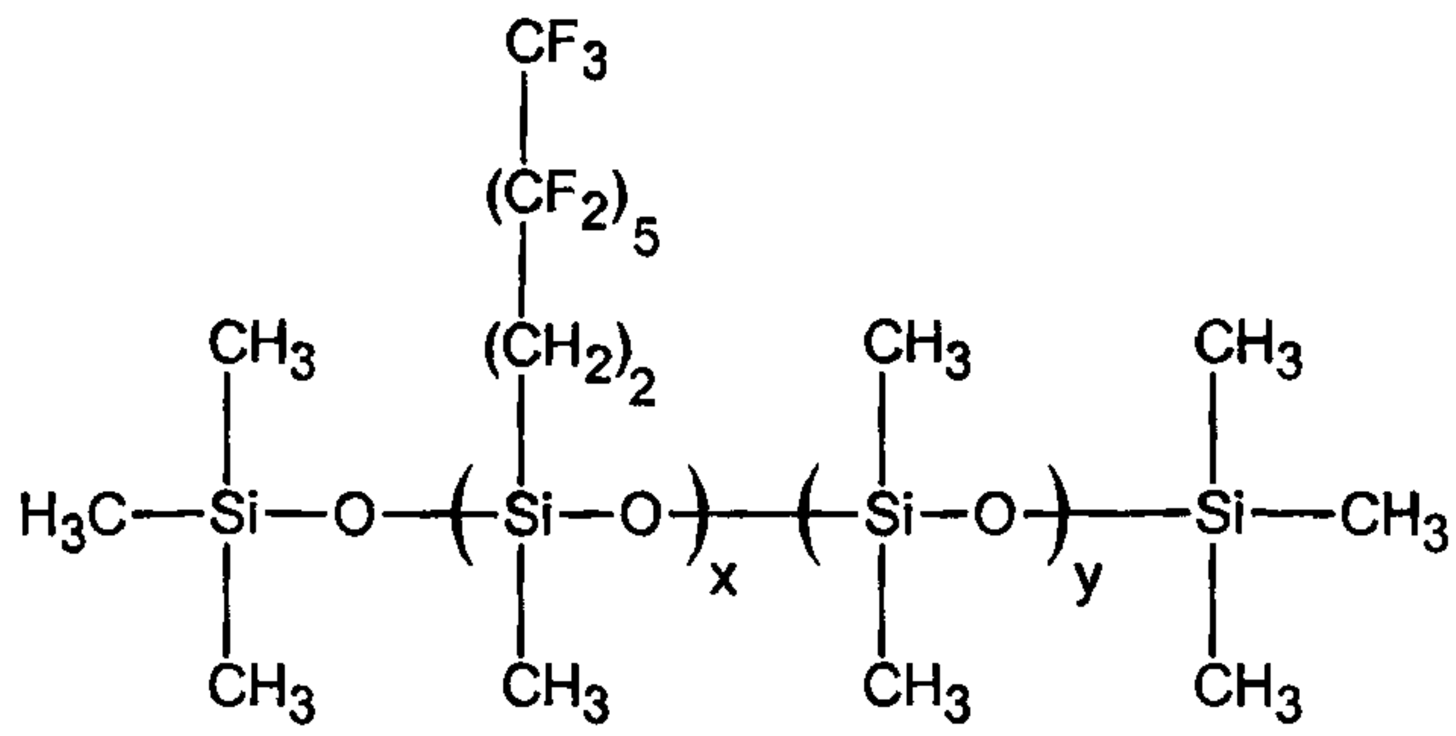
20. A fuser member in accordance with claim 19, wherein said thickness is from about 15 to about 100 micrometers.

21. A fuser member comprising

a substrate;

an outer layer comprising a silicone rubber material; and

a release agent material coating on the outer silicone rubber layer, wherein the release agent material coating comprises a) a non-functional release agent, and b) a fluorinated silicone release agent having the following Formula III:



wherein x/(x + y) is about 2.4 percent.

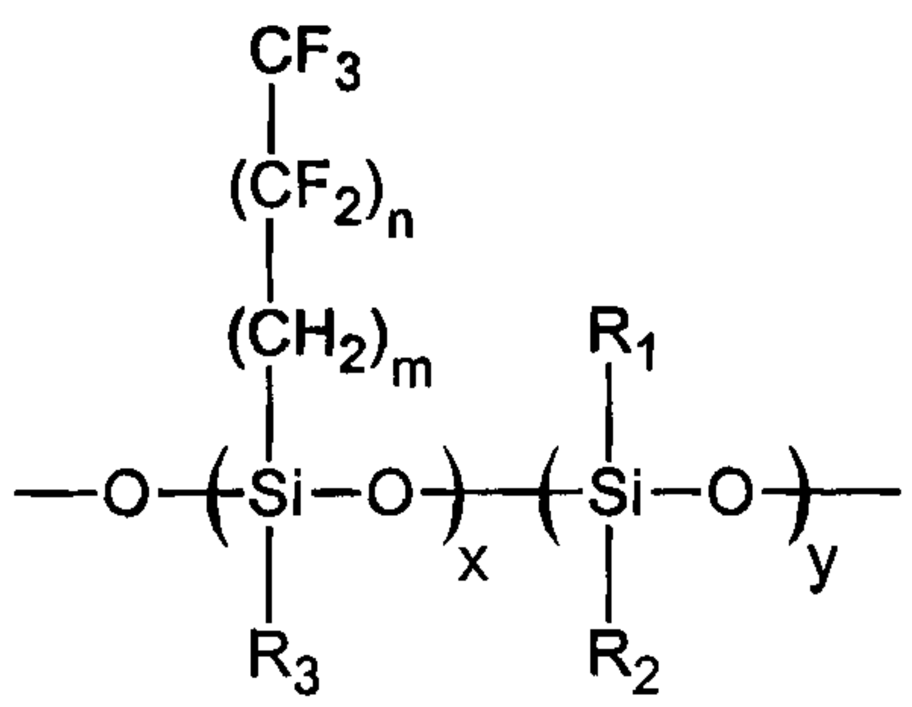
22. An image forming apparatus for forming images on a recording medium comprising:

a charge-retentive surface to receive an electrostatic latent image thereon;

a development component to apply a developer material to the charge-retentive surface to develop the electrostatic latent image to form a developed image on the charge retentive surface;

a transfer component to transfer the developed image from the charge retentive surface to a copy substrate; and

a fuser member component to fuse the transferred developed image to the copy substrate, wherein the fuser member comprises a) a substrate; b) an outer layer comprising a silicone rubber material; and c) a release agent material coating on the outer silicone rubber layer, wherein the release agent material coating comprises i) a non-functional release agent, and ii) a fluorinated silicone release agent having the following Formula I:



wherein m is a number of from about 0 to about 25 and n is a number of from about 1 to about 25; $x/(x + y)$ is from about 1 percent to less than about 100 percent; R_1 and R_2 are selected from the group consisting of alkyl, arylalkyl, amino, and alkylamino groups; and R_3 is selected from the group consisting of alkyl, arylalkyl, polyorganosiloxane chain, and a fluoro-chain of the formula $-(CH_2)_o-(CF_2)_p-CF_3$ wherein o is a number of from about 0 to about 25 and p is a number of from about 1 to about 25.

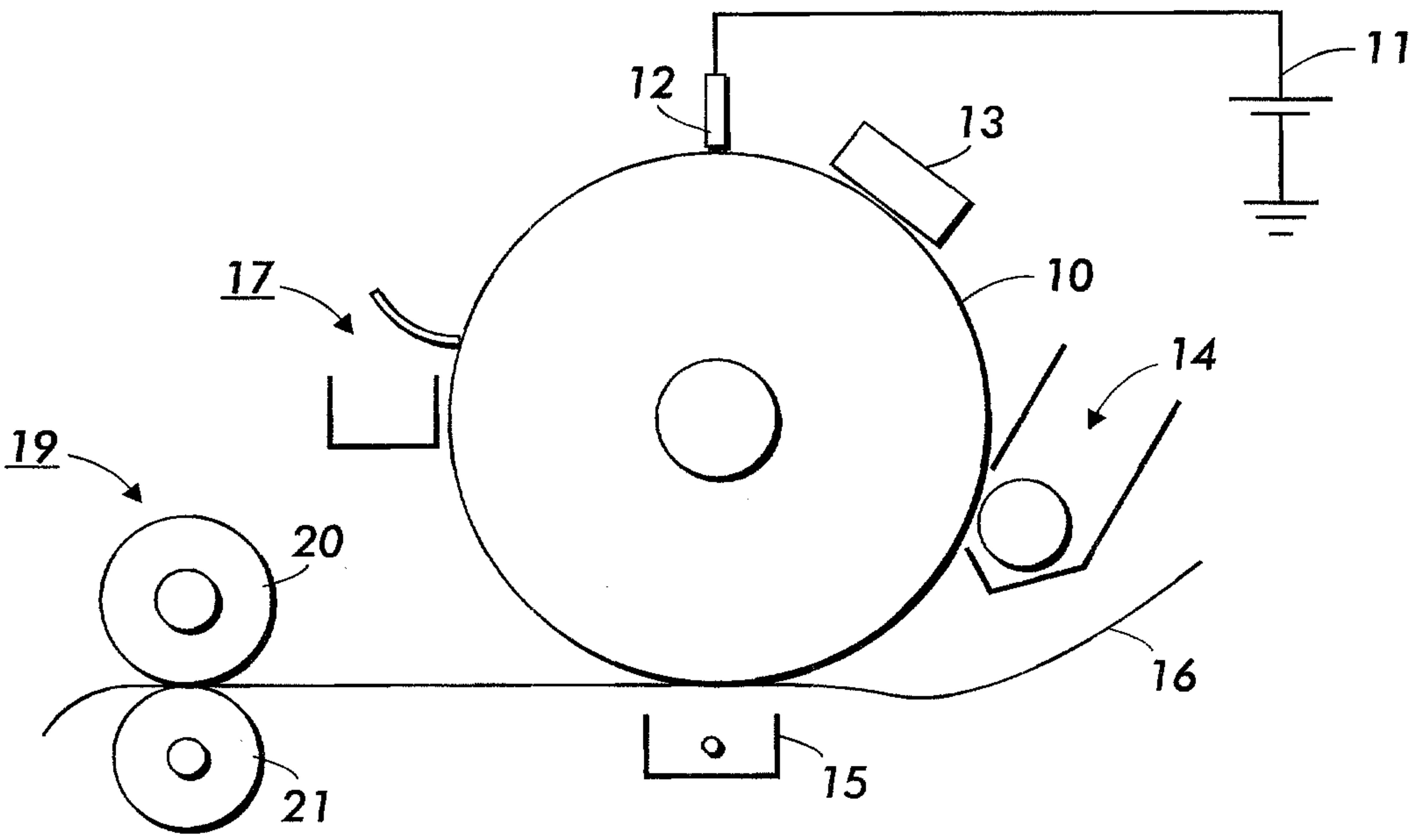


FIG. 1

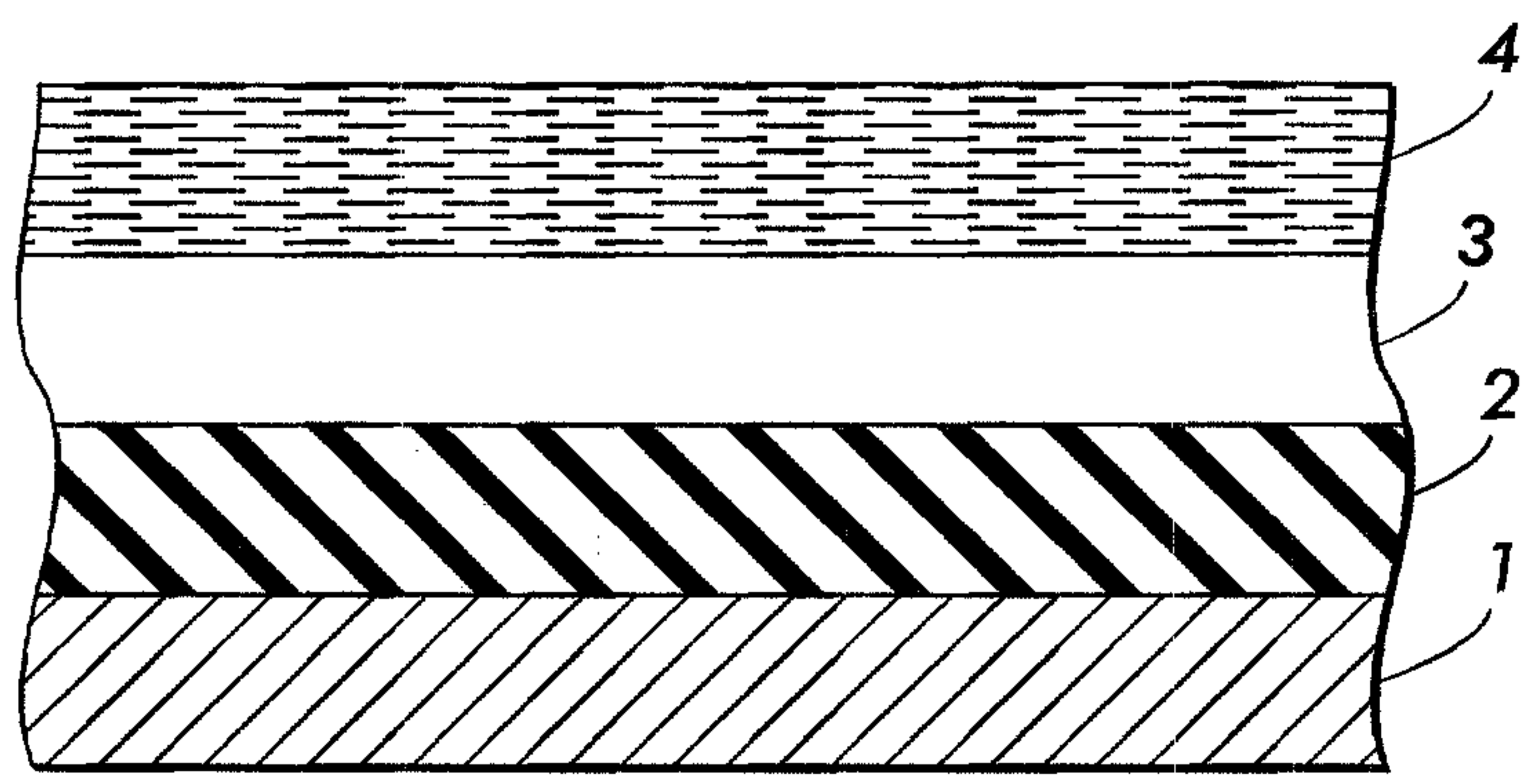


FIG. 2

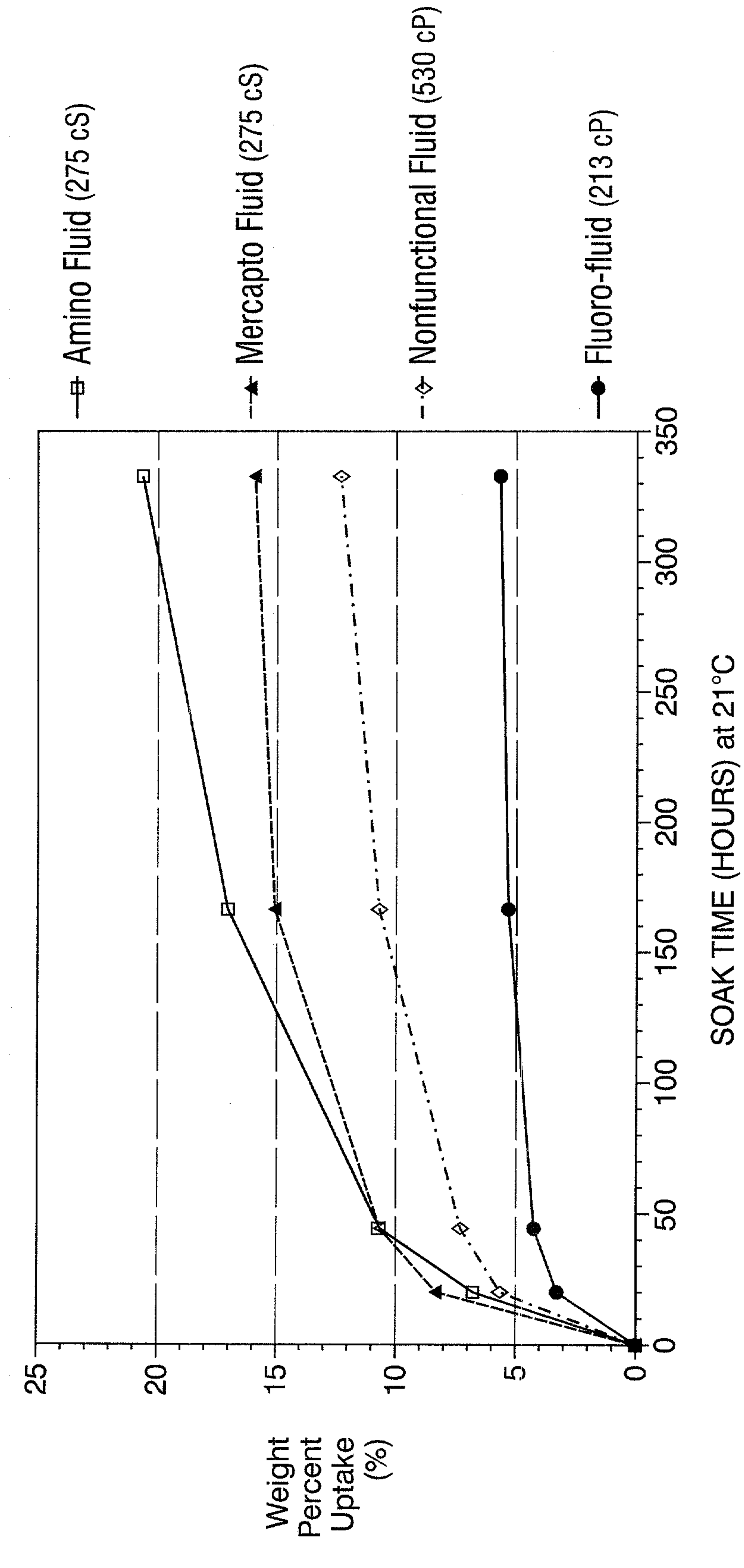
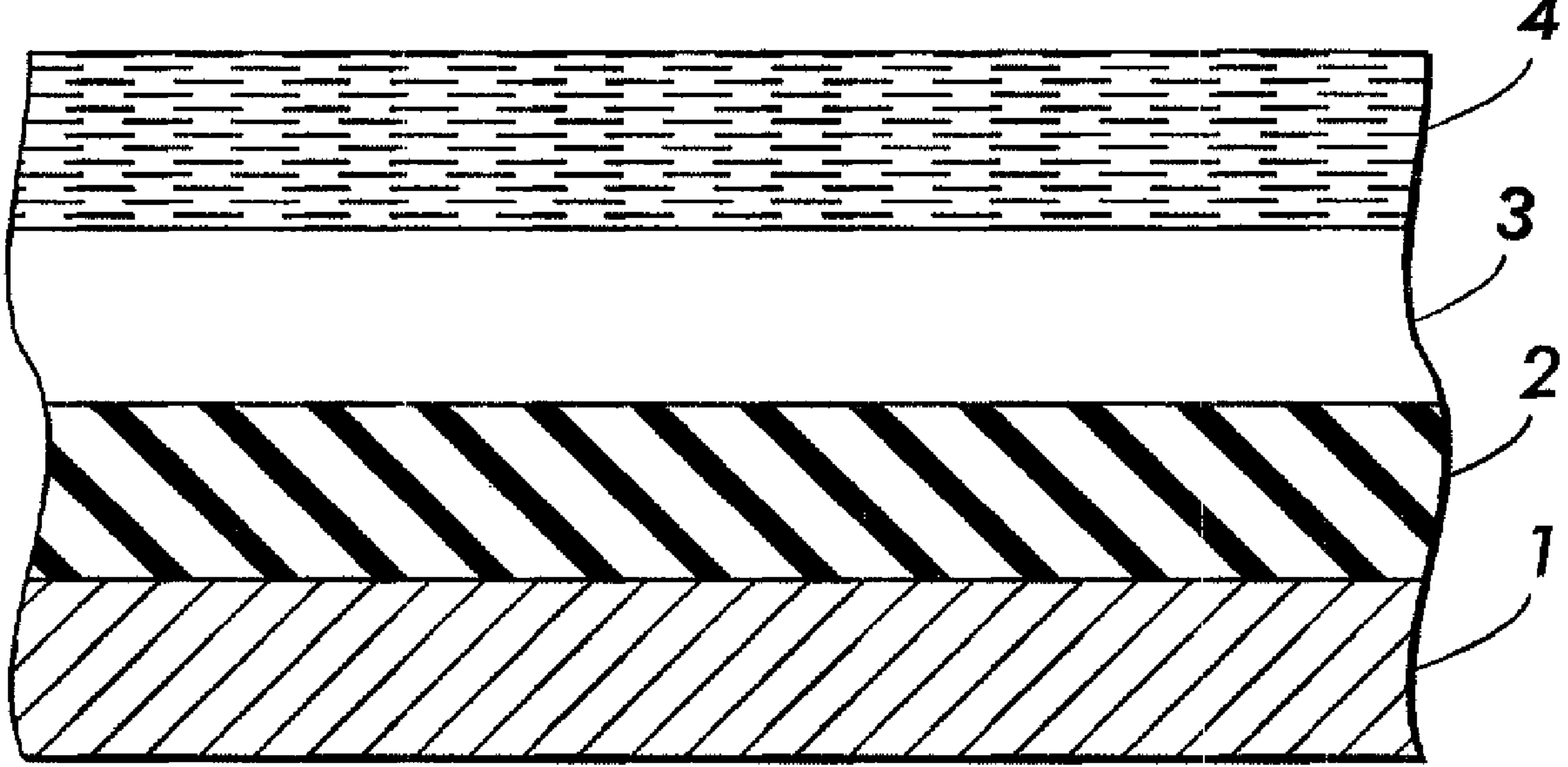

Weight Percent Uptake (%)
0
5
10
15
20
25
0
50
100
150
200
250
300
350
SOAK TIME (HOURS) at 21°C
Amino Fluid (275 cS)
Mercapto Fluid (275 cS)
Nonfunctional Fluid (530 cP)
Fluoro-fluid (213 cP)

FIG. 3


4
3
2
1