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(54) **Method of lithographic printing with a reusable substrate.**

Verfahren zum lithographischen Druck mit wiederverwendbarem Träger

Procédé d' impression lithographique avec support réutilisable

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(73) Proprietor: **AGFA-GEVAERT**
2640 Mortsel (BE)

(72) Inventors:
- **Verschueren, Eric,**
  Agfa-Gevaert N.V.
  2640 Mortsel (BE)
- **Geerts, Peter**
  c/o AGFA-GEVAERT, Corporate IP
  2640 Mortsel (BE)

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EP-A- 0 802 457
US-A- 4 847 182
US-A- 5 156 760

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a method for treating a micro-emulsion that is used as a cleaning liquid in a method for recycling the lithographic substrate of a printing plate.

BACKGROUND OF THE INVENTION

[0002] In conventional lithographic printing, ink and an aqueous fountain solution are supplied to the surface of a printing master that contains ink accepting (oleophilic) and water-accepting (hydrophilic) areas. The inked image pattern is then transferred from the surface of the master to a blanket cylinder having a compressible surface. From the blanket cylinder the image is impressed onto paper. The master is typically a printing plate that carries an image on a dimensionally stable substrate such as an aluminium sheet. The imaged aluminium plate is secured to the plate cylinder of a printing press by a mechanical lock-up mechanism that defines positional registration between the plate and the surface of the cylinder. After the end of the press run, the mechanical lock-up system is released so that the printing plate carrying the printed image can be removed and discarded and another printing plate can be positioned and locked into place. A new print job can then be started.

[0003] Printing masters are generally obtained by the so-called computer-to-film method wherein each colour selection is transferred to graphic arts film using an image-setter. After processing, the film can be used as a mask for the exposure of an imaging material called plate precursor and after plate processing, a printing plate is obtained which can be used as a master. These steps are usually performed in dedicated exposure and processing equipment and the printing plates are then transported to the printing press and attached to the printing cylinder by press operators using a lock-up mechanism built into the cylinder itself. Although the attachment of the printing cylinder is generally a manual operation, robotic means have been developed for positioning and securing the printing plates.

[0004] In recent years the so-called computer-to-plate method has gained a lot of interest. This method, also called direct-to-plate method, bypasses the creation of film because the digital data are transferred directly to a plate precursor by means of a so-called plate-setter. On-press imaging is a direct-to-plate method (also called direct-to-press), wherein the image is exposed on the plate while said plate is mounted on the plate cylinder of a printing press. The major advantage of the latter method compared to off-press plate making is the improved registration between printing stations of a multi-colour printing press.

[0005] Two types of such on-press imaging methods are known. According to a first type, a printing plate precursor is mounted on a printing press, image-wise exposed, optionally developed, and then used as a printing master and finally removed from the press and disposed of, thus requiring a new plate material for each image. An example of this technology is the Heidelberg Model GTO-DI, manufactured by Heidelberg Druckmaschinen AG (Germany) which is described in detail in US 5,339,737. A drawback of this method is the need to use a new plate for each press run, thus increasing the cost of the printing process.

[0006] In a second type of on-press imaging systems, the same lithographic substrate is used in a plurality of press runs (hereinafter called printing cycles). In each printing cycle, a heat-sensitive or photosensitive layer is coated on the lithographic substrate to make a printing plate precursor and after image-wise exposure and optional development a printing master is obtained. After the press-run, the ink-accepting areas of the printing master are removed from the lithographic substrate in a cleaning step so that the substrate is recycled and can be used in a next cycle of coating, exposing and printing without the need to mount a new plate on the cylinder. Examples of such on-press coating and on-press imaging systems are described in e.g. US 5,188,033; US 5,713,287; EP-A 786 337 and EP-A 802 457. The latter patent application describes an apparatus comprising a printing member, means for applying a uniform coating, means for scan-wise exposing said uniform coating in accordance with an image pattern and means for developing said uniform coating to leave an image on said printing member, the image consisting of ink-accepting areas on an ink-repellent background or ink-repellent areas on an ink-accepting background. According to a preferred embodiment, the coating comprises hydrophobic thermoplastic polymer particles in a hydrophilic binder.

[0007] Cleaning liquids for lithographic printing plates have been described in **EP-A-1118470, EP-A-1118471** and **EP-A-1118472** all filed on 18-01-2000 and **DE-A-42 16 636.**

[0008] US 4,847,182 discloses a method for developing a photopolymer printing plate, which includes portions of cured and portions of uncured photopolymer. The developer comprises terpenes alone, terpenes mixed with organic non-solvents, or terpenes emulsified with water and can produce images superior to those obtained with commercially available solvents currently used in such applications.

[0009] The known cleaning liquids typically contain solvents which are harmful to hoses, pumps and sealings and/or require a very thorough rinsing with water because these liquids are not compatible with the coating step in the next printing cycle.

[0010] In the known on-press coating methods, the cleaning of the lithographic substrate often fails because no suitable compromise can be found between the chemical reactivity of the cleaning liquid versus the ink-accepting areas which have to be removed on the one hand and the required inertness of said cleaning liquid versus

the fragile lithographic surface on the other hand. A typical lithographic surface is mechanically as well as chemically quite vulnerable. A lithographic surface consists generally of a micro-pore structure in order to obtain a good differentiation between the spreading properties of the ink and the fountain. Anodised aluminium plates comprise a lithographic surface containing one or more metal oxides on which absorption phenomena can take place. These metal oxides are very susceptible to chemical conversion into forms that are no longer lithographically active.

[0011] The above mentioned micro-porosity of a lithographic surface is also highly susceptible to mechanical damage. The presence of solid particles in cleaning liquids, which is often required for efficient mechanical cleaning of the lithographic surface, results inevitably in a disturbance of the micro-structure of said surface. Because ink and the coated imaging layer penetrate in the micro-pore structure, it is necessary to carry out a vigorous cleaning so as to avoid ghost images in the subsequent printing cycles, which are due to an incomplete removal of the previous image.

[0012] A suitable cleaning liquid is a micro-emulsion of an organic compound in water. The cleaning liquid consumed in each cleaning step needs to be collected and its disposal represents a problem for the user.

SUMMARY OF THE INVENTION

[0013] It is an object of the present invention to provide a method which offers a convenient solution for disposing of a cleaning liquid that is capable of removing ink-accepting areas from a lithographic printing master.

[0014] It is a further object of the present invention to provide a method for removing ink-accepting areas of a lithographic printing master. These objects are realised by the method of claim 1. The micro-emulsion defined in claim 1 effectively removes the ink-accepting areas of the printing master. No ghost images are observed after several (>10) print cycles of coating, exposure, printing and cleaning. Rubber hoses and seals are not affected by the cleaning liquid. A simple heating step suffices for inducing a phase separation, so that the water of the used micro-emulsion can easily be recycled.

[0015] Further objects of the present invention will become clear from the description hereinafter.

[0016] Preferred embodiments of the method of the present invention are defined in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The present invention is illustrated by way of reference to the following drawings without however the intention to limit the invention thereto:

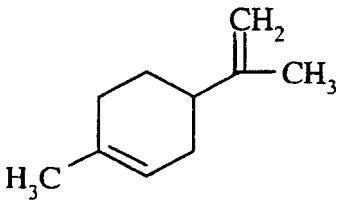
FIG. 1 is a schematic representation of a device that is suitable for heating and separating the micro-emulsion described herein.

DETAILED DESCRIPTION OF THE INVENTION

[0018] With the term micro-emulsion as used herein an emulsion is defined having a particle size of less than 1μm and preferably less than 200nm.

[0019] According to the present invention a direct-to-plate method of lithographic printing is provided according to claim 1, comprising removal of ink-accepting areas by a specified micro-emulsion and, treating said specified micro-emulsion according to a method comprising in a first step the heating of the micro-emulsion to a temperature above 50°C whereby an aqueous and an organic phase are obtained and in a second step the separating of the obtained phases. The heating can be performed by known methods such as a heat resistor, microwaves etc. The phases can be separated by the known liquid separation techniques e.g. membrane processes or diffusional separation processes, or the method described below while discussing FIG. 1.

[0020] The micro-emulsion comprises a mixture of a cyclic organic compound containing at least one double bond, an alcohol, water and an emulsifying agent. Suitable examples of cyclic organic compounds having at least one double bond are: toluene, xylene, propylbenzene, 3-methyl-6-isopropyl-1,4-cyclo-hexadiene, 3-(1-methylpropylidene)-cyclohexene, 6-methyl-1-(1-methylethyl)-1,3-cyclohexadiene, 4-methyl-5-(1-methylethenyl)-cyclohexene, o-mentha-4,6-diene, o-mentha-2(8), 3-diene, o-mentha-1(7),4-diene, 6-methyl-1-(1-methylethenyl)-cyclohexene, 1-methyl-5-(1-methylethyl)-1,4-cyclohexadiene, isosylvestrene, 4-ethyl-3-ethylidene-cyclohexene, 1-ethyl-6-ethylidene-cyclohexene, o-mentha-3,6-diene, o-mentha-2,5-diene, o-mentha-1,4-diene, 3-methyl-4-isopropenyl-1-cyclohexene, 3-methyl-5-isopropenyl-1-cyclohexene, 2-methyl-3-propyl-1, 3-cyclohexadiene, 1-methyl-6-propylidene-cyclohexene, tetranaphtalene and preferably dipentene (formula II).



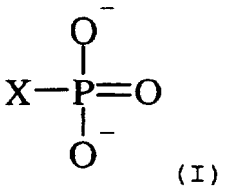
(II)

[0021] The alcohol is preferably an aliphatic alcoholether. Suitable examples of such aliphatic alcoholethers are: methoxypropanol, propoxyethanol, 2-butoxyethanol, propanol, 2-(propyloxy)ethanol, fenoxyethanol, benzylalcohol, butoxypropanol, ethoxypropanol, 1-isobutoxy-2-propanol, 1-isomethoxy-2-propanol, 1-propoxy-2-propanol, diacetone alcohol, tetrahydrofurfuryl alcohol, cathechol, trimethylolpropane, ethanediol, propanediol, and butanediol. Highly preferred is 2-butoxyethanol. The

alcohol and cyclic compound are preferably present in an amount of 5 to 50 wt.% each and most preferably in an amount of 10 to 30 wt.% each.

[0022] The emulsifying agent is preferably an anionic compound and/or preferably comprises an alkylene oxide chain. Suitable examples are Akypo OP80, Akypo RO90 (both commercially available from Chem-Y), Empicol ESC70 (commercially available from Albright & Wilson), Aerosol OT (commercially available from AM Cynamid). The emulsifying agent is preferably present in an amount of 5 to 50 wt.% and most preferably in an amount of 10 to 30 wt.%. The above alcohol may also function as a co-emulsifying agent.

[0023] Furthermore the micro-emulsion can comprise a compound according to formula I:



(I)

wherein X is OH, O^- or a polymer backbone.

The counter ion can be, depending on the pH, H or a metal such as an alkali or alkaline earth metal or a transition metal, e.g. chromium.

[0024] Suitable examples of the compound according to formula (I) are polyvinylphosphonic acid, copolymers of vinylphosphonic acid with acrylic acid and vinyl acetate, acrylamidoisobutylene phosphonic acid. Preferably the compound is phosphoric acid or a phosphate salt. The compound is preferably present in an amount of 1.5 to 6 wt.%.

[0025] The micro-emulsion can be used in a method for removing ink-accepting areas of a lithographic printing master. The micro-emulsion is capable of removing the ink remaining on the printing areas as well as the hydrophobic coating itself that gives rise to the ink-accepting properties of the printing areas.

[0026] The above micro-emulsion is very suitable for removing the ink-accepting areas from a printing master which is obtained by coating a hydrophilic substrate with a coating solution containing hydrophobic thermoplastic polymer particles and a hydrophilic binder. The imaging layer thus obtained is negative-working, i.e. hydrophobic areas are formed upon exposure. These areas define the printing areas of the master. It is believed that the applied heat induces a coagulation of the hydrophobic polymer particles, thereby forming a hydrophobic phase, whereas the hydrophobic polymer particles remain unchanged in the non-heated areas. Coagulation may result from heat-induced softening or melting of the thermoplastic polymer particles.

[0027] The imaging layer which is preferably used in the present invention contains a coating comprising hydrophobic thermoplastic polymer particles having an average particle size between 40 nm and 2000 nm, and more preferably between 40 nm to 200 nm, so as to improve sensitivity and throughput and to avoid scumming. Furthermore the polymer particles preferably have a coagulation temperature above 50°C and more preferably above 70°C. There is no specific upper limit to the coagulation temperature of the polymer particles, however the temperature should be sufficiently below the decomposition temperature of the polymer particles. Preferably the coagulation temperature is at least 10°C below the temperature at which the decomposition of the polymer particles occurs.

[0028] Preferred examples of thermoplastic hydrophobic polymer particles for use in the present invention have a Tg above 80°C. The weight average molecular weight of the polymers may range from 5,000 to 5,000,000 g/mol. Preferably the polymer particles are selected from the group consisting of polyvinyl chloride, polyvinylidene chloride, polyesters, polyurethanes, polyacrylonitrile, polyvinyl carbazole etc., and copolymers or mixtures thereof. The most preferred examples are polystyrene and polymethylmethacrylate or copolymers thereof.

[0029] The polymer particles are present as a dispersion in the coating solution and may be prepared by the methods disclosed in US 3,476,937. Another method especially suitable for preparing an aqueous dispersion of the thermoplastic polymer particles comprises:

- dissolving the hydrophobic thermoplastic polymer in an organic solvent which does not mix with water,
- dispersing the thus obtained solution in water or in an aqueous medium and
- removing the organic solvent by evaporation.

[0030] Suitable hydrophilic binders for use in the present invention are preferably water-soluble (co)polymers for example synthetic homo- or copolymers such as polyvinylalcohol, a poly(meth)acrylic acid, a poly(meth)acrylamide, a polyhydroxyethyl(meth)acrylate, a polyvinylmethylether or natural binders such as gelatine, a polysaccharide such as e.g. dextran, pullulan, cellulose, arabic gum, alginic acid, inuline or chemically modified inuline.

[0031] In addition, the coating solution may also contain surfactants that can be anionic, cationic, non-ionic or amphoteric. Perfluoro surfactants are preferred. Particularly preferred are non-ionic perfluoro surfactants. Said surfactants can be used alone or preferably in combination.

[0032] The coverage of the coated layer ranges preferably from 0.3 to 20 g/m^2, more preferably from 0.5 to 5 g/m^2. The amount of hydrophobic thermoplastic polymer particles contained in the coated layer is preferably between 50 and 90 wt.% and more preferably between 60 and 80 wt.% of the total weight of said layer.

[0033] The coating solution is preferably applied to the substrate by spraying or jetting but other coating techniques may also be used.

[0034] The substrate used in the present invention can be a plastic support or a ceramic but is preferably a metal such as aluminium. The substrate has a hydrophilic surface and is preferably characterised by a roughness value of at least 0.2 μm, more preferably of at least 0.3 μm, e.g. electrochemically and/or mechanically grained and anodised aluminium. The substrate can be a sheet-like material such as a plate but, alternatively, the coating solution may be applied directly to the plate cylinder of a rotary printing press, said cylinder thereby acting as the substrate. The lithographic substrate can also be a seamless sleeve printing plate, obtained by e.g. soldering a plate into a cylindrical form by means of a laser. The sleeve then can be slid around the plate cylinder instead of mounting a conventional printing plate. More details on sleeves are given in "Grafisch Nieuws" , 15, 1995, page 4 to 6.

[0035] The exposure of the imaging layer obtained by coating the above coating solution on the lithographic substrate can be carried out by means of direct thermal recording using e.g. a thermal head, or by irradiation with high intensity light. In the latter embodiment, the heat-sensitive material preferably comprises a compound capable of converting light into heat, preferably a compound having sufficient absorption in the wavelength range of the light source used for image-wise exposure. Particularly useful compounds are for example dyes and in particular infrared dyes as disclosed in EP-A 908 307 and pigments and in particular infrared pigments such as carbon black, metal carbides, borides, nitrides, carbonitrides, bronze-structured oxides and oxides structurally related to the bronze family but lacking the A component e.g. $WO_{2.9}$. It is also possible to use conductive polymer dispersions such as polypyrrole, polyaniline or polythiophene-based conductive polymer dispersions. The lithographic performance and in particular the print endurance obtained depends i.a. on the heat-sensitivity of the imaging material. In this respect it has been found that carbon black yields very good and favourable results.

[0036] Image-wise exposure in the method of the present invention is preferably an image-wise scanning exposure involving the use of a laser or L.E.D. Preferably used are lasers that operate in the infrared or near-infrared, i.e. wavelength range of 700-1500 nm. Most preferred are laser diodes emitting in the near infrared.

[0037] The printing method of the present invention will be further described hereinafter according to a preferred embodiment. First, a grained and anodised aluminium plate is mounted on the plate cylinder of a rotary printing press. Then, the coating solution described above is sprayed on the hydrophilic lithographic surface of the plate, so as to form a continuous imaging layer. Preferred values of the spraying parameters have been defined in EP-A no. 99203064 and EP-A no. 99203065, both filed on 15th September 1999. The imaging layer is then image-wise exposed by a laser device which is integrated in the printing press e.g. as described in **US-P-5 163 368** and **US-P-5 174 205,** whereby the exposed areas are converted to hydrophobic ink-accepting areas while the unexposed areas remain hydrophilic. The hydrophobic areas define the printing areas of the master. Subsequently, printing is started by applying ink and a fountain solution to the printing master. In order to dissolve and remove the non-exposed areas of the coated layer effectively, only fountain solution is preferably supplied during a few revolutions of the press (about 10), and then also ink is fed to the plate. After the press run, the lithographic substrate is recycled by treatment with a micro-emulsion as described above. Finally, the substrate can be rinsed with water or an aqueous solution and dried and then, a new printing cycle can be started by spraying the coating solution to the recycled substrate.

[0038] The cleaning step can be executed in a cleaning unit similar to the known blanket cleaning systems. According to that embodiment, a cloth is preferably moistened with the micro-emulsion, contacted with the printed plate during 1 to 50, more preferably during 2 to 10 revolutions with a contacting pressure between 10^4 and $6x10^5$ Pa at a rotation speed in the range of 2 to 50 m/min. Afterwards the contact between the printing surface and the cleaning cloth is disrupted and the cloth is transported until a dry and clean part of the cloth is available.

[0039] The micro-emulsion can also be applied by spraying, coating or jetting the liquid on the lithographic substrate or on the cloth. The removal of the ink-accepting areas can also be effected with another absorbing medium than a cloth. Cleaning can also be effected by combining the treatment with the micro-emulsion of the present invention with other means of mechanical cleaning such as a rotating brush or by jetting water or a volatile medium such as air, a solvent or dry ice pellets. Also vacuum extraction can be used during the cleaning treatment.

[0040] After the cleaning step, the used micro-emulsion containing dissolved ink and hydrophobic coating, is treated as described above. The obtained aqueous phase can be used for preparing fresh micro-emulsion or for rinsing the substrate before starting a new print cycle of coating, printing and cleaning.

[0041] All the steps of the method of the present invention are preferably performed on-press. Alternatively, the lithographic substrate can also be mounted on a drum in a dedicated coating apparatus (off-press coating) and subsequently be mounted on a plate setter for image-wise exposure (off-press exposure). Then, the printing master thus obtained can be mounted on a press cylinder and printing is started by supplying ink and a fountain solution. After the press run, the plate can be cleaned as described above, either on-press or in a dedicated cleaning apparatus, and the recycled substrate can then be used again in a next printing cycle. The used micro-emulsion can be collected and separated in a device that may be integrated in the printing press or in a stand-alone apparatus.

[0042] A preferred means for separating the obtained phases is described in 'Perry's Chemical Engineers

Handbook', ed. McGraw-Hill, 1999,Section 15 'Liquid-Liquid Extraction and Operations and Equipment', and schematically represented in FIG.1.

[0043] A housing (4) containing an inlet (2) and an outlet (3). In this housing, a heating element (10) is constructed, able to maintain a constant temperature of 50°C. A conductivity measurement cell (5) is used to maintain the level of water lower than the outlet for the organic based compounds (7). This level is regulated both by a pump before the inlet (2) and a valve system after outlet (3) assures that the part (1) is filled with water and part (6) is filled with organic components. This system can be used in a discontinuous way, batchwise, but also in a continuous process by introducing plates (8) to avoid flowing of the micro-emulsion into the outlet (7).

[0044] Furthermore according to the present invention a printing apparatus according to claim 11 is provided, comprising a print cylinder, means for mounting a reusable substrate having a hydrophilic surface to the print cylinder, means for coating an imaging layer onto the hydrophilic surface, means for image-wise exposing the imaging layer, means for applying ink and fountain solution to the print cylinder. Additionally the printing apparatus comprises means for supplying micro-emulsion to the print cylinder and means for treating the micro-emulsion as described above.

Examples

[0045] The following examples illustrate the present invention without limiting it thereto. All parts and percentages are by weight unless otherwise specified.

Example 1

Preparation of the lithographic base

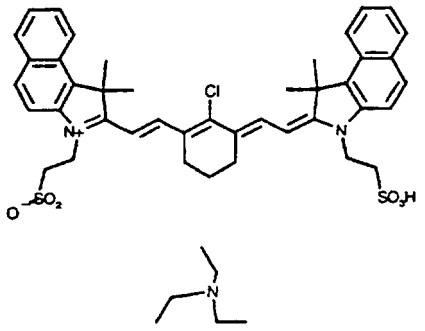
[0046] A 0.30 mm thick aluminium foil was degreased by immersing the foil in an aqueous solution containing 5 g/l of sodium hydroxide at 50°C and rinsed with demineralized water. The foil was then electrochemically grained using an alternating current in an aqueous solution containing 4 g/l of hydrochloric acid, 4 g/l of hydroboric acid and 5 g/l of aluminium ions at a temperature of 35°C and a current density of 1200 A/m^2 to form a surface topography with an average centre-line roughness Ra of 0.5 μm.

[0047] After rinsing with demineralized water the aluminium foil was then etched with an aqueous solution containing 300 g/l of sulphuric acid at 60°C for 180 seconds and rinsed with demineralized water at 25°C for 30 seconds.

[0048] The foil was subsequently subjected to anodic oxidation in an aqueous solution containing 200 g/l of sulphuric acid at a temperature of 45°C, a voltage of about 10 V and a current density of 150 A/m^2 for about 300 seconds to form an anodic oxidation film of 3.00 g/m^2 of Al_2O_3 then washed with demineralized water, post-treated with a solution containing polyvinylphosphonic acid and subsequently with a solution containing aluminium trichloride, rinsed with demineralized water at 20°C during 120 seconds and dried.

Preparation of spray solution

[0049] A 2.61% wt solution in water was prepared by mixing polystyrene latex, a heat absorbing compound and a hydrophilic binder. After spraying and drying, the resulting layer contained 75% wt. of the polystyrene latex, 10 % wt. of the heat absorbing compound, presented in formula (I) and 15% wt. polyacrylic acid (Glascol E15, commercially available at N.V. Allied Colloids Belgium).



Formula (I)

Preparation of the heat-mode imaging element

[0050] The spray solution was sprayed on above mentioned lithographic base. Therefore, the lithographic base was mounted on a drum, rotating at a line speed of 164 m/min. The imaging element was coated by a spray nozzle moving in transverse direction at a speed of 1.5 m/min. The spray nozzle was mounted at a distance of 80mm between nozzle and receiving substrate. The flow rate of the spray solution was set to 7 ml/min. During the spray process an air pressure of 90 psi was used on the spray head. This layer was dried at a temperature of 70°C during the spraying process and additionally during 30 s.

[0051] The spray nozzle was of the type SUJ1, an air assisted spray nozzle, commercially available from Spraying Systems Belgium, Brussels.

Printing step

[0052] The above mentioned heat mode imaging element was imaged in a Creo 3244™ external drum platesetter at 2400 dpi at 150 rpm with a power setting of 15.5 Watt. The imaged plates were printed on a GT046 printing press (from Heidelberger Druckmaschinen) with K+E 800 Skinnex ink, fountain (Combifix XL (4%) - isopropylalcohol (10%) in water) to a run length of 5000. The print quality was evaluated.

Preparation of micro-emulsion A:

[0053] 10 g of dipentene (commercially available from Sigma-Aldrich) was mixed with 20 g of Akypo OP80. While stirring, 14 g of butoxyethanol as added. In the next step, 50 g of water was added while stirring.

Cleaning step:

[0054] 10 ml/m^2 of micro-emulsion A was sprayed on the plate which still contained the adhered ink, using a manual pressure sprayer commercially available from Premal Sprayer Division of Precision Valve corporation, New York.

[0055] After a time lapse of 30 s during which the micro-emulsion was allowed to interact with the coating, the plate was cleaned by use of a standard high pressure washer, using a volume of water of 10 litre/m^2.

[0056] Finally, the plate was dried by pressurised air of room temperature until the plate surface seemed dry visually.

[0057] The used emulsion was collected and heated up to 50°C in an apparatus according to FIG.1. After 30s the organic compounds were completely separated from the water. The water was collected and used for rinsing substrates after the ink accepting areas were removed with micro-emulsion as described above. The substrates were then recoated with spray solution as described above.

Claims

1. Direct-to-plate method of lithographic printing with a reusable substrate having a hydrophilic surface comprising the steps of:

   (a) making a negative-working imaging layer by coating on the hydrophilic surface a solution comprising hydrophobic thermoplastic particles and a hydrophilic binder;
   (b) making a printing master having ink-accepting areas by image-wise exposing the imaging layer to heat or light;
   (c) applying ink and fountain solution to the printing master;
   (d) removing the ink-accepting areas from the printing master by supplying a micro-emulsion to the imaging layer, said micro-emulsion comprising a mixture of a cyclic organic compound containing at least one double bond, an alcohol, water and an emulsifying agent,
   (e) treating the micro-emulsion according to a method comprising the steps of:

      (1) heating the micro-emulsion to a temperature above 50°C thereby obtaining an aqueous phase and an organic phase and

      (2) separating the aqueous phase from the organic phase.

2. Direct-to-plate method according to claim 1 comprising the additional step (f) wherein the aqueous phase is used for preparing fresh micro-emulsion or for rinsing the substrate after step (d) or before step (a).

3. Method according to any of the preceding claims wherein the cyclic organic compound is dipentene.

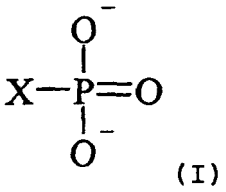
4. Method according to any of the preceding claims wherein the alcohol is an aliphatic alcoholether.

5. Method according to claim 4 wherein the aliphatic alcoholether is butoxyethanol.

6. Method according to any of the preceding claims wherein the emulsifying agent is an anionic compound.

7. Method according to any of the preceding claims wherein the emulsifying agent comprises an alkylene-oxide chain.

8. Method according to any of the preceding claims wherein the micro-emulsion further comprises a compound according to formula I:



(I)

   wherein X is OH, O^- or a polymer backbone.

9. Method according to any of the preceding claims wherein the reusable substrate is a plate cylinder of a rotary press or a plate or sleeve mounted on a plate cylinder of a rotary press.

10. Method according to any of the preceding claims wherein the solution or the micro-emulsion is sprayed or jetted onto the substrate.

11. A printing apparatus comprising:

   - a print cylinder
   - means for mounting to the print cylinder a reusable substrate having a hydrophilic surface
   - means for coating an imaging layer on the hydrophilic surface
   - means for image-wise exposing the imaging layer

- means for applying ink and fountain solution to the print cylinder
- means for supplying micro-emulsion to the print cylinder
- means for treating the micro-emulsion according to the method of claim 1.

Revendications

1. Procédé d'impression lithographique numérique à gravure directe de la plaque (direct-to-plate) avec un substrat réutilisable possédant une surface hydrophile, comprenant les étapes consistant à :

(a) fabriquer une couche de formation d'image à effet négatif en enduisant la surface hydrophile d'une solution comprenant des particules thermoplastiques hydrophobes et un liant hydrophile ;
(b) fabriquer une matrice d'impression possédant des zones acceptant l'encre en exposant en forme d'image la couche de formation d'image à la lumière ou à la chaleur ;
(c) appliquer de l'encre et une solution de mouillage sur la matrice d'impression ;
(d) éliminer les zones acceptant l'encre de la matrice d'impression en amenant une microémulsion à la couche de formation d'image, ladite microémulsion renfermant un mélange d'un composé organique cyclique contenant au moins une liaison double, d'un alcool, d'eau et d'un émulsifiant;
(e) traiter la microémulsion conformément à un procédé comprenant les étapes consistant à :

(1) chauffer la microémulsion jusqu'à une température supérieure à 50°C pour obtenir ainsi une phase aqueuse et une phase organique et
(2) séparer la phase aqueuse et la phase organique.

2. Procédé numérique à gravure directe de la plaque selon la revendication 1, comprenant l'étape supplémentaire (f) pendant laquelle la phase aqueuse est utilisée pour préparer de la microémulsion fraîche ou pour rincer le substrat après l'étape (d) ou avant l'étape (a).

3. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le composé organique cyclique est le dipentène.

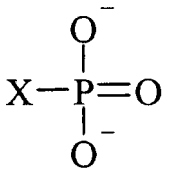
4. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'alcool est un éther d'alcool aliphatique.

5. Procédé selon la revendication 4, **caractérisé en ce que** l'éther d'alcool aliphatique est le butoxyéthanol.

6. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'émulsifiant est un composé anionique.

7. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'émulsifiant renferme une chaîne d'oxyde d'alkylène.

8. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la microémulsion renferme en outre un composé répondant à la formule I:



(I)

dans laquelle X représente OH, O^- ou une chaîne principale polymère.

9. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ledit substrat réutilisable est un cylindre porte-plaque d'une presse rotative ou encore une plaque ou un manchon accroché sur un cylindre porte-plaque d'une presse rotative.

10. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la solution ou la microémulsion est pulvérisée ou projetée sur le substrat.

11. Appareil d'impression comprenant :

- un cylindre d'impression
- des moyens servant à accrocher un substrat réutilisable possédant une surface hydrophile au cylindre d'impression
- des moyens servant à enduire la surface hydrophile d'une couche de formation d'image
- des moyens servant à exposer la couche de formation d'image en forme d'image
- des moyens servant à appliquer de l'encre et une solution de mouillage sur le cylindre d'impression
- des moyens servant à amener de la microémulsion au cylindre d'impression
- des moyens servant à traiter la microémulsion conformément au procédé tel que défini dans la revendication 1.

Patentansprüche

1. Ein durch die folgenden Schritte **gekennzeichnet**es lithografisches Direct-to-Plate-Druckverfahren mit einem wieder verwertbaren Substrat mit einer hydrophilen Oberfläche :

   (a) Herstellung einer negativarbeitenden bilderzeugenden Schicht durch Beschichtung der hydrophilen Oberfläche mit einer hydrophobe thermoplastische Teilchen und ein hydrophiles Bindemittel enthaltenden Lösung,
   (b) Herstellung eines Druckmasters mit farbanziehenden Bereichen durch bildmäßige Belichtung der bilderzeugenden Schicht unter Verwendung von Wärme oder Licht,
   (c) Auftrag von Druckfarbe und Feuchtwasser auf den Druckmaster, (d) Entfernung der farbanziehenden Bereiche vom Druckmaster durch Zuführung einer Mikroemulsion zu der bilderzeugenden Schicht, wobei die Mikroemulsion ein Gemisch aus einer wenigstens eine Doppelbindung enthaltenden, organischen Ringverbindung, einem Alkohol, Wasser und einem Emulgiermittel umfasst;
   (e) Behandlung der Mikroemulsion nach einem Verfahren mit den Schritten:

      (1) Erhitzen der Mikroemulsion auf eine Temperatur höher als 50°C zum Erhalten einer wässrigen Phase und einer organischen Phase und
      (2) Trennen der wässrigen Phase und der organischen Phase.

2. Direct-to-Plate-Verfahren nach Anspruch 1 mit dem zusätzlichen Schritt (f), in dem die wässrige Phase zum Ansetzen frischer Mikroemulsion oder zum Spülen des Substrats nach Schritt (d) oder vor Schritt (a) verwendet wird.

3. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** es sich bei der organischen Ringverbindung um Dipenten handelt.

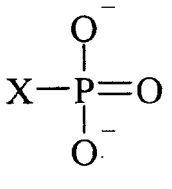
4. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** es sich beim Alkohol um einen aliphatischen Alkoholether handelt.

5. Verfahren nach Anspruch 4, **dadurch gekennzeichnet, dass** es sich beim aliphatischen Alkoholether um Butoxyethanol handelt.

6. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** es sich beim Emulgiermittel um eine anionische Verbindung handelt.

7. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** das Emulgiermittel eine Alkenoxid-Kette umfasst.

8. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** die Mikroemulsion weiterhin eine der nachstehenden Formel I entsprechende Verbindung umfasst:



(I)

   in der bedeuten X OH, O^- oder eine Polymerhauptkette.

9. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** es sich beim wieder verwertbaren Substrat um einen Plattenzylinder einer Rotationsdruckpresse oder eine auf einen Plattenzylinder einer Rotationsdruckpresse aufgespannte Platte oder hülsenförmige Platte handelt.

10. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** die Lösung oder die Mikroemulsion auf das Substrat aufgesprüht oder ausgestoßen wird.

11. Druckmaschine allerdings bestehend aus :

   - einem Druckzylinder
   - Mitteln zum Aufspannen eines wieder verwertbaren Substrats mit einer hydrophilen Oberfläche auf den Druckzylinder
   - Mitteln zum Beschichten der hydrophilen Oberfläche mit einer bilderzeugenden Schicht
   - Mitteln zum bildmäßigen Belichten der bilderzeugenden Schicht
   - Mitteln zum Auftragen von Druckfarbe und Feuchtwasser auf den Druckzylinder
   - Mitteln zum Zuführen einer Mikroemulsion zu dem Druckzylinder
   - Mitteln zum dem Verfahren nach Anspruch 1 entsprechenden Behandeln der Mikroemulsion.

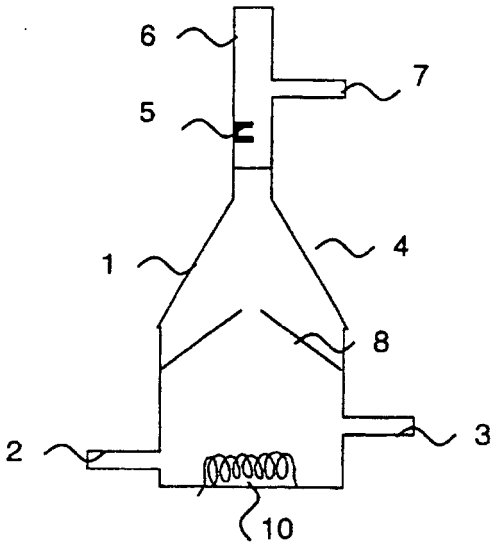


FIG.1