

Distribution system for a process fluid for a chemical and/or electrolytic surface treatment of a substrate

5 Technical field

The disclosure relates to a distribution system for a process fluid for a chemical and/or electrolytic surface treatment of a substrate and a manufacturing method for a distribution system for a process fluid for a chemical and/or electrolytic surface treatment of a substrate.

Background

10 The best processing results when producing printed circuit boards (PCBs) with high dimensions are achieved with so-called HSP systems, meaning systems containing High Speed Plating technology. In the high-speed plating technology, one or two HSPs (High Speed Plates) are immersed into a tank containing a liquid electrolyte together with one or several anodes and together with one or two substrates. The electrolyte flow is directed from
15 inside of the HSP plate(s) via jet holes towards the substrate surface(s) and at the same time, the electric current is directed towards the substrate surface through the HSP via drain holes. The drain holes serve to drain off the used electrolyte away from the substrate. Due to the small distance of the HSP to the substrate and the high exit flow velocities of the electrolyte from the jet holes, the electrolyte flow is poorly scattered and will impinge the substrate
20 surface pointwise. The impacted area exhibits nearly the same diameter as the diameter of the fluid electrolyte flow exiting the jets. To reach a uniform material deposition on the substrate, and hence fully cover the surface of interest with the fluid electrolyte flow from the jet holes and uniformly distribute the electric current through the drain holes, the arrangement of the jet holes and the drain holes is vital and is even more important in case the substrate is exhibiting
25 a patterned surface.

To overcome the pointwise exit of the fluid electrolyte flow from the jet holes and the electric current through the drain holes, various arrangements of jet holes and drain holes on the surface of an HSP are known from prior art. The main purpose of these arrangements is to reach a full coverage of the HSP by the fluid electrolyte flow and the electric current flow.
30 However, these arrangements reach their limitations when it comes to substrates with patterned surfaces to be electrochemically coated. Especially if a drain hole or a jet hole is

located exactly directly in front of a hole or a cavity in the substrate, the coating thickness will be increased in this area, whereas the neighboring area will show a reduced coating thickness. This will lead to an unfavorable non-uniformly coated surface. When trying to reduce this issue by increasing the density of available jets holes and drain holes, there occur significant
5 limitations regarding the manufacturing of HSP plates. A minimum distance between individual jet holes and drain holes as well as a minimum diameter of these holes must be ensured. It is currently technically impossible to manufacture an HSP with jet holes and drain holes below a specific minimum diameter and distance.

Summary

10 Hence, there may be a need to provide an improved distribution system for a process fluid for a chemical and/or electrolytic surface treatment of a substrate, which allows in particular a more uniform surface treatment.

The problem of the present disclosure is solved by the subject matters of the independent claims, wherein further embodiments are incorporated in the dependent claims. It should be
15 noted that the aspects of the disclosure described in the following apply also to the distribution system for a process fluid for a chemical and/or electrolytic surface treatment of a substrate and the manufacturing method for a distribution system for a process fluid for a chemical and/or electrolytic surface treatment of a substrate.

According to the present disclosure, a distribution system for a process fluid for a chemical
20 and/or electrolytic surface treatment of a substrate is presented. The distribution system comprises a distribution body and a distribution medium. The distribution body comprises several openings for a process fluid and/or an electric current. The distribution medium covers at least some of the openings of the distribution body. The distribution medium comprises a netted framework with passages to distribute the process fluid and/or the electric current from
25 the distribution body.

To overcome the limitations of the prior art, a distribution system with a distribution medium has been invented, which may ensure a scattering or distraction of the process fluid flow and/or the electric current flow out of the passages of the distribution medium. By means of the distribution medium, a diameter of the process fluid flow and/or the electric current flow
30 impingement area on the surface of the substrate may be highly increased. This may allow continuing with small distances between the distribution body and the substrate, small openings and/or high flow velocities of the process fluid flow without having the process fluid

impinge the substrate surface pointwise. As there is no or only a less severe pointwise impingement or impact, it may be easier to fully or at least better cover the substrate surface with the process fluid flow and/or to more uniformly distribute the electric current flow over the substrate surface. Further, with this scattering of the process fluid flow / electric current
5 flow exiting the openings by using the distribution medium, a topology of the surface of the substrate may have less influence on a coating uniformity. As a result, the surface treatment may be more uniform and may lead to an e.g. more uniform coating. This applies in particular for substrates with patterned surfaces.

The netted framework with passages means that the framework is a group of passages (or
10 channels) that are in communication with each other to form a network of channels. A process fluid and/or electric current entering the netted framework may pass to the connected channels to spread throughout the framework of channels. Here, network of channels means interconnected passages or channels that allow the process fluid and/or electric current to pass from one to another. Because the netted framework provides predictable flow paths to the
15 process fluid and/or electric current, it is also possible to create a targeted flow (a localized exit of the process fluid/electric current) to the specific areas of the substrate to be treated.

Thanks to the high distribution capability of the distribution system, it is possible to dimension the distribution body and/or the distribution medium smaller than the substrate to be treated. Accordingly, the limitation imposed on the size of the distribution system to-be-
20 used by the substrate size is eliminated or at least significantly reduced and the size of the distribution system may be selected completely or at least partially independent of the substrate to be treated.

The surface treatment may be a chemical and/or electrolytic surface treatment of a substrate. It may be a material deposition, electroplating, lithography, a wet- or dry-etching, a wet- or
25 dry-cleaning, a water or chemical rinsing and/or the like.

The substrate may be any plate shaped material with or without structures and/or layers on at least one of its surfaces. It may be a semiconductor, an insulator (e.g. glass, quartz, plastic, polymer etc.), a solar cell, a printed circuit board production, a (flat) panel display and/or the like. There may be also two substrates to be treated together or simultaneously.
30 The distribution body can be understood as a plate or any plate shaped material with several, a plurality, or an array of openings to direct the process fluid flow (e.g. an electrolyte) and/or a

current density distribution towards the substrate. The distribution body may be arranged between an anode and the substrate forming a cathode.

The openings can be understood as holes, cavities or channels extending through the distribution body. The openings may have an outlet at a front surface of the distribution body facing the substrate. The openings may have an inlet at a rear surface of the distribution body facing the anode. The inlet(s) and/or outlet(s) may also be at a lateral surface of the distribution body facing for example an opening, a sidewall or a bottom of the processing chamber, in which the distribution body is inserted or immersed. The openings may extend linearly or angularly through the distribution body. The openings may be jet holes to direct the process fluid from the distribution body to the substrate. The openings may be drain holes for a return flow of the process fluid back from the substrate and through the distribution body.

The distribution medium may be located on a surface of the distribution body, which is facing the substrate. The distribution medium may cover the distribution body at least partially. The distribution medium can be understood as a perforated body. The distribution medium may comprise a netted or meshed framework or carcass with passages or channels to pass the process fluid and/or the electric current through the distribution medium and to distribute or spray the process fluid and/or the electric current away from the distribution medium and preferably towards the substrate.

The distribution medium and/or its netted framework can be understood as porous, a foam, a sponge, a grid or the like. The netted framework can comprise a network of randomly or non-randomly distributed passages or channels within a bulk material, wherein the passages enable the process fluid flow and/or the electric current flow from one side to the other side of the distribution medium. A network is an arrangement of intersecting horizontal and vertical lines. At least some lines might also be arranged in different angles from horizontal and vertical. By intersecting the passages or channels, it is possible to spread the process fluid and/or electric current to the other parts of the distribution medium to allow an exit therefrom onto the substrate to be treated. The passages or channels may extend linearly or angularly through the distribution medium. The passages or channels may extend and the process fluid flow and/or the electric current flow may flow from one side (e.g. a rear or a lateral surface) of the distribution medium to another side (e.g. a front or a lateral surface) of the distribution medium.

In an embodiment, the openings covered by the distribution medium are jet holes configured to direct the process fluid towards the substrate. Jet holes or jets may be openings to direct the process fluid from the distribution body to the substrate. In an embodiment, additionally or alternatively, the openings covered by the distribution medium are drain holes configured to
5 drain off the process fluid relative to the substrate. Drain holes or drains may be openings for a return flow of the process fluid back from the substrate and through the distribution body. This means, for a better distribution of the process fluid flow, only the openings in form of jet holes can be covered with the distribution medium and the openings in form of drain holes may not be covered. Vice versa, only the openings in form of drain holes can be covered to
10 scatter the electric current flow and the openings in form of jet holes can be left uncovered. Preferably, both types of openings (jet holes and drain holes) are covered with the distribution medium or each with a different version of the distribution medium.

The drain holes can be arranged next to or around the jet holes. In other words, there is at least a drain hole dedicated or assigned to a jet hole. Preferably, there are a plurality of drain holes
15 dedicated or corresponding to a smaller amount of jet holes. The drain holes allow that the flow paths are rather short and/or the flow cell is rather small. This is in particular in comparison to prior art distribution bodies, which guide a backflow via open edges of the distribution body and therefore form much longer flow paths and/or larger flow cells. A distribution body comprising a plurality of jet holes to direct the process fluid to the substrate and a plurality of
20 drain holes for a return flow of the process fluid back from the substrate and through the drain holes form a high-speed plate (HSP). The HSP may allow that the process fluid is accelerated and/or that it is easier to control, balance and/or equilibrate the current distribution towards the substrate.

In an example, the openings of the distribution body may be more than the passages of the
25 distribution medium or the number of openings and the number of passages may be equal. When there are equal number of openings and passages in the distribution system, every passage may correspond to one opening. Thereby, all of the process fluid and/or the electric current travelling through the distribution body can be directed to the substrate through the distribution medium efficiently. Of course in another example, the passages may be more than
30 the openings.

In an embodiment, the distribution medium comprises a netted framework with passages to distribute the process fluid and/or the electric current from the distribution body, through the

distribution medium, from the distribution medium and towards or relative to the substrate. In an embodiment, the netted framework forms a sponge with randomly distributed passages. This means, the passages can be distributed irregularly like polymer chains. Random distribution can be also understood as the amount of passages that are forming the netted framework per unit area may be unequal throughout the distribution medium. In another embodiment, the netted framework forms a grid with evenly distributed passages. This means, the passages can be distributed regularly like a checkered pattern. Even distribution can be also understood as the amount of passages that are forming the netted framework per unit area are equal throughout the distribution medium. In all embodiments, the passages can be understood as a network of channels within the netted framework, which enable the process fluid flow and/or the electric current flow from a first surface (e.g. a distribution body facing surface) to another, second surface (e.g. a substrate facing surface) of the distribution medium.

In an embodiment, at least some of the passages may be interconnected. This means, at least one passage may be connected with at least another passage to pass from one surface of the distribution medium to another surface of the distribution medium. The interconnected passages may allow the process fluid flow and/or the electric current flow to better pass from one passage to another (like relays) to cross the distribution medium. The interconnected passages may form a straight puncture from one surface to another, preferably opposite surface of the distribution medium. The interconnected passages may form additionally or alternatively a wound, transverse or oblique interconnection between one surface and another surface of the distribution medium. The interconnected passages may also form a branch and/or a bypass. The interconnected passages are, preferably configured such that the process fluid and/or the electric current may flow without disruptions on the flow path. Accordingly, an energy loss and a speed reduction in the flow of the process fluid and/or electric current may be kept at a minimum.

A bulk material of the distribution medium between the rather empty passages can be understood as cells, pores or (honey) combs. In an embodiment, the netted framework comprises a single layer of cells and passages. This can be understood in that the distribution medium has essentially a height (seen perpendicular to a surface of the distribution medium) of only one layer, in which one cell is arranged next to one passage and there is no pile up. In another embodiment, the netted framework comprises at least two layers of cells and passages. This can be understood in that the distribution medium has essentially a height (seen perpendicular to a surface of the distribution medium) of only two or two and more

layers, wherein the term layer is defined as one cell arranged next to one passage without no pile up.

When the netted framework comprises at least two layers of cells and passages, the stapled layers can be at least partially displaced relative to each other, like e.g. a brick wall with
5 displaced layers of bricks. This means a first passage of a first layer is at least not fully flush with a second passage of a thereon laying second layer. Of course, in contrast, the passages of stapled layers can be aligned with each other so that a first passage of a first layer is at least partially flush with a second passage of a thereon laying second layer.

In the example where the netted framework comprises two layers, the layers may have
10 passages of different intensity (in other words, different amount of passages). By changing the rate of the passages in the layers, it is possible to control the flow speed and scatter level of the process fluid and/or the electric current from the distribution body.

The distribution medium and/or the netted framework may have a high permeability to avoid additional electric current resistance in the openings (in particular the jet holes) and/or to
15 avoid poor drainage of the process fluid through the openings (in particular the drain holes). The permeability can be described as porosity, hydraulic conductivity or the like. Porosity can be understood as a ration of pore volume to bulk volume of a porous material. Permeability can be understood as a means to describe a quality or property of a connection between pores of a porous material. In an embodiment, the distribution medium has a porosity in a range of
20 0.1 to 0.95, preferably 0.4 to 0.9 and more preferably 0.6 to 0.85. The term "porosity" can be understood as effective porosity, accessible void fraction through connected pores and/or interconnected passages, a measure of void (i.e. "empty") spaces in a material as well as a fraction of a volume of voids over a total volume.

There are several methods to measure porosity: directly by determining a bulk volume of a
25 porous sample and then determining a volume of a skeletal material with no pores (pore volume = total volume – material volume), optical by determining an area of the material versus an area of the pores visible under a microscope, by means of a computed tomography method using CT scanning to create a 3D rendering of external and internal geometry, including voids and implementing a defect analysis utilizing computer software, and the like.

30 In an embodiment, the distribution medium has a hydraulic conductivity in a range of 10^{-4} to 10 m/s, preferably 10^{-3} to 1 m/s and more preferably 10^{-3} to 10^{-1} m/s. The term "hydraulic

conductivity” can be understood as a property that describes the ease with which a fluid can move through voids or pores. It may depend on an intrinsic permeability of a material, a degree of saturation, and on a density and viscosity of the fluid. By definition, the hydraulic conductivity is the ratio of velocity to hydraulic gradient indicating a permeability of porous media.

There are several methods to measure the hydraulic conductivity. There is the constant-head method, which allows water to move through a specimen under a steady state head condition while a volume of water flowing through the specimen is measured over a period of time. By knowing a volume ΔV of water measured in a time Δt over a specimen of a length L and a cross-sectional area A , as well as a head h , which is the column height difference of the water, the hydraulic conductivity K can be derived by:

$$K = \frac{\Delta V}{\Delta t} \frac{L}{Ah}$$

There is also the falling-head method, wherein a specimen is first saturated under a specific head condition. Liquid (preferably water) is then allowed to flow through the specimen without adding any liquid, so that a pressure head declines as the liquid passes through the specimen of a length L . If the head drops from height h_i to height h_f in a time Δt , then the hydraulic conductivity K is equal to:

$$K = \frac{L}{\Delta t} \ln \frac{h_i}{h_f}$$

In an embodiment, the permeability, the porosity and/or the hydraulic conductivity is anisotropic. This means, the permeability, porosity and/or hydraulic conductivity is different in a first direction (e.g. parallel to a surface of the distribution medium) from a second direction (e.g. perpendicular to the surface of the distribution medium) through the distribution medium. For example, the permeability, porosity and/or hydraulic conductivity is lower in a direction parallel to the surface of the distribution medium than in a direction perpendicular to the surface of the distribution medium. This allows spreading or distributing the process fluid and/or the electric current first within the distribution medium before distributing or spraying it outside and away from the distribution medium preferably towards the substrate. This allows a broader distribution and a more uniform surface treatment of the substrate. Of course, the permeability, the porosity and/or the hydraulic conductivity can also

be higher in the direction parallel to the surface of the distribution medium than in the direction perpendicular to the surface of the distribution medium. Certainly, there can be no anisotropy and the permeability, the porosity and/or the hydraulic conductivity is similar in all directions.

- 5 The passages or more precisely the apertures or openings of the passages of the distribution medium can be locally closed, for example by laser writing. By such closing method, the apertures can be selectively sealed depending on dimensions and/or locations of structures at the substrate. Unsealed apertures provide fluid flow and electric current to enable a target process at the substrate, i.e. metal deposition, whereas sealed apertures restrict flow and
- 10 current and therefore restrict the target process at the substrate. The apertures of the distribution medium can be selectively closed, either a single apertures or a group or array of adjacent apertures to form e.g. a random or non-random pattern.

The passages or apertures or openings of the passages of the distribution medium can also be partially closed, in other words, narrowed. Narrowing the exit of the passages (opening of the

15 passages or apertures) can allow a local control of the process fluid and/or electric current flow according to, for instance, the thickness needed at a particular portion of the substrate surface.

One or a group of unsealed apertures of the distribution medium may have a circular shape, an angular shape or a line shape. A line shaped opening or group of openings may have a

20 straight, round, zigzag or corrugated shape or the like. The plurality of apertures may comprise combinations of differently shaped or sized openings or all can be the same. The openings at the edges of the distribution medium can be bigger than the openings at a central part of the distribution medium for counterweighing the higher density of the process fluid and/or electric current reaching the central portion of the substrate (through overlapping of the

25 process fluid/electric current from the surrounding openings). Similarly, the opening size can be smaller at a central part of the distribution medium for reducing the chemical and/or electrolytic surface treatment of the substrate at the center to balance the lower surface treatment at the sides of the substrate. A diameter or cross-sectional dimension of a passage of the distribution medium may be in a range of micrometers to millimeters.

- 30 The distribution medium can be manufactured of any material and in any form and/or thickness. Furthermore, the distribution medium can comprise one material only or also various materials representing a composite material.

The distribution medium can be attached to the distribution body in several ways, removable or non-removable, i.e. mechanically, chemically or the like, whereas it can be attached by one of those methods or by a combination of methods. A mechanical attachment of the distribution medium can be by clamps or fastening devices such as screws or the like. An advantage of mechanically attaching the distribution body is that it can be removed and replaced any time without destruction of the distribution medium or distribution body. Another possibility is a chemical attachment of the distribution medium to the distribution body by means of a chemical bond between the two interfaces. This can be achieved by forming a direct chemical bond between the two interfaces or by using a type of adhesive in between, where the distribution body is chemically bonded to one side of the adhesive and the distribution medium is chemically bonded to the other side of the adhesive. An advantage of the chemically attachment of distribution body and distribution medium is the strong bond between them, which guarantees a fixed placement, unremovable, in the required position. The chemical bond can be induced thermally or mechanically, i.e. applying pressure, or the manufacturing of the distribution medium can be conducted directly on the distribution body, i.e. by means of 3D printing of a distribution medium, either directly onto a distribution body or distribution body and distribution medium can be produced, i.e. 3D printed, together during the same manufacturing step.

According to the present disclosure, also a manufacturing method for a distribution system for a process fluid for a chemical and/or electrolytic surface treatment of a substrate is presented. The manufacturing method comprises the following steps, not necessarily in this order:

- Providing a distribution body, wherein the distribution body comprises several openings for a process fluid and/or an electric current.
- Covering at least some openings of the distribution body by means of a distribution medium, wherein the distribution medium comprises a netted framework with passages to distribute the process fluid and/or the electric current from the distribution body.

The present manufacturing method allows an easy manufacturing of a distribution system with a distribution medium, which may increase a scattering or distraction of the process fluid flow out of and/or a scattering of the electric current flow through the passages of the distribution medium. As a result, the surface treatment by means of the distribution system may be more uniform and may lead to an e.g. more uniform coating.

The distribution medium and/or the netted framework can be porous, such as a sponge or a grid. The distribution medium and/or its netted framework can comprise a network of randomly or non-randomly distributed channels or passages within the material, which enable the process fluid flow and/or the electric current flow from one side to the other side of the distribution medium. At least some of the passages may be interconnected, which means at least one passage is connected with at least another passage.

The openings covered by the distribution medium can be jet holes configured to direct the process fluid towards the substrate. The openings covered by the distribution medium can be drain holes configured to drain off the electrolyte relative to the substrate. There may be at least one drain hole dedicated or assigned to a jet hole. Preferably, there are a several drain holes dedicated or assigned to a smaller amount of jet holes. The distribution body may be a high-speed plate (HSP) comprising a plurality of jet holes to direct the process fluid to the substrate and a plurality of drain holes for a return flow of the process fluid back from the substrate and through the drain holes.

It shall be understood that the system and the method according to the independent claims have similar and/or identical preferred embodiments, in particular, as defined in the dependent claims. It shall be understood further that a preferred embodiment of the disclosure can also be any combination of the dependent claims with the respective independent claim.

These and other aspects of the present disclosure will become apparent from and be elucidated with reference to the embodiments described hereinafter.

Brief description of the drawings

Exemplary embodiments of the disclosure will be described in the following with reference to the accompanying drawing:

Figure 1 shows schematically and exemplarily an embodiment of a distribution system for a process fluid for a chemical and/or electrolytic surface treatment of a substrate according to the disclosure.

Detailed description of embodiments

Figure 1 shows schematically and exemplarily an embodiment of a distribution system 10 for a process fluid for a chemical and/or electrolytic surface treatment of a substrate 20. The distribution system 10 comprises a distribution body 11 and a distribution medium 12.

The distribution body 11 is here a plate and in particular a high-speed plate (HSP) with a plurality of openings 13 for a process fluid and/or an electric current to direct the process fluid flow F (an electrolyte) and/or a current density distribution C towards the substrate 20. The distribution body 11 is arranged between an anode 21 and the substrate 20 forming a cathode.

5 The distribution system 10 can be immersed into a tank containing the process fluid and at least the anode 21 and at least the substrate 20.

The openings 13 are through holes extending through the distribution body 11. The openings 13 have an outlet at a front surface of the distribution body 11 facing in the direction of the substrate 20 and the distribution medium 12. The openings 13 have an inlet at a rear surface

10 of the distribution body 11 facing the anode.

Some of the openings 13 are jet holes 15 to direct the process fluid from the distribution body 11 to the substrate 20 and the distribution medium 12. Some of the openings 13 are drain holes 16 for a return flow of the process fluid to drain off the electric current back from the substrate 20 and the distribution medium 12 and through the distribution body 11. The drain

15 holes 16 are arranged next to the jet holes 15. Each drain hole 16 is assigned to a jet hole. Preferably, there are more drain holes 16 than jet holes 15.

The distribution medium 12 is located on the front surface of the distribution body 11, which is facing the substrate 20. The distribution medium 12 covers the distribution body 11 and the openings 13 of the distribution body 11.

20 The distribution medium 12 can be understood as a perforated body, as porous, a foam, a sponge, a grid or the like. The distribution medium 12 comprises a netted framework with passages 14 to pass the process fluid and/or the electric current from the distribution body 11 and through the distribution medium 12 and to distribute the process fluid and/or the electric current away from the distribution medium 12 and towards the substrate 20.

25 The passages 14 enable the process fluid flow F and/or the electric current flow C from one side of the distribution medium 12 (here a first or rear surface facing the distribution body 11) to another side (here a second or front or opposite surface facing the substrate 20). The passages 14 in the distribution medium 12 can be randomly or non-randomly distributed in a bulk material. The passages 14 in the distribution medium 12 can form a sponge with

30 randomly distributed passages 14; this means the passages 14 can be distributed like polymer

chains. The passages 14 in the distribution medium 12 can form a grid with evenly distributed passages 14; this means, the passages 14 can be distributed like a checkered pattern.

The passages 14 are here interconnected, which means that a passage 14 is connected with at least another passage 14 to pass the process fluid flow F and/or the electric current flow C
5 from one surface of the distribution medium 12 to the other surface of the distribution medium 12. The passages 14 may also form branches, junctions and/or bypasses.

The bulk material of the distribution medium 12 between the rather empty passages 14 can be understood as cells, pores, (honey) combs or the like. The netted framework here comprises several layers of cells and passages 14. This means that the distribution medium 12 has
10 essentially a height (seen perpendicular to a surface of the distribution medium 12) of two and more layers, wherein the term layer is defined as one cell arranged next to one passage 14 without pile up. The stapled layers are displaced relative to each other, so that a first passage 14 of a first layer is not flush with a second passage 14 of a thereon laying second layer.

It has to be noted that embodiments of the disclosure are described with reference to different
15 subject matters. In particular, some embodiments are described with reference to method type claims whereas other embodiments are described with reference to the device type claims. However, a person skilled in the art will gather from the above and the following description that, unless otherwise notified, in addition to any combination of features belonging to one type of subject matter also any combination between features relating to different subject
20 matters is considered to be disclosed with this application. However, all features can be combined providing synergetic effects that are more than the simple summation of the features.

While the disclosure has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary
25 and not restrictive. The disclosure is not limited to the disclosed embodiments. Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing a claimed disclosure, from a study of the drawings, the disclosure, and the dependent claims.

In the claims, the word “comprising” does not exclude other elements or steps, and the
30 indefinite article “a” or “an” does not exclude a plurality. A single processor or other unit may fulfil the functions of several items re-cited in the claims. The mere fact that certain measures

are re-cited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope.