

## **DISTRIBUTION SYSTEM FOR A PROCESS FLUID AND ELECTRIC CURRENT FOR CHEMICAL AND/OR ELECTROLYTIC SURFACE TREATMENT OF A SUBSTRATE**

### **FIELD OF THE INVENTION**

The invention relates to a distribution system for a process fluid and an electric current for chemical and/or electrolytic surface treatment of a substrate, a distribution method for a process fluid for chemical and/or electrolytic surface treatment of a substrate and a corresponding data processing device.

### **BACKGROUND OF THE INVENTION**

Substrate dimensions of panels for producing printed circuit boards (PCBs) are undergoing significant increases in their dimensions in order to enhance manufacturing efficiency as well as to accommodate large physical size technology requirements. Panels are already reaching single side lengths of significantly more than 1000 mm and in some cases even more than 3000 mm.

During the manufacturing of panels for the electronic industry, an important processing step is the creation of so called interconnects, meaning the manufacturing of the individual electrical connections between devices on a board. Usually, the technique of electrochemical deposition of copper (or other electrically conducting materials) is being used to create these interconnects. In comparison to microelectronic interconnects, electrical connection lines on panels can be macroscopic in dimensions and are mostly macroscopically uneven distributed over the whole panel area. The macroscopic uneven distribution of areas where e.g. copper has to be deposited leads to the effect that in areas with a low density of metal lines a higher deposition rate of copper is observed compared to areas where the density of copper lines is higher. This is because in low-density metal line areas more copper containing electrolyte is available for the deposition process (less metal ion diffusion limitations) relative to areas with a higher density of metal lines to be deposited. In addition, the density of the effective electrical field lines is higher relative to the available metal lines.

The best processing method to date to improve the overall deposition uniformity for interconnects is based on so-called HSP systems, meaning systems containing High Speed

Plating technology. In such a system, one or two HSPs together with one or two substrates are immersed into a tank containing an electrolyte and one or several anodes. Within this tank filled with electrolyte, the electrolyte (and with this the current distribution) is directed through the HSP plate(s) towards the substrate surface(s). HSPs are usually produced specifically to process certain panel designs, where the panel features are to a certain extent aligned with the to be electroplated metal line features on the substrate. In the prior art, the problem of spatial non-uniform plating on substrates has been improved by creating a high density of electrolyte jets and current density distribution elements approximately corresponding to a distribution of surface elements reacting on the substrate, which define a structure to be displayed such that, for example, an outlet opening is in approximate alignment with a surface element. However, when the panel sizes are reaching large dimensions the manufacturing of specific HSP distribution bodies for different panel design and with varying sizes becomes very time consuming and expensive.

DE 102010033256 A1 discloses a device and method for producing targeted flow and current density patterns in a chemical and/or electrolytic surface treatment. The device comprises a flow distributor body which is disposed, with a front face thereof plane-parallel to a substrate to be processed, and which has outlet openings on the front face through which process solution flows onto the substrate surface. The process solution flowing back from the substrate is led off through connecting passages onto the rear face of the flow distributor body. At the same time, a targeted distribution of an electrical field on a conductive substrate surface is affected by a specific arrangement of said connecting passages.

## **SUMMARY OF THE INVENTION**

Hence, there may be a need to provide an improved distribution system for a process fluid and an electric current for chemical and/or electrolytic surface treatment of a substrate, which allows a better deposition uniformity for varying panel designs and sizes without having to re-manufacture and exchange the HSP unit.

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

According to the present invention, a distribution system for a process fluid and an electric current for chemical and/or electrolytic surface treatment of a substrate is presented. The distribution system comprises a distribution body and a shield element. The distribution body comprises a plurality of openings. The openings can be passed by the process fluid and/or an electrical current. The openings for the process fluid and the openings for the electrical current can be separate, which means different openings. In other words, some openings are for the process fluid and other openings are for the electrical current. The shield element is configured to at least partially cover at least one (or at least some) of the plurality of openings to limit a flow of the process fluid and/or of the electrical current through the distribution body. This can be understood in that the shield element can independently cover the process fluid openings and the electrical current openings and thereby independently control and limit the flow of the process fluid and the flow of the electrical current.

In other words, the shield element may cover parts of the distribution body and thereby influences a local deposition rate of a deposition material, e.g. copper, on the substrate. The term "local" refers to different areas or spots on the same substrate. By controlling the local deposition rate on a substrate, a better and more uniform overall deposition can be achieved. This applies in particular, if the substrate shall be provided with differently dense structures that would conventionally lead to different deposition rates and a poor overall deposition uniformity. As a result, the distribution system according to the present invention allows balancing the conventionally negative effects of differently dense structures to be deposited on the same substrate. Consequently, the distribution system allows a processing of differently dense structures on a substrate with a great deposition uniformity.

In more detail: By the deposition process, the substrate can be provided with dense and non-dense structures as well as isolated and non-isolated structures. Dense and non-dense structures as well as isolated and non-isolated structures may lead to different levels of deposition rates. Dense structures can be understood to have a coverage of the deposition material on the substrate in the range of 70 to 90%, whereas non-dense structures can be understood to have a coverage in the range of 10 to 30%. In addition, a 100% to 0 % distribution is possible. If one area has dense structures and the other area has non-dense structures, the non-dense structure area may have a higher deposition rate than the dense structure area. For isolated and non-isolated structures, the substrate may have a non-uniform deposition rate with a higher deposition rate in the isolated area of the substrate. Additionally,

an area close to an edge of the substrate or the edge itself may have a higher deposition rate than an area further away from an edge of the substrate.

By applying the shield element to the distribution system, the distribution rate of the deposition material on the substrate may be adjusted to balance at least above explained irregularities. In particular, by varying a coverage of the openings of the distribution body by means of the shield element, the distribution rate of the deposition material may be adjusted, and the deposition can be made more uniform.

In an embodiment, the distribution body may comprise a plurality of openings for the process fluid and an electrical current. In this embodiment, some of the openings may be drain holes and some other openings may be jet holes. The drain holes may be configured to direct an electric current. The drain holes may be through holes extending between a front face and a rear face of the distribution body. The drain holes may act as current density distribution elements. The jet holes may be electrolyte jets for discharging an electrolyte. The front face of the distribution body may be directed towards the substrate and the rear face of the distribution body may be on an opposite side of the front face, not facing the substrate (but facing, for instance, at least one anode). The shield element may be configured to partially cover at least one of the plurality of openings to limit a flow of the process fluid and/or a flow of the electrical current through the distribution body. By covering at least some of the openings of the distribution body the flow of the process fluid may be modified and/or the electrical current distribution of the substrate may be altered.

Directing the electric current separate from the process fluid through respective separate openings may provide further flexibility and conciseness in the treatment of specific parts of the substrate surface. By separating the distribution of electric current and process fluid through different openings, a targeted selection can be made, for instance, while the flow of electric current is changed (decreased or increased), the process fluid flow may remain unaffected. Not reducing the process fluid flow towards the substrate while reducing the current density leads to, for instance, preventing hydrogen gas bubbles to adhere to the substrate more strongly during the chemical and/or electrolytic surface treatment of a substrate or that particles can still be washed away from the surface after treatment. Similarly, the flow of process fluid may be changed (increased or decreased) while the flow of electric current stays constant. It is also possible that one of the electric current or process fluid flow is cut (prevented from reaching the substrate), while the other continues to flow through the

distribution body. In an embodiment, the shield element is configured to at least partially cover at least one (or at least some) of the plurality of openings to modify not only a flow of the process fluid through the distribution body, but also alter an electrical current distribution for chemical and/or electrolytic surface treatment of the substrate.

In chemical and/or electrolytic surface treatment systems and methods, a substrate to be processed may be attached to a substrate holder, immersed into an electrolytic process fluid and serves as a cathode. An electrode may be immersed into the process fluid in a process chamber and serves as an anode. A direct current may be applied to the process fluid to dissociate positively charged metal ions at the anode. The ions may then migrate to the cathode, where they plate the substrate attached to the cathode. Alternatively, the anode can be inert and enables in this case the provision of the electric current required for the deposition of the metal ions, which are provided through the electrolyte composition.

The distribution system may be a vertical distribution system with a vertical process chamber, in which the substrate is inserted vertically. The distribution system may also be a horizontal distribution system with a horizontal process chamber, in which the substrate is inserted horizontally.

The substrate may comprise a conductor plate, a semi-conductor substrate, a film substrate, an essentially plate-shaped, metal or metallized workpiece or the like.

To direct a flow of process fluid and/or electrical current to the substrate, the distribution body comprises a plurality of openings. The openings may be configured to eject the process fluid in the process chamber and/or to receive a backflow of the process fluid from the process chamber. The openings directing the process fluid may be directed towards the substrate and/or towards the opposite direction averted to the substrate.

The shield element may correspond to the distribution body in particular in view of its shape and size. This means, they can have the same shape and size. The shield element may also be smaller than the distribution body. The shield element may also be larger than the distribution body or larger than the area to be treated, in particular in an area of an edge of the substrate. The shield element may comprise at least one aperture through which the process fluid can pass. In other words, a bulk material of the shield element may cover at least one of the plurality of openings of the distribution body and interfere or block the flow of the process fluid and/or the electrical current. Accordingly, the flow of the process fluid and/or the flow

of the electrical current through the distribution body is modified and only a portion of the process fluid, which passes through the aperture(s) of the shield element, may arrive at the substrate. Hence, a deposition rate of the deposition material (e.g. copper) over a substrate may be influenced by the shield element.

The shield element may comprise at least one aperture, but also a plurality of apertures allowing the process fluid and the electrical current passing through. The apertures may be formed in a same size and shape. However, the apertures may be differently formed in size and/or shape. The aperture may be rectangular, triangular, polygonal, or circular shaped. The aperture may also comprise several slots arranged vertically, horizontally or crossed-over.

The shield element may cover a particular portion of the openings such that some of the openings may directly eject the process fluid towards the substrate or in the opposite direction, whereas the rest of the openings may be covered by the shield element such that the process fluid out of these openings may not directly reach the substrate. The shield element may also cover a particular portion of the openings directing the electrical current towards the substrate, whereas the rest of the openings may be covered by the shield element such that the electrical current out of these openings may not directly reach the substrate. Such a coverage of the shield element may be between 0% and 100%. In other words, the bulk material of the shield element may cover some of the openings of the distribution body, for example may cover 30% or more of all openings, 50% or more of all openings or 70% or more of all openings.

In an embodiment, the distribution system for a process fluid for chemical and/or electrolytic surface treatment of a substrate comprises a process unit configured to control a coverage of the openings by means of the shield element based on a predetermined local deposition rate for a local portion of the substrate to be treated. The process unit may block or cover only the openings for the process fluid or only the openings for electric current. In other words, the process unit may monitor and determine a portion of the openings of the distribution body to be blocked or covered by the shield element according to the predetermined local deposition rate of the process fluid. Hence, an automated change or movement of the shield element according to the required coverage of the openings may be implemented.

In an embodiment, the process unit is further configured to determine the local deposition rate based on a local density of structures to be applied on the local portion of the substrate. According to a predetermined requirement, for example a local density of structures or a

uniformity of deposition, the process unit may monitor and determine the local deposition rate of the process fluid. Hence, an automated change or movement of the shield element according to the required coverage of the openings may be implemented.

In an embodiment, the shield element is plate shaped to cover an array of openings. The shield element may be formed such that a specific or pre-determined area of the openings of the distribution body may be blocked or interfered. The shield element may be arranged parallel relative to the substrate surface to be treated either between the distribution body and the substrate or between the distribution body and the anode. Hence, if the shield element may be formed in a plate shape, a size of the process chamber, in which the distribution body, the substrate, the anode and the process fluid may be inserted, may be reduced. Further, all openings of the distribution body to be covered may have a same distance to the shield element, which may lead to an even covering effect of the openings. However, the shield element may be, for example, shell-shaped or ring-shaped. Ring-shaped does not only include circular ring shapes, but also ring-shapes expressed by squares, rectangles, or any other angular form that can accomplish and support the goal of higher deposition uniformity.

In an embodiment, the shield element is movable relative to the distribution body. In other words, the shield element may be smaller than the distribution body and may be moved to a position, which is determined to be covered. Preferably, the shield element is here movable in a vertical and a horizontal direction. Additionally, or alternatively, the shield element may be releasably fixed at the distribution body and if necessary, the shield element may be replaced with another shield element having a different coverage. Preferably, the shield element is here movable in a vertical direction.

In an embodiment, the shield element comprises a plurality of stencils or pins to be inserted at least partially in at least one (or at least some) of the plurality of openings of the distribution body to prevent a flow of the process fluid or the electric current. The plurality of pins may be inserted into at least one (or at least some) of the openings of the distribution body according to a required coverage determined based on a predetermined local deposition rate, a local density of structures and/or an electrical current distribution.

In an embodiment, the shield element is mechanically, electro-statically and/or magnetically connected to the distribution body. The shield element may be releasably attached to the distribution body at a predefined distance or may tightly fit to the distribution body. The shield element and the distribution body can be simultaneously or separately inserted into the

process chamber. The shield element may be inserted along the distribution body and/or along the substrate surface to be treated.

In an embodiment, the distribution body may comprise a shield element frame. The shield element frame may comprise a groove, in which the shield element may be inserted. The shield element frame may be directly arranged at the distribution body. The shield element frame may hold the shield element by applying an electrostatic, mechanical or a magnetic force or the like. The shield element frame may allow an (automated) exchange of the shield element depending on e.g. different substrates to be treated.

In case of stencils, the stencils may be inserted in a form-fitting manner in the openings of the distribution body to avoid losing the stencils in the process fluid or a removal thereof during a passage of the electric current. Additionally, an electrostatic, mechanical, or magnetic force or the like may be applied to fixedly hold the stencils in the openings. The stencils can be exchanged (automatically) depending on e.g. different substrates to be treated. The stencils can be cleaned after use.

In an embodiment, at least one (or at least some) of the stencils comprise boreholes. The stencils to be inserted into the openings may comprise through holes extending in a direction of the openings of the distribution body. Through the through holes, the process fluid may be ejected or drained. Accordingly, the boreholes may allow an additional adjustment of a coverage of the openings or an electrical current distribution by varying a diameter of the through hole.

In an embodiment, the openings are drain holes. The term “drain holes” can be understood as openings, through which an electric current flows through the distribution body.

In an embodiment, the drain holes are through holes extending between a front face of the distribution body directed towards the substrate and a rear face of the distribution body opposite to the front face. In other words, the distribution body may comprise a first face and a second face. To allow a fluid communication of the electric current through the distribution body, the distribution body may comprise through holes between the first or front face and the second or rear face. For example, an electric current may be provided at the front face of the distribution body and flow back to the distribution body to reach the rear face. Accordingly, the drain holes may be formed as a through hole or a passage connecting the front face and the rear face of the distribution body.

In an embodiment, the openings are jet holes configured to direct the process fluid onto the substrate. The term “jet holes” can be understood as openings, through which the process fluid flows out of the distribution body in direction to the substrate or to a process side. In other words, the jet holes arranged at or in the distribution body may face the substrate to be treated. Hence, in this case, the jet holes may be covered by the shield element at least partially according to a pre-determined coverage to adjust an ejection rate of the processing fluid and accordingly the deposition rate on the substrate.

In an embodiment, the size and/or shape of the openings directing the electric current may be different to the openings directing the process fluid. For instance, the size and /or shape of the jet holes may be different than the drain holes.

In an embodiment, the amount of openings for directing the process fluid flow may be more than the amount of openings for directing the electric current flow. In other words, the amount of drain holes may be less than the amount of jet holes. Yet, the openings directing the process fluid flow may also be equal to the amount of the openings directing the electric current; namely, the number of drain holes and jet holes may be equal.

In an embodiment, the openings are arranged at the front face of the distribution body. The front face of the distribution body is configured to be directed towards the substrate for the surface treatment of the substrate. The front face of the distribution body may be facing the process side, at which the substrate is arranged, and the rear face of the distribution body may be facing an anode side, at which an anode is arranged. The front face and the rear face may be opposite to each other relative to the distribution body.

In other words, the openings to be covered by the shield element may be arranged in the direction of the substrate. Accordingly, either the ejection rate or drain rate (or both) of the process fluid in the process chamber and the current density may be adjusted with respect to the local density of structures.

In an embodiment, the openings are arranged at the rear face of the distribution body. The rear face is arranged opposite to the front face of the distribution body where the front face is configured to be directed towards the substrate for the surface treatment of the substrate. In other words, the openings to be covered by the shield element may be arranged in the direction of the anode. Accordingly, the drain rate of the process fluid into the anode side may

be adjusted. Preferably, the shield element may be directly arranged on the openings at the rear face of the distribution body.

In an embodiment, the rear face of the distribution is also configured to be directed toward an additional substrate for a surface treatment of this additional substrate. Accordingly, two substrates to be treated are arranged symmetrically relative to the distribution body and the process unit may be configured to control the coverage of the openings for two substrates. Hence, the chemical and/or electrolytic surface treatment of more than one substrate may be further facilitated and expedited. In this embodiment, the openings directing the electric current may be also through holes, directing the electric current to both substrates to be treated.

According to the present invention, also a distribution method for a process fluid and an electrical current for chemical and/or electrolytic surface treatment of a substrate is presented. The distribution method for a process fluid and an electric current for chemical and/or electrolytic surface treatment of a substrate comprises the following steps:

- providing a distribution body, wherein the distribution body comprises a plurality of openings for the process fluid and the electric current,
- providing a shield element, wherein the shield element is configured to at least partially cover at least one (or at least some) of the plurality of openings to limit a flow of the process fluid and the electric current through the distribution body, and
- controlling the flow of process fluid and the electric current through the distribution body by means of the shield element.

Accordingly, a distribution rate of a deposition material on the substrate may be adjusted. In particular, by varying a coverage of the shield element and therefore by varying a coverage of the openings of the distribution body for a process fluid and an electric current, the distribution rate of the deposition material may be controlled. Hence, the substrate may comprise a uniform layer of deposition material.

In an embodiment, the distribution body provided according to the distribution method may comprise openings for directing the process fluid and other openings for directing an electrical current. Some of the openings may be drain holes and some other openings may be jet holes. Drain holes may be configured to direct an electric current, whereas the jet holes may be configured to direct the process fluid onto the substrate. The drain holes may extend between

a front and a rear surface of the distribution body, the front surface being directed towards the substrate. In this embodiment, the shield element may be configured to cover at least partially the openings to limit a flow of the process fluid and/or a flow of the electrical current through the distribution body to modify a flow of the process fluid or alter the electrical current distribution of the substrate or modify both, the flow of the process fluid and the electrical current.

According to the present invention, also a data processing device comprising means for carrying out above described method steps is presented.

It shall be understood that the system, the method, and the data processing device 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 invention can also be any combination of the dependent claims with the respective independent claim.

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

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

Exemplary embodiments of the invention 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 and an electric current for chemical and/or electrolytic surface treatment of a substrate according to the invention. |
| Figures 2a,b | show schematically and exemplarily an embodiment of a shield element arranged at a distribution body in a distribution system according to the invention.                                                            |
| Figures 3a,b | show schematically and exemplarily an embodiment of a shield element arranged in a distribution system according to the invention.                                                                                   |
| Figures 4a,b | show schematically and exemplarily an embodiment of a shield element according to the invention.                                                                                                                     |

Figure 5

show schematically and exemplarily an embodiment of a shield element according to the invention.

#### **DETAILED DESCRIPTION OF EMBODIMENTS**

Figure 1 shows schematically and exemplarily an embodiment of a distribution system 1 for a process fluid and an electric current for chemical and/or electrolytic surface treatment of a substrate 20 according to the invention.

In chemical and/or electrolytic surface treatment techniques, a substrate 20 to be processed is attached to a substrate holder 21 and immersed into an electrolytic process fluid and serves as a cathode. An electrode is immersed into the process fluid and serves as an anode 40. A direct current is applied to the process fluid and dissociates positively charged metal ions at the anode 40. The ions then migrate to the cathode, where they plate the substrate 20 attached to the cathode.

The substrate 20 may comprise a conductor plate, a semi-conductor substrate, a film substrate, an essentially plate-shaped, metal or metallized workpiece or the like.

The distribution system 1 comprises a distribution body 10 and a shield element 30. To direct a flow of process fluid and/or an electrical current to the substrate 20, the distribution body 10 comprises a plurality of openings 11 (see also figures 3a and 3b). The openings 11 may eject the process fluid to the substrate 20 and/or receive a backflow of the process fluid from the substrate 20. Other openings 11 may eject the electric current to the substrate 20. The shield element 30 is configured to cover some of the plurality of openings 11 to limit a flow of the process fluid and/or the electric current through the distribution body 10. The shield element 30 comprises at least an aperture 32, through which the process fluid and an electrical current may flow (see also figures 4a and 4b).

The openings 11 to be covered by the shield element 30 may be drain holes. The drain holes may be formed as through holes extending between a front face of the distribution body 10 directed towards the substrate 20 and a rear face of the distribution body 10 opposite to the front face and directed towards the anode 40. The drain holes through the distribution body 10 are configured to provide the electric current towards the substrate 20 for the surface treatment of the substrate 20. The rear face is arranged opposite to the front face of the distribution body 10.

Alternatively, the openings 11 may be jet holes arranged on the front face and configured to direct the process fluid towards the substrate 20.

In yet another arrangement, the openings 11 maybe a combination of drain holes to provide an electric current and jet holes to direct the process fluid to the substrate.

The openings 11 to be covered by the shield element 30 may be arranged at the front face of the distribution body 10. The openings 11 may be drain holes or jet holes or a mixture of both. In other words, the shield element 30 may be arranged between the substrate 20 and the distribution body 10. Alternatively, the openings 11 to be covered by the shield element 30 may be arranged at a rear face of the distribution body 10. In other words, the shield element 30 may be arranged between the anode 40 and the distribution body 10.

The distribution system 1 further comprises a process unit (not shown) configured to control a coverage of the openings 11 by means of the shield element 30 based on a predetermined local deposition rate for a local portion of the substrate 20 to be treated. The process unit is further configured to determine the local deposition rate based on a local density of structures to be applied on the local portion of the substrate 20. The process unit is also configured to control the coverage of the openings by means of the shield element to limit an electrical current distribution for chemical and/or electrolytic surface treatment of the substrate. The shield element may block or cover only the openings 11 for the process fluid or the openings 11 for electric current or a mixture of both.

Figures 2a and 2b show schematically and exemplarily an embodiment of a shield element 30 arranged at a distribution body 10. The shield element 30 is plate shaped to cover an array of openings 11 (see figures 3a and 3b). The shield element 30 is movable relative to the distribution body 10, preferably in a vertical direction. To fixedly hold the shield element 30 at the distribution body 10, a shield element frame 31 is arranged at the distribution body 10. The shield element frame 31 comprises a groove, in which the plate shaped shield element can easily slide. Alternatively or additionally to the shield element frame 31, the shield element 30 may be connected to the distribution body 10 by applying an electrostatic, mechanical or magnetic force.

Figures 3a and 3b show schematically and exemplarily an embodiment of a shield element 30 arranged in a distribution system. In particular, figure 3a shows a distribution body 10 without a shield element 30. In contrast, figure 3b shows a distribution body 10, at which at least an

array of the openings 11 is covered by the plate shaped shield element 30. The coverage of the openings 11 may be determined and controlled by a process unit (not shown) based on a predetermined local deposition rate for a local portion of the substrate 20 to be treated and/or a local density of structures to be applied on the local portion of the substrate 20.

The shield element 30 corresponds to the distribution body 10 in particular in view of its shape and size. As shown in figure 3b, the shield element 30 covers a particular portion of the openings 11 such that only the remaining uncovered openings may directly eject the process fluid or the electric current to the substrate 20. The covered openings 11 are covered by the shield element 30 such that the process fluid out of these openings 11 may not directly reach the substrate 20 and/or the electric current may not directly reach the substrate 20 (see also figures 4a and 4b). A bulk material of the shield element 30 may cover for example 30%, 50% or 70% of the openings 11 of the distribution body 10.

Figures 4a and 4b show two designs of the shield element 30. As shown in figure 4a, the shield element 30 comprises a single aperture 32. As shown in figure 4b, the shield element 30 comprises a plurality of apertures 32 according to e.g. a predetermined electrical current distribution.

As an alternative, Figure 5 shows a shield element 30 comprising a plurality of stencils 33 to be inserted at least partially in at least some of the plurality of openings 11 of the distribution body 10. Further, at least one of the stencils may comprise boreholes (not shown). The boreholes may allow an additional adjustment of a coverage or an electrical current distribution by varying a diameter of the through hole.

It has to be noted that embodiments of the invention are described with reference to different 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 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 invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive. The invention 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 invention, 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 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.

**Claims**

1. A distribution system (1) for a process fluid and an electric current for chemical and/or electrolytic surface treatment of a substrate (20), comprising:
  - a distribution body (10), and
  - a shield element (30),wherein the distribution body (10) comprises a plurality of openings (11) for the process fluid and an electric current, and  
wherein the shield element (30) is configured to at least partially cover at least one of the plurality of openings (11) to limit a flow of the process fluid and the electric current through the distribution body (10).
2. Distribution system (1) according to claim 1, further comprising a process unit configured to control a coverage of the openings (11) by means of the shield element (30) based on a predetermined local deposition rate for a local portion of the substrate (20) to be treated.
3. Distribution system (1) according to the preceding claim, wherein the process unit is further configured to determine the local deposition rate based on a local density of structures to be applied on the local portion of the substrate (20).
4. Distribution system (1) according to claim 2 or 3, wherein the process unit is configured to control the coverage of the openings (11) by means of the shield element (30) to limit an electrical current distribution for chemical and/or electrolytic surface treatment of the substrate (20).
5. Distribution system (1) according to one of the preceding claims, wherein the shield element (30) is plate shaped to cover an array of openings (11).
6. Distribution system (1) according to one of the preceding claims, wherein the shield element (30) is movable relative to the distribution body (10).

7. Distribution system (1) according to the preceding claim, wherein the shield element (30) is mechanically, electro-statically and/or magnetically connected to the distribution body (10).
8. Distribution system (1) according to one of the preceding claims, wherein the shield element (30) comprises a plurality of stencils (33) to be inserted at least partially in at least some of the plurality of openings (11) of the distribution body (10).
9. Distribution system (1) according to claim 8, wherein at least one of the stencils (33) comprise boreholes.
10. Distribution system (1) according to one of the preceding claims, wherein the openings (11) are drain holes configured to direct the electric current and wherein the drain holes are through holes extending between a front face of the distribution body (10) directed towards the substrate (20) and a rear face of the distribution body (10) opposite to the front face.
11. Distribution system (1) according to one of the preceding claims, wherein the openings (11) are jet holes configured to direct the process fluid onto the substrate (20).
12. Distribution system (1) according to one of the preceding claims, wherein the openings (11) are arranged at the front face of the distribution body (10), wherein the front face of the distribution body (10) is configured to be directed towards the substrate (20) for the surface treatment of the substrate (20).
13. Distribution system (1) according to one of the claims 1 to 11, wherein the openings (11) are arranged at the rear face of the distribution body (10), wherein the rear face is arranged opposite to a front face of the distribution body (10), wherein the front face is configured to be directed towards the substrate (20) for the surface treatment of the substrate (20).

14. A distribution method for a process fluid and an electric current for chemical and/or electrolytic surface treatment of a substrate (20), comprising the following steps:
  - providing a distribution body (10), wherein the distribution body (10) comprises a plurality of openings (11) for the process fluid and the electric current,
  - providing a shield element (30), wherein the shield element (30) is configured to at least partially cover at least one of the plurality of openings (11) to limit a flow of the process fluid and the electric current through the distribution body (10), and
  - controlling the flow of process fluid and the electric current through the distribution body (10) by means of the shield element (30).
15. A data processing device configured for carrying out the method steps of claim 14.