

Method and Device for Removing Swellable
Polymer Particles from a Liquid Dispersion

Description:

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The invention relates to a method and to a device for removing swellable polymer particles from a liquid dispersion.

- 10 In known methods of producing conductor structures on printed circuit boards, the board laminate coated with copper is firstly coated with photo-sensitive polymer combinations (photo resists), the coated layer is then exposed to electromagnetic radiation in order to
- 15 produce a structure, and the structure is developed on the resist.

The undeveloped portions of the resist layer are removed, the copper layer no longer covered with resist

20 is etched off, and the remaining resist portions are finally treated by bringing the printed circuit board into contact with a coating removal means, forming a dispersion of the removed resist in the form of resist particles in the coating removal means.

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The coating removal solution is used in order to remove the resist from a printed circuit board, so that a

circuit type of a desired arrangement is obtained. In known methods, the coating removal solution is thereafter either disposed of, or the resist is removed therefrom, so that the solution can be re-used.

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The last-names procedure is preferred for economic reasons. According to removal methods known in prior art, the filtering of the resist particles leads to an alteration in the coating removal solution. On the
10 other hand treatment of the dispersion with a filtering agent in an appropriate device is necessary, considerable problems arising such for example as clogging of the filter, care and servicing of the device and removal of the auxiliary and residual
15 materials. Moreover the filtering process for the coating solution containing the particles for a sufficient separation is both time-consuming and labour-intensive, and is thus uneconomic.

20 According to the conventionally used method, separation of the resist particles from coating removal solutions is effected for example by means of a hydrocyclone filter, in which a solution is pumped through a conical hollow member and thus subjected to rapid rotary
25 movements. The liquid is turbulently moved about, and the resultant centrifugal force causes separation of approximately 40% of the resist particles from the

solution by means of screen filtering. The filtered solution with the resist particles not removed by filtering is again prepared for renewed use in the coating removal method. The retained particles are
5 removed from the filter screen in an appropriate way such for example as by scraping or by rinsing with water, and said particles are then disposed of.

As most of the particles remain behind in the filter
10 solution, the effectiveness of the solution as a means of removing a resist coating gradually decreases, so that the filter solution requires to be replaced by fresh solution relatively frequently (weekly or more frequently). Moreover, manufacture of printed circuit
15 boards in this case generally requires to be stopped, leading to a loss of production time and costs for non-productive interruption of production.

Other methods however are known of separating the
20 removed resist from the removal solutions. Thus, in US Patent 47 60 014 there is described a device for manufacturing and coating removal of printed circuit boards in which, in order to remove the resist particles from the dispersion formed, an acid is added
25 to the resist removal solution, so that the resist can coagulate into reasonably non-adhesive small particles, which can then be removed relatively simply

from the fluid phase. It should be noted, that the coating removal solution has been changed after this treatment.

5 Other publications disclose various filtering methods and devices suitable for this purpose, whereby the liquid containing the solid particles is separated by means of filter materials, for example steel wool, woven metal meshes or also resilient fibre materials
10 such as glass fibres, or plastic strips. Such methods and devices are used in particular for separating silver from used solutions which are made use of for the photographic process (US-A-50 26 029, US-A-44 41 697, US-A-42 40 617, US-A-37 44 995, US-A-30 43 432,
15 US-A-29 05 323, US-A-37 92 845, US-A-43 25 732, US-A-46 62 613), or for neutralising used solutions and wastes of solid materials from the solutions (US-A-46 08 177).

There is described in US Patent 46 61 253 a device for
20 solid/liquid separation of animal waste from an aqueous carrier flow via a screen, which is held at an angle of approximately 60° to the horizontal, oscillating high pressure water jets impinging on the lower surface of the screen so that blockage of the screen holes with
25 materials consisting of particles is prevented.

There is described in the German Laying-Open Document
36 38 371 A1 a device for separating solid matter
contained in a liquid, particularly in waste water,
having an arcuate or oblique screen which is inclined
5 at an angle to the vertical, so that solid matter
separated by the screen can slide downwards thereon.

There is described in GB-A-20 61 748 a liquid/solid
separating device in which a plurality of separating
10 screens is provided at variously inclined positions
relative to the vertical, and in which the liquid
containing the solid matter is placed from above on the
screens.

15 There is described in GB-A-20 50 855 a device for
removing curdled milk from whey, which likewise
substantially has an inclined screen, upon which the
liquid is placed from above, in order to undertake the
separation.

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There is described in US Patent 46 26 329 (Uphus) the
physical separation of liquids and solids in which a
carrier flow with solid bodies dispersed therein flows
through a screen, whose inclination to the horizontal
25 can be changed. An inverted hopper at the inlet for
the liquid flow into the device, and partition walls
arranged in the device, are intended to reduce the

speed of the carrier flow. The device provides no means for returning the separated liquid to the treatment process in which the liquid has taken up the dispersed solid bodies.

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There is described in US Patent 38 33 123 a device with an inclined screen, preferably for treatment of flows of material occurring during paper manufacture, by means of which a carrier flow can be separated into its
10 solid and liquid components. The device contains partition walls in order to reduce the surface tension of the filtrate, which adheres to the lower side of the screen. This type of device is similar to the device described in US-A-46 61 253. Here also sprayed water
15 jets are described, in order that the screen does not clog.

There is described in US Patent 48 67 879 a device for mechanically cleaning liquids, in which a rotationally
20 symmetrical screen is disposed in an appropriate screen chamber at an angle of 30° to 60° to the axis of said screen chamber, and in which a device is provided by means of which residues adhering to the screen can be removed by continuous wiping.

25

When the known methods are used, the contact time of the particles to be removed with the solution is

relatively long, so that there is a risk of dissolution of swellable particles, particularly resist particles, in said solution. None of the publications cited contains a solution for the problem of keeping the
5 duration of the process as short as possible.

Therefore the problem underlying the present invention was to avoid the disadvantages of prior art and to produce a method and a device for removing swellable
10 polymer particles from a liquid dispersion, in which the separating means used to remove polymer particles from the dispersion does not clog, and the process length and residence time of the particles in the dispersion are kept as low as possible.

15

This problem is solved by Claims 1, 7, 8 and 21. Preferred embodiments of the invention are given in the sub-claims.

20 The invention in particular involves a method for removing swellable polymer particles from a liquid dispersion, comprising a solution and polymer particles contained therein, involving the following method steps:

25

a) homogenisation of the dispersion,

- a) uniform distribution and bringing into contact of the homogenised dispersion on a separating means inclined relative to the vertical for mechanical separation of the resist particles from the solution,

5

so that the polymer particles are continuously removed from the dispersion.

The device for carrying out the method comprises

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- a) means for feeding the dispersion to a homogenising and distributing device,
b) homogenising and distributing devices for bringing the homogenised dispersion into contact with a separating device,

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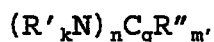
- a) separating devices for separating the resist particles from the solution.

20 The method can in particular also be used to remove resists from printed circuit board surfaces with the method steps:

- a) bringing the printed circuit board surfaces into contact with a solution comprising

25

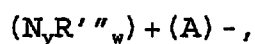
- a) compounds with the general structural formula



wherein R', R'' = hydrogen, hydroxyl, substituted or
 5 unsubstituted linear or branched alkyl, aryl or aralkyl
 groups with 1 to 10 carbon atoms
 k - 1 or 2,
 n, m are whole numbers from 1 to 5 and
 the compounds contain at least one carbon hydroxyl
 10 group,

a) an ionic nitrogen compound with the general
 formula:

15



wherein R''' = hydrogen, a hydroxyl substituted or
 20 unsubstituted linear or branched alkyl, aryl or aralkyl
 group with 1 to 10 carbon atoms with substituents,
 selected from the functional groups containing
 hydrogen, halogen, oxygen, nitrogen or sulphur atoms,
 A = an inorganic or organic anion,
 25 y is a whole number from 1 to 3, and
 w is a whole number from 4 to 8,

- a) an alkali or alkaline earth metal hydroxide,
a dispersion containing resist particles being formed,
- 5 a) separation of the resist particles from the dispersion by the method according to the invention, forming a solution substantially free of resist particles,
- 10 a) bringing the printed circuit board surface into contact with the solution substantially free of resist particles.

For homogenisation, the dispersion passes through
15 homogenising devices and is then brought into contact with appropriate separating means, in order to separate the particles from the liquid and to recover the solution after its separation into solution and polymer particles.

20

In particular, filters are used as separating means. Flat screens have proved particularly suitable, the screen plane being preferably inclined at an angle of approximately 35° to approximately 85° relative to the
25 horizontal, and whose inclination is adjustable. Cylindrical, rotatable screens disposed parallel to the

slot in the homogenising and distributing device may also be used as separating means.

In particular, screens with mesh openings of
5 approximately 60 μm to approximately 250 μm , preferably
90 μm to 150 μm and particularly preferably below 120
 μm , have proved favourable for effective separation.
Particularly well suited are screens with mesh openings
of approximately 75 μm to approximately 120 μm , with a
10 mesh density of approximately 50 meshes/cm up to
approximately 85 meshes/cm and a filament thickness of
approximately 35 μm to approximately 65 μm .

In order to obtain a homogeneous dispersion and a
15 regular application of the dispersion on the screen
surface, the dispersion before application to the
screen is firstly homogenised by means of a
homogenising and distributing device, preferably
comprising a plurality of perforated tubes disposed
20 coaxially one in the other, said device being disposed
above the separating device.

Homogenisation is effected in that the dispersion is
deflected a number of times within the device. The
25 inner tube of the device for this purpose has a
plurality of openings and is secured relative to the
outer tube. The outer tube has a slit disposed on the

peripheral line of the tube and extending substantially over the entire length of the tube, as a perforation.

The position of the tube is adjustable relative to the
5 position of the separating device in the vertical. The slot can preferably be disposed at an angle of approximately 45° to approximately 90° relative to the vertical. The slot is disposed to lie substantially opposite the screen.

10.

By selecting a sufficiently high flow speed of the dispersion in the entire treatment installation, residence times of the polymer particles in the dispersion of an average 20 seconds to 5 minutes are
15 achieved.

After separation of the polymer particles from the treatment solution, the latter can be prepared again for re-use, and returned to a treatment container.

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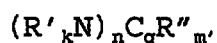
In the preferred embodiment according to the invention, the method and the device are used for separating solid bodies comprising swellable polymer resist particles from a solution for removing coatings from printed
25 circuit boards.

In the method according to the invention, swellable polymer resist particles contained in a coating removal solution are passed over a screen, the resist particles thus being separated from solution. Thereafter the
 5 coating removal solution is again brought into the process circuit for contact with the printed circuit board. During this cycle the resist particles remain in the coating removal means for only a minimum period of time. The residence time is defined as the period
 10 of time in which the swellable polymer particles, particularly the polymer particles produced during coating removal of printed circuit boards, come into contact with the solution.

15 There is used as a coating removal means an aqueous solution containing one or more compounds comprising

a) one or more amines, selected from a group of compounds with the general structural formula

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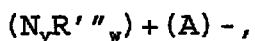


wherein R' , R'' = hydrogen, hydroxyl, substituted or unsubstituted linear or branched alkyl, aryl or
 25 aralkyl groups with 1 to 10 carbon atoms,
 $k = 1$ or 2 ,
 n , m are whole numbers from 1 to 5 and

the compounds contain at least one carbon-hydroxyl group,

a)

- 5 - an ionic nitrogen compound with the general structural formula:



- 10 wherein $R'{}^w$ = hydrogen, a hydroxyl, substituted or unsubstituted linear or branched alkyl, aryl or aralkyl group with 1 to 10 carbon atoms with substituents, selected from the functional groups containing hydrogen, halogen, oxygen, nitrogen or sulphur atoms,
- 15 A = an inorganic or organic anion,
y is a whole number from 1 to 3 and
w is a whole number from 4 to 8,

a) n alkali or alkali earth metal hydroxide.

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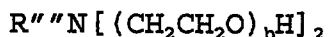
- There are used in particular as coating removal solutions aqueous solutions containing 1 to 80% by weight of at least one of the abovenamed compounds, preferably in a concentration of 5% by weight to
- 25 approximately 50% by weight. The pH value of the solution may lie in the range of approximately 9.5 to

approximately 13.5. Alkanolamines have proved particularly suitable amines.

Preferred coating removal agents are aqueous solutions of ethylenediaminetetraethanoic acid (EDTA) and their salts, teramethylammoniumhydroxide, choline and their derivatives, the derivatives containing functional groups containing for example esters, ethers, thiols or halogen. As particularly preferred coating removal agents the following are used:

alkanolamines, particularly methanolamine, ethanolamine, dimethanolamine, diethanolamine, trimethanolamine, triethanolamine and $\text{HO-C}_2\text{H}_4\text{-NH-C}_2\text{H}_4\text{-NH}_2$.

The coating removal solution can in addition contain at least one surface-active compound. Preferred surface active compounds are ethoxylised tertiary amines with the general formula



R''' being the residue of a fatty acid with approximately 6 to 20 carbon atoms and,
 $b = 2$ to approximately 50, which may be the same or different for both ethylene oxide groups.

The preferred surface-active compounds are non-ionic.

The temperature of the coating removal solution is set to approximately 40°C to approximately 60°C, preferably
5 to approximately 45°C to approximately 55°C.

In addition to means for feeding the dispersion to the homogenising and distributing device, the homogenising and distributing device itself, and the separating
10 device, the device comprises further devices for circulating the dispersion or solution through the coating removal installation and the device according to the invention.

15 Pumps or similar arrangements are suitable as devices for circulating the solution generally. More conventionally a pump is used as a circulating device in order to return the coating removal solution to the coating removal installation.

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Removal of the resist from the surfaces of the printed circuit board results in the dispersion comprising resist particles and coating removal solution which require to be separated. This is firstly passed into
25 the homogenising and distributing device and from there to the separating device, preferably a screen. The coating removal solution is collected in appropriate

containers, which are preferably disposed beneath the separating device. In addition, circulating devices ensure that the recovered coating removal solution is passed back to the resist removal installation.

5

The screen can be of any appropriate shape. It is preferably flat or cylindrical. The angular position of the adjustable slot in the homogenising device is defined as the angle formed by a line passing through
10 the centre line both of the slot and of the outer concentric tube.

In the usually preferred embodiment according to the invention there are associated with the filter
15 installation a rust-resistant screen with apertures of a size of approximately 60 μm to 150 μm , preferably from 90 μm to 110 μm . There is used as a coating removal solution an aqueous solution with ethanolamine in a concentration of 5% by weight to 40% by weight and
20 a surface-active compound at a content of approximately 0.05% by weight.

In a further device according to the invention, which will be described in detail in the following, a
25 cylindrical rotatable screen disposed parallel to the slot in the homogenising and distributing device is used in conjunction with a coating removal solution, in

order to bring about a separation of the resist particles from the solution.

The coating removal solution, enriched with resist particles due to the coating removal of the resist from the printed circuit boards, is conveyed to the homogenising and distributing device connected with the coating removal installation by means of conventional devices such for example as pumps, and is then passed on to a separating device, for example a filter device, such as a screen. The filtering device is preferably attached to devices which support the homogenising and distributing device or form a compact unit therewith, and is so mounted that the liquid dispersion from the homogenising and distributing device impinges on the filtering device. As the solution runs along the screen, the liquid component of the dispersion flows through and over the meshes of the screen into collecting containers disposed therebeneath, such for example as a tub or a tank, being exposed to a force of acceleration, for example gravity. The resist particles not dissolved in the coating removal solution remain behind on the surface of the screen or another filtering or separating device. The liquid in the storage containers is then preferably prepared again for coating removal by a connected device for

circulating the recovered solution, such for example as a pump.

In the method according to the invention, the coating
5 removal agent and the resist particles are in contact
with one another for a shorter time than is the case
with previous methods. A short residence time of
approximately 20 seconds to approximately 5 minutes and
preferably between approximately 30 seconds and
10 approximately 2 minutes is achieved. With methods
according to prior art the resist particles were in
contact with the coating removal solution for
approximately 10 minutes to approximately 30 minutes.

15 By means of the method according to the invention,
therefore, the resist particles dissolve in the coating
removal agent to a much lesser extent, so that the
coating removal solution may be re-used almost without
restriction. Re-use of the coating removal solution by
20 the method according to the invention is possible if
small amounts of fresh solution are added to the said
solution. Contrary to this, re-use of solutions freed
of resist particles by previous methods is only
possible to a limited degree. For example, a coating
25 removal solution may be prepared again more than 100
times. In this way the economy of the coating removal
solution is considerably increased, as much less

coating removal agent is consumed. In addition, the environment is under reduced stress due to the lower output of waste water and other wastes.

5 The device according to the invention is shown by way of example and diagrammatically in Figures 1 to 5.
Shown are:

Figure 1: a side elevation of the overall device;
10

Figure 2: a front elevation of the homogenising and distributing device and of the screen;

Figure 3: a view along section line 3-3 of Figure 2;
15

Figure 4: a further embodiment of the device;

Figure 5: a device connected to the coating removal device for printed circuit boards.

20

The arrangement 100 is shown in Figure 1. It comprises a homogenising and distributing device in the form of two perforated tubes 101, coaxially disposed one inside the other, rotatably mounted on a support device 125
25 and secured to the frame 102. The solution 111 flows through the slot 109 down from the homogenising and distributing device 101 and impinges on the flat screen

121 correspondingly disposed beneath the homogenising and distributing device. The screen plane of the screen is set an angle α to the horizontal. Adjustment of the inclination of the screen is effected by an
5 adjusting device 141, shown in the Figure as a rod 143 rotatably mounted on the screen at point 145. For locking, a clamp screw 147 or similar means is conventionally used. It is sufficient if the angle α of the screen relative to the horizontal can be changed
10 approximately 25° to approximately 85° , preferably approximately 35° to approximately 85° . Further details, such as electrical, mechanical devices and means as well as pipe connections necessary for operation of the device, are not shown in the Figure.

15

The dispersion 111 comprises the coating removal solution 113 and the resist particles 115. While the dispersion 111 moves downwards along the screen under the influence of gravity, the coating removal solution
20 113 passes through the screen 121 and drops into the storage container 131. From the storage container 131, the coating removal solution 113 is transported, preferably by pumps 133, for preparation of the solution, to an appropriate device, but may also
25 optionally be disposed of or otherwise treated. The resist particles 115 flow further along the screen in a downward direction and drop into the collector 123.

From the collector 123 the resist particles 115, after corresponding treatment, are generally disposed of.

Figures 2 and 3 show the homogenising and distributing device 101. This consists of the outer tube 105 and the inner tube 103 disposed concentrically in said outer tube. The inner tube has a plurality of apertures 107 in order to produce a communication between the interior of the inner tube 103 with the interspace between interior tube 103 and exterior tube 105. A slot 109 is provided in the outer tube. This slot extends along the outer tube 105, preferably on the peripheral line. The slot 109 is set at an angle of approximately 45° to approximately 90° to the vertical. For this purpose the homogenising and distributing device 101 is rotatably guided on the support device 125 on support points 127. The feedpipe 129 for the dispersion 111 is preferably connected to one of the rotational points 127 with the homogenising and distributing device 101. In this way the dispersion 111 is passed into the inner tube 103.

The dispersion 111 is conveyed through the feedpipe 129 by means of appropriate circulating devices 135, for example a pump, into the inner tube 103. In this way, as well as transporting the dispersion through the homogenising and distributing device 101, the

dispersion is both thoroughly mixed and suspended, so that the particles 115 are uniformly distributed in the dispersion 111. The dispersion 111 flows from the inner tube 103 into the outer tube 105 and then from
5 the outer tube 105 through the slot 109 down on to the screen 121.

The screen is preferably made of rust-resistant steel, although basically any material which is resistant to
10 the solution and the suspended particles can be used, including glass, nylon, high-pressure polyethylene and gold. Independently of the screen material, the screen however must be wettable by the solution.

15 Depending on requirements, appropriate amounts of fresh coating removal agent may be added to the dispersion, in order to be able to set any optional desired physical or chemical property of the dispersion, such for example as to maintain the pH value, the
20 temperature or viscosity.

The screen 121 is held at an angle α to the horizontal. The angle α is preferably set in a range of approximately 35° to approximately 85° , particularly from approximately
25 40° to approximately 75° , and particularly preferably from approximately 50° to approximately 55° . By means of maintaining an appropriate angle, the

dispersion 111 can flow under the influence of gravity along the screen 121, in order to enable a separation of the resist particles 115 from the coating removal solution 113 and also to cause the particles 115 to flow further down along the screen 121 and drop into a collector 123, while the coating removal solution 113
5 flows through the screen 121 into the collector vessel 131.

In Figure 2, the homogenising and distributing device 101 is shown in partial section, the dispersion 111 flowing from the slot on to the screen 121. The inner
10 tube 103 containing the holes 107 forms the homogenising and distributing device 101. The downwardly-flowing dispersion 111 is at least partially thoroughly mixed in the inner tube 103 and during its flow from the inner to the outer tube, in order to
15 achieve a homogeneous distribution of the particles in the dispersion. In this way the dispersion 111 is also uniformly distributed over the entire width of the homogenising and distributing device 101, so that it can flow uniformly through the slot 109 in the outer
20 tube 105 on to the screen 121, wetting the latter over its entire width.

The homogenising and distributing device 101 is therefore the functional equivalent of a mixing device,
25 by means of which the mixed dispersion 111 is distributed under pressure on the screen 121.

As mentioned before, the angle α of the screen 121 can be set from approximately 25° to approximately 85° to the horizontal, in order to control the flow speed of the dispersion on the screen 121 and thus the effectiveness of separation. Furthermore, the angle β , formed by the centre line of the slot 109 with the centre line of the homogenising and distributing device 101 may be set, the homogenising and distributing device 101 being rotated about the points of rotation 127. In this way the power is set at which the solution 111 impinges on the screen 121. Further, the flow speeds may naturally also be set by the pump 135. The angle β can adopt any optional value between 0 and 90° . A preferred range for β lies between approximately 45° and approximately 90° . By setting the angles α and β the separation of the particles 115 from the coating removal solution 113 may be optimised with changing temperature, production speed, composition of the coating removal solution and other variables relevant to the manufacture of printed circuit boards and influencing the composition of the dispersion 111.

Underlying the method according to the invention is probably the following functional mechanism, without the interpretation given representing any restriction to the protective scope of the invention: the

dispersion 111 resulting from the coating removal from printed circuit boards, consisting of the coating removal solution 113 and the dispersed resist particles 115 of a photopolymer removed from the printed circuit board, is conveyed through appropriate feed pipes 129 by means of pumps 135 into a homogenising and distributing device 101. From this point the thoroughly mixed dispersion 111 drops from the outer tube 105 through the slot 109 on to the screen 121.

10 The coating removal solution 113 passes through the screen 121 leaving behind the resist particles 115 on the upper surface of the screen 121. Due to the surface tension of the coating removal solution 113, a thin film of liquid remains behind on the individual

15 particles 115. Due to gravity, a migration of the resist particles on the surface of the screen is brought about, this being reinforced by a sequential venturi effect occurring as a consequence of the main component of the coating removal solution 113 passing

20 through the screen and running along the screen underneath it, each mesh opening acting as an individual vacuum pump, before the filtered coating removal solution 113 is deflected by deflector 151 into the collector 131. Surprisingly, the particles 115

25 separated by means of the method and the device do not clog the screen 121. It has been observed that the resist particles 115 remain on the upper surface of the

screen 121, flow downwards along the screen 121 and finally drop into the collector 123, without clogging the screen 121.

5 Figure 4 shows a device with a rotatable cylindrical screen 421, secured on the axis 422 by a suspension device 423, instead of the screen 121. In order to remove the resist particles from the surface of the screen there is used for example a scraper 402 or a
10 similar device. The coating removal solution 113 drops on to a collector container, here constructed as a cell 431, from which it may then be returned back into the coating removal process. This return is effected by appropriate devices such for example as a pump, a
15 siphon or similar arrangements.

After removal of the resist particles 115 from the surface of the screen 421, and their collection in containers, they can be treated in an appropriate
20 manner for disposal.

The screen 121, 421 preferably has mesh openings of approximately $100\text{ }\mu\text{m}$ with a mesh density of approximately 67 meshes/cm and a filament thickness of
25 approximately $50\text{ }\mu\text{m}$. This construction enables an open surface of approximately 45%. An appropriate screen should for example be selected in dependence on the

type of resist, the composition and viscosity of the coating removal liquid and the temperature range of the solution containing the resist particles.

5 Apart from the type of particle removal according to the method according to the invention, the resist particles are in contact with the solution for only a short period. This short residence time enables repeated use of the coating removal agent without it
10 being heavily contaminated with resist and without loss of its useability for removing resist from the printed circuit board. Removal of the resist particles 115 from the coating removal solution is greater than 99.5%, i.e. less than approximately 0.5% of the resist
15 originally contained in the solution 111 passes through the screen 121 with the coating removal solution 113, and remains in the solution.

The method is preferably suited for removal of resist
20 particles from coating removal solutions for printed circuit boards, the solution charged with resist being conveyed to the device according to the invention, freed of resist at that point and then again returned into the printed circuit board process. The method for
25 removing resist particles from the printed circuit board by means of a coating removal solution in a coating removal device suitable for this purpose, can

thus be applied together with the device according to the invention in a continuous procedure.

It may also however be imagined that the method and the
5 device are suitable also for separation of fine particles from dispersions which occur in other manufacturing or working processes.

In an uninterrupted three-shift production operation,
10 coating removal from printed circuit boards can therefore be carried out without interruption in time, without stopping the installation for servicing of the devices or the necessity to replace consumed coating removal solution.

15

The device may be used in conjunction with a device for manufacturing printed circuit boards and for removing resist particles. Figure 5 shows a device such as is described in Figure 1, which is combined with a device
20 500 for removal of coatings from printed circuit boards. Such devices are known. The coating removal solution with the resist particles dispersed therein is conveyed through an appropriate pipe 501 by means of a circulating device 135, for example a pump, to the
25 homogenising and distributing device 101 for treatment according to the method described with reference to Figure 1. Here also the filtered solution 113 is

returned from the collector containers 131 by means of pumps 133 and through further pipes 503 to the device 500 and to the coating removal device.

- 5 The invention will be explained with reference to the following examples:

Comparative Example

- 10 In a coating removal process, hydrocyclone filtering according to prior art was used in order to separate resist particles from the coating removal solution. After operating the coating removal installation for approximately 40 hours with an aqueous solution
- 15 containing 15% by weight of a mixture of 75% by weight triethanolamine and 25% by weight NaOH, at a temperature of 50°C, continuous separation of the resist particles from the coating removal solution and return of the solution to the coating removal device,
- 20 it was necessary to interrupt operation in order to replace the used coating removal solution by a new one, as its effectiveness for coating removal was no longer sufficient.

- 25 Example 1:

A solution of 15% by weight of ethylenediaminetetraethanoic acid in an alkaline aqueous solution was produced as a coating removal solution and used at a temperature of 50°C. After
5 removal of the resist particles the solution, which consisted of a liquid with resist particles removed from a printed circuit board, was conveyed into the homogenising and distributing device according to the invention. The solution was then passed down from the
10 outer tube of the arrangement through a slot, so that it dropped on to the flat screen provided for separation of the resist particles. The filtered liquid was returned to the coating removal device. The resist particles were disposed of. After operational
15 time of 480 hours at a temperature of 50°C and continuous filtration and return of the solution to the coating removal installation, the appearance and physical properties of the coating removal solution were unaltered. The coating removal process could be
20 continued without difficulty.

Examples 2 to 10:

The procedure of Example 1 was repeated, aqueous
25 solutions of the coating removal agent quoted in the following table being used:

5

10

15	Example No.	Coating Removal Agent	Solution [% weight in water]	Operational Time [hours]
	2	KOH/ (HOCH ₂ CH ₂) ₃ N	5/10	400
	3	Choline/ (CH ₃) ₃ N	5/5	900
	4	(HOCH ₂ CH ₂) NH ₂	5	1200
20	5	(HOCH ₂ CH ₂) NH ₂	40	800
	6	[(CH ₃) ₄ N] ⁺ [OH] ⁻	10	320
	7	(HOCH ₂ CH ₂) ₃ N	40	750
	8	EDTA	35	700
	9	HO-C ₂ H ₄ -NH-C ₂ H ₄ -NH ₂	35	1000
25	10	(HOCH ₂) ₃ N	40	850

The results obtained with the solutions in each Example were excellent; the coating removal agent was visibly unaltered, removal of the resist from printed circuit boards could be continued without any reduction in effectiveness being observed. It was only necessary to interrupt the experiment at the beginning of a new test.

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The advantages of the invention, which consist in a practically completely continuous separation of the resist particles from the coating removal solution without manual servicing of the process and of the

device even over a lengthy process duration without interruption, have thus been demonstrated. The only requirements for maintaining the process are periodic removal of the resist particles from the storage
5 containers and occasional stoppage of the entire system for cleaning.

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5 Patent Claims

1. Method of removing swellable polymer particles from
a liquid dispersion comprising a solution with polymer
particles contained therein, comprising the method
10 steps:

a) homogenisation of the dispersion,
b) uniform distribution and bringing into contact
of the homogenised dispersion on a separating means
15 inclined relative to the vertical, for mechanical
separation of the resist particles from the solution.

2. Method according to claim 1, characterised in that
the solution is collected after separation.
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3. Method according to one of the preceding claims,
characterised in that filters are used as separating
means.

25 4. Method according to one of the preceding claims,
characterised in that flat, or cylindrical screens are
used as separating means.



5. Method according to one of the preceding claims,
characterised in that, for homogenisation, the
dispersion is passed through an arrangement of a
plurality of perforated tubes disposed coaxially one
5 inside the other.

6. Method according to one of the preceding claims,
characterised in that the solution is prepared for re-
use and is returned into a treatment container.

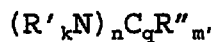
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7. Method of removing resist particles from the
surfaces of printed circuit boards, with the method
steps

15 a) bringing the surfaces of the printed circuit
boards into contact with a solution comprising

a) compounds with the general structural formula

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wherein R' , R'' = hydrogen, hydroxyl, substituted or
unsubstituted linear or branched alkyl, aryl or aralkyl
groups with 1 to 10 carbon atoms

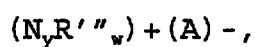
25 $k = 1$ or 2 ,

n , m are whole numbers from 1 to 5 and



the compounds contain at least one carbon-hydroxyl group,

- a) an ionic nitrogen compound with the general
5 formula



wherein R' = hydrogen, a hydroxyl, substituted or
10 unsubstituted linear or branched alkyl, aryl or aralkyl
groups with 1 to 10 carbon atoms with substituents,
selected from the group of functional groups containing
hydrogen, halogen, oxygen, nitrogen or sulphur atoms,
A - an inorganic or organic anion,
15 y is a whole number from 1 to 3 and
w is a whole number from 4 to 8

- a) an alkali or alkaline earth metal hydroxide, a
dispersion containing resist particles being formed,

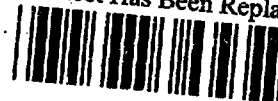
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- a) separation of the resist particles from the
dispersion by a method according to one of the
preceding claim

s, a solution substantially free of resist particles
25 being formed



- a) bringing the surface of the printed circuit boards into contact with the solution substantially free of resist particles.
- 5 8. Device for removing swellable polymer particles from a liquid dispersion comprising a solution with the polymer particles, comprising
- a) means for feeding the dispersion to a
- 10 homogenising and distributing device,
- a) homogenising and distributing devices for bringing the homogenised dispersion into contact with a separating device,
- 15 a) separating devices for separating the resist particles from the solution.
9. Device according to claim 8, characterised in that
- 20 the homogenising and distributing device is disposed above the separating device.
10. Device according to one of claims 8 or 9, characterised by an arrangement of a plurality of
- 25 perforated tubes disposed coaxially one inside the other, as a homogenising and distributing device.



11. Device according to one of claims 8 to 10,
characterised in that the homogenising and distributing
device comprises two tubes disposed coaxially one
inside the other, the inner tube having a plurality of
5 openings and the outer tube having a slot, disposed on
the peripheral line of the tube and extending
substantially over the entire length of the tube, as a
perforation.
- 10 12. Device according to one of claims 8 to 11,
characterised in that the position of the slot is
adjustable relative to the position of the separating
device.
- 15 13. Device according to one of claims 8 to 12,
characterised in that the slot is disposed relative to
the vertical at an angle of approximately 45° to
approximately 90° .
- 20 14. Device according to one of claims 8 to 13,
characterised in that the slot is disposed to lie
substantially opposite the separating device.
15. Device according to one of claims 8 to 14,
25 characterised by filters as separating means.



16. Device according to one of claims 8 to 15,
characterised by a screen as separating means.
17. Device according to one of claims 8 to 16,
5 characterised in that the screen is flat, the screen
plane being inclined at an angle of approximately 35°
to approximately 85° relative to the horizontal.
18. Device according to one of claims 8 to 15,
10 characterised by a rotatable, cylindrical screen
disposed parallel to the slot in the homogenising and
distributing device.
19. Device according to one of claims 8 to 18,
15 characterised by a screen with mesh openings of a size
of approximately $60\text{ }\mu\text{m}$ to approximately $250\text{ }\mu\text{m}$.
20. Device according to one of claims 8 to 19,
characterised by a screen with mesh openings of a size
20 of approximately $75\text{ }\mu\text{m}$ to approximately $120\text{ }\mu\text{m}$, with a
mesh density of approximately 50 meshes/cm to
approximately 85 meshes/cm and a filament thickness of
approximately $35\text{ }\mu\text{m}$ to approximately $65\text{ }\mu\text{m}$.
- 25 21. Utilisation of a device according to one of claims
8 to 20 for removing resist particles from a solution



serving to remove coatings from printed circuit boards.

22. Method according to one of claims 1 to 7,
5 characterised by individual or all the new features or combinations of disclosed features.

23. Device according to one of claims 8 to 20,
characterised by individual or all the new features or
10 combinations of disclosed features.

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ABSTRACT:

The invention relates to a method for removing
swellable polymer particles from a solution used to
25 remove coatings of resists from printed circuit boards.
The dispersion resulting during coating removal,
containing fine resist particles, is passed over a