METHOD AND DEVICE FOR TREATING SUBSTRATES

Field of the invention and prior art

[0001] The invention relates to a method for treating substrates, in particular for the production of photovoltaic modules, and to an apparatus suitable for carrying out this method.

[0002] In photovoltaic technology, and in particular PCB technology, resist layers are removed from the corresponding substrates by means of a process solution. This sometimes involves using process solutions which froth or, in combination with the resist or other substances with which they come into contact during cleaning, lead to froth formation. Such resists are wax-like hot melts or thermal inks or polymers or inks that can be applied by means of printers or photolithography and screen printing. The said froth formation may lead to interruptions in the process or to malfunctions of the installations, under some circumstances even to the extent that the process solution can no longer be used at all. Froth can also occur in cases where the process solution is recirculated or sprayed onto the substrates and possibly also in a return from a process chamber to a tank or container.

[0003] Antifrothing agents are used as additives to reduce froth. However, they are increasingly meeting with disapproval for reasons of cost and environmental protection, since there is an increase in both the total organic carbon (TOC) load of the waste water and the chemical oxygen demand (COD) value, and consequently the discharge values for the waste water are exceeded. This therefore means that the loading of the water with organic substances is too high.

Problem and solution

[0004] The invention addresses the problem of providing a method specified at the beginning and an apparatus suitable for carrying it out with which problems of the prior art can be avoided and, in particular, froth formation in the process solution when removing resist layers from substrates can be minimized.

[0005] This problem is solved by a method with the features of Claim 1 and an apparatus with the features of Claim 7. Advantageous and preferred embodiments of the invention are the subject of the further claims and are explained in more detail below. Some of the features enumerated below are only mentioned for the method or only mentioned for the apparatus. However, irrespective of this, it is intended that they can apply both to the method and to the apparatus. The wording of the claims is made the content of the description by express reference.

[0006] According to the invention, it is provided that the substrates are first wetted with the process solution in a main stripping module and then in a post-stripping module; it may also be possible to do without the post-stripping module. Process solution collects in containers under the modules or at least in a container under the main stripping module. In this case, at least one container is provided for the post-stripping module, with at least two containers being provided for the main stripping module. Process solution is first fed from the main stripping module directly into a second container, in particular by a pipe that is bent or angled at least once. The second container is substantially separated from the first container of the main stripping module by a wall in between, which however is liquid-permeable as a result of clearances, holes, cutouts or the like in a region significantly below the surface level of process solution located in it. In particular, the liquid permeability is provided as low down as possible in the containers. The two containers may in this case be formed by inserting a wall into a large container, that is to say by separating it. The said clearances or the like are then either provided in the lower region of the wall

or else the wall is inserted not quite down to the bottom. Process solution is removed from the first container, in particular pumped out by means of a pump, and returned into the cycle of the process for wetting the substrates.

[0007] Consequently, it is thus provided that, in the main stripping module, the process solution collects in a second container and froth is thereby produced on its surface, or froth that is present rises to the surface. As a result of the liquid-carrying connection to the first container, the latter is likewise filled with process solution, but as far as possible without froth. Consequently, process solution that is substantially froth-free can be removed there for renewed spraying or wetting of the substrates.

[0008] To collect the process solution in the main stripping module, under some circumstances also in the post-stripping module, a kind of pan or the like may be provided as a collecting pan, with a lowest point from which a pipe or other line leads into the said container. Such a return pipe can indeed reduce froth formation, or make the froth break down again as far as possible, as a result of the said bending or its shaping in general.

[0009] In a further refinement of the invention, it may be provided that froth in the second container, on the surface of process solution located in it, is moved over a side wall of the container, that is to say is removed as it were, into a separate froth pan arranged alongside. This may be performed in various ways, for example with mechanical slides, by blasting with compressed air or by spraying, in particular spraying with process solution itself. The spraying is regarded as advantageous in particular, since in this case not only is the froth as it were mechanically moved but also at least partially broken down or made to disintegrate. In this froth pan there may then likewise once again be process solution with froth on the surface, the process solution once again being removed and advantageously returned into the first container, particularly advantageously once again by pumping. Alternatively, a branch to a waste-water discharge line or treatment may be provided.

[0010] To allow better control of the movement of the froth away from the second container into the froth pan, that is to say when the froth is moved over a side wall of the second container, a kind of height-adjustable weir or kind of bulkhead strip may be provided. This can respectively be adjusted in height so as to be located at the height of the liquid level of the process solution or a little above it. This achieves the effect that only froth is pushed over the side and, as far as possible, no process solution.

[0011] In an advantageous refinement of the invention, the froth may also be broken down or eliminated in the froth pan by spraying, in particular once again with process solution.

[0012] A number of nozzle devices or spraying devices arranged one behind the other may be provided in the direction of movement of the froth towards the froth pan, in order as it were to break down the froth repeatedly and move it well. The individual devices then do not have to be operated with very great pressure, which in turn is advantageous for the movement and the conversion into process solution.

[0013] The aforementioned return pipe may be advantageously formed in such a way that it ends below the surface of the process solution in the second container. This allows froth formation during feeding into the second container to be reduced.

[0014] A post stripping module may be constructed in a way similar to the main stripping module, that is to say for example be of approximately the same length and also have a first and a second container for the process solution used in it. The post stripping module is advantageously of a shorter and simpler construction and has only a single container. In this in turn, the process solution used in the post stripping module is collected, advantageously in a way similar to in the main stripping module, and then fed into the container. Once again a return pipe described above may be provided for this. With the simplified construction of the post stripping module with only one container, it is possible to return the process solution

from there once again into one of the containers of the main stripping module for renewed use there. For this purpose, either once again a liquid-permeable wall may be provided or a wall with clearances or the like. Alternatively, a cascade of the containers may be provided in the post stripping module, transferring process solution while likewise avoiding froth formation as far as possible.

[0015] Both in the main stripping module and in the post stripping module, spraying devices or the like for the process solution may be fed from a single container, namely the first container of the main stripping module. The avoidance of froth formation can then concentrate entirely on the process solution in this container.

[0016] These and other features emerge not only from the claims but also from the description and the drawings, where the individual features can be realized in each case by themselves or as a plurality in the form of subcombinations in an embodiment of the invention and in other fields and can constitute advantageous and inherently protectable embodiments for which protection is claimed here. The subdivision of the application into individual sections and subheadings does not restrict the general validity of the statements made thereunder.

Brief description of the drawings

[0017] Exemplary embodiments of the invention are illustrated schematically in the drawings and are explained in greater detail below. In the drawings:

Figure 1 shows a schematic side illustration of an installation according to the invention for treating substrates,

Figure 2 shows a main stripping module and a post stripping module from Figure 1 in an enlargement with functional illustrations,

Figure 3 shows a view of the main stripping module according to Figure 2 in the direction in which the substrates run through,

Figure 4 shows a plan view of the illustration corresponding to Figure 3 and

Figure 5 shows a view of an immersion bath instead of spray pipes for the substrates in an alternative main stripping module.

Detailed description of the exemplary embodiments

[0018] Figure 1 illustrates an installation 11 according to the invention for treating substrates 13, the substrates 13 advantageously being for solar cells for photovoltaic modules. The installation 11 has in a way known per se an entry module 15, which is adjoined by an etching module 17. There, the structures on the substrates 13 are opened by etching, as is also known, for which reason it does not have to be discussed in any further detail. After the etching module 17 there is a likewise known rinsing module 19.

[0019] This is adjoined by a main stripping module 21, as has been explained in general above, which in turn is followed by a post stripping module 23. That in turn is then followed by a second rinsing module 25, a drying module 27 and an exit module 29. Thus, the substrates 13 are treated in a way known per se in the direction of running through from left to right.

[0020] The main stripping module 21 has above the substrates 13, or their running-through path, upper spray pipes 31a and, below them, lower spray pipes 31b. These respectively spray process solution 33 onto the substrates 13, which could alternatively also be performed only from one side. As has been described above, the substrates 13 are freed of resist by the sprayed-on process solution 33. Underneath the substrates 13 there is a container 32, in which the process solution 33 finally collects. On the surface of the process solution 33 there is froth 34, which is, as far as possible, to be avoided or eliminated in the manner described below. By means of a pump 36, process solution 33 is pumped out of the container 32

and fed again to the spray pipes 31a and 31b, for the removal of resist layers from the substrates 13.

[0021] In the post stripping module 23 there are upper spray pipes 38a and lower spray pipes 38b for the substrates 13. These serve the purpose of removing remains of resist layers from the substrates 13, generally no longer being very great in number. This has the result that only very little or scarcely any froth is produced in the container 39 under the substrates 13 in the post stripping module 23, so that virtually only process solution 33 is contained there. By means of a cascade line 40, such process solution that is substantially froth-free can be fed into the container 32 alongside the mainstream module 21. Furthermore, the spray pipes 38a and 38b can be supplied with process solution 33 by means of a pump 42.

[0022] In the detailed illustration according to Figure 2 it can be seen that underneath the substrates 13 or their running-through path there is a collecting pan 44. This collects all of the process solution 33 discharged from the spray pipes 31a and 31b and feeds it into the container 32 by means of a return pipe 46, to be precise into a second tank container 49 on the right. As illustrated, the return pipe 46 may be bent or kinked one or more times or be formed in some other way to feed process solution 33 that is carried in it into the second tank container 49 froth-free, or with the froth being reduced as much as possible. One end of the return pipe 46 may either end near the surface level of the process solution 33. Alternatively, it may end deeper, which in many cases serves for reducing froth further.

[0023] On the surface of the process solution 33 in the second tank container 49 there is a considerable amount of froth 34, since the froth formation is increased here by the fragments of resist detached from the substrates 13. In the container 32, a first tank container 48 is also formed by a separating wall 51. This may be performed simply by inserting the separating wall 51 into the container 32. In this case, an opening 52 is provided in the lower region of the separating wall 51, for example by the separating wall 51 not extending quite down to the bottom. Alternatively,

openings or apertures or clearances could also be provided in the separating wall 51. Consequently, the first tank container 48 and the second tank container 49 are connected to each other in a liquid-carrying manner. An exchange of process solution 33 alone, that is to say without froth 34, takes place through the opening 52 in the lower region. This has the effect that only uncontaminated process solution 33, or little froth, is actually contained in the first tank container 48.

[0024] Likewise provided in the post stripping module 23, which is illustrated on an enlarged scale, is a collecting pan 55, which can feed the process solution 33 into the container 39 in fact in a very simple manner. Since scarcely any fragments of resist are contained here in the process solution 33, or none at all, froth formation is indeed reduced considerably. Alternatively, a return pipe 46 may be provided in a way similar to in the main stripping module 21. It can be seen that the process solution 33 in the container 39 has no froth.

[0025] Furthermore, a cascade line 40 is provided, in order to feed the process solution 33, which is froth-free and substantially resist-free, and consequently still very unused, into the container 32, that is to say as it were to refresh the process solution there. Such a cascade line 40 may, in a way similar to the return line 46, be designed for reducing froth. It may either lead into the first tank container 48 or, as illustrated, lead into the second tank container 49.

[0026] In Figure 3, a sectional illustration through the main stripping module 21 in the direction in which the substrates run through is shown. It can be seen that froth 34 formed on the second tank container 49 is treated or moved. For this purpose, there is a froth pan 59 alongside the second tank container 49 to the right, separated by a side wall 50. It is intended for the froth 34 to be introduced into this froth pan and broken down, in order that the process solution 33 can be used again. In order that, as far as possible, only froth 34 is transported to the right and no process solution 33 runs out of the second tank container 49, a height-adjustable bulkhead strip

57 is provided. This can be moved up to such a height that it corresponds approximately to the surface level of the uncontaminated process solution 33 in the second tank container 49. Only froth 34 is then still moved to the right over it into the froth pan 59.

[0027] For moving the froth 34, pipe-like elongated froth nozzles 61a are provided as spraying devices on the extreme left over the second tank container 49 and froth nozzles 61b near the sidewall 50 or the bulkhead strip 57. These nozzles are called froth nozzles because they are designed for and serve the purpose of moving the froth or even breaking it down. They are not, however, in any way intended to serve for or be conducive to producing froth. The nozzles may have round nozzle openings or elongated openings, for example in the manner of slit nozzles. A plurality or even a multiplicity of such nozzles is provided on elongated pipes, for which reason they are indeed referred to as pipe-like and elongated.

[0028] These froth nozzles are all directed to the right and obliquely downwards, that is to say approximately in one direction; the froth nozzles 61a are even at a still shallower angle. They spray process solution 33 out at high pressure as a more or less fine mist, which drives the froth 34 from the surface of the process solution 33 in the second tank container 49 to the right into the froth pan 59 and already breaks it down somewhat, that is to say reduces it.

[0029] Above the froth pan 59 there are third froth nozzles 61c, the direction of the jet of process solution 33 of which is obliquely downwards to the left, to be precise as it were onto the entire surface of the froth 34 in the froth pan 59. This does not serve for moving the froth 34 but for breaking it down, so that it again assumes the form of uncontaminated process solution 33. Process solution 33 can then be removed from the froth pan 59 by means of a discharge line 62 and a drainage pump 63 and, depending on the state or resist content, either be passed on for waste-water treatment or else be returned into the cycle.

[0030] To the left alongside the second tank container 49 there is a first tank sub-container 48' of the first tank container 48. It is separated by a separating wall 50' with an opening 52' provided in the lower region and has the previously described pump 36, which supplies the spray pipes 31a and 31b.

[0031] In the plan view according to Figure 4, it can be seen how froth 34 on the surface of the process solution 33 both over the first tank container 48 and over the second tank container 49 is moved downwards in the illustration and towards the froth pan 59 by means of the froth nozzles 61a and 61b. A separating wall 51 between the first tank container 48 and the second tank container 49 can also be seen. At the top left there is the previously described first tank sub-container 48', separated from the first tank container 48 by the said separating wall 51'. It can be seen that the side wall 50 runs over the entire width of the first tank container 48 and the second tank container 49 alongside each other, and similarly also the froth pan 59. The same applies to the froth nozzles 61a, 61b and 61c.

[0032] Illustrated in Figure 5 is a modification of the illustration from Figure 2 with a main stripping module 21', in which the container 32' with process solution 33 in it and the return pipe 46' correspond to the configuration from Figure 2. The modification here is that the substrates 13 are not transported as it were freely in the air by a roller transporting path and sprayed by the spray pipes 31, but are taken through an immersion bath 45'. In this case, surge pipes 65a and 65b above and below the substrates serve the purpose of additionally mixing up the process solution 33 even during the immersion, and consequently of intensifying the effect of the treatment. For the upper surge pipes 65a it is provided that they may either be immersed in the process solution 33 or else be partly immersed and partly above it, and can then possibly even also perform a spraying function. The surge pipes 65a and 65b are supplied by means of a pump 36' in the liquid container 32'.

[0033] Figure 5 reveals that the principle of the immersion bath is also realized here in the case of the post-stripping module to the right thereof, which however does not necessarily have to be the case. Therefore, a precise explanation is not given here. The treating of substrates in an immersion bath instead of by spraying is known in principle. In this respect, the technical implementation is also not difficult for a person skilled in the art. The advantage here is, in particular, that little froth is produced in the chamber of the main stripping module 21. Combinations of these techniques are also possible.

[0034] Illustrated here is the application of the invention in individual process chambers or modules in which the substrates are sprayed or immersed in a continuous treatment bath or immersion bath. It may, however, also be advantageously used in the case of baths with standing waves, so that wetting can take place over the surface area without immersion. An effective application of the invention may also be obtained in combination with ultrasound.

Patent claims

1. Method for treating substrates, in particular for the production of photovoltaic modules, wherein in one method step resist layers are removed from the substrates by spraying or wetting with process solution, wherein the substrates are wetted with the process solution first in a main stripping module and then in a post stripping module, and process solution collects in containers beneath the modules, wherein at least one container is provided for each module and wherein the containers of different modules are separated from one another, wherein the process solution in the main stripping module is collected in two containers and first fed directly into a second container, which is substantially separated from the first container by a wall, which is liquid-permeable as a result of clearances or holes in a region significantly below the surface level of process solution located in it, wherein process solution is removed from the first container and returned once again into the cycle of the process for wetting the substrates.

2. Method according to Claim 1, wherein the process solution is fed into the second container in a return pipe from a collecting device of a flat form in the main stripping module, wherein preferably froth formation is reduced by shaping of the return pipe, in particular with at least one bend.

3. Method according to Claim 2, wherein the return pipe ends below the surface level of the process solution in the second container.

4. Method according to one of the preceding claims, wherein froth in the second container, on the surface of the process solution, is moved by spraying devices over a side wall of the container into a separate froth pan arranged alongside, wherein disintegrated froth or

cleaning process solution is removed or pumped out of the froth pan and returned into the first container.

5. Method according to Claim 4, wherein the froth in the froth pan is also sprayed with process solution from above by means of spraying devices for breaking down the froth or eliminating the froth and converting it into process solution.

6. Method according to one of the preceding claims, wherein process solution from the post stripping module or a container provided there is directed into the second container in the main stripping module, in particular is directed via at least one cascade.

7. Apparatus for treating substrates, in particular for the production of photovoltaic modules, preferably for carrying out the method according to one of the preceding claims, wherein a main stripping module and a downstream post-stripping module are provided for the substrates, with spraying devices or wetting devices for applying process solution to substrates in a transporting path through the stripping modules, wherein the main stripping module has two containers for collecting the process solution, with process solution being fed into the second container after it has been collected, wherein the second container is largely separated from a first container by a wall, which is liquid-permeable as a result of clearances or the like in a region significantly below the surface level of process solution located in it.

8. Apparatus according to Claim 7, characterized by a collecting device of a flat form in the main stripping module with a return pipe which leads into the second container, in particular below a surface level of process solution in it, preferably in the lower third.

9. Apparatus according to Claim 8, wherein the return pipe is designed for reducing froth formation of process solution flowing through, in particular by at least one bend.

10. Apparatus according to one of the claims 7 to 9, characterized by spraying devices above the containers in the main stripping module, which have a spraying direction towards a side region of at least one of the containers, preferably of both containers, wherein a froth pan is arranged in this side region for collecting froth that has moved over a side wall of the container, wherein in particular a further spraying device is directed into the interior of the froth pan for breaking down the froth located in it as process solution.

11. Apparatus according to one of the claims 7 to 10, characterized by an immersion bath with process solution for the substrates in the main stripping module as a wetting device, in particular also in the post-stripping module, wherein preferably an overflow from the immersion bath into the second container is provided.

12. Apparatus according to Claim 11, characterized by surge pipes above and below a running-through path for substrates through the immersion bath for specifically directed application or wetting with process solution.

13. Apparatus according to one of the claims 7 to 12, characterized by a cascading line from a container for collecting process solution in the post-stripping module into the second container of the main stripping module.