US 20050061661A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2005/0061661 A1**

Muller-Hipper et al. (43) **Pub. Date: Mar. 24, 2005**

(54) **ELECTRODEPOSITION DEVICE AND ELECTRODEPOSITION SYSTEM FOR COATING STRUCTURES WHICH HAVE ALREADY BEEN MADE CONDUCTIVE**

(75) Inventors: **Andreas Muller-Hipper**, Regensburg (DE); **Ewald Simmerlein-Erlbacher**, Pegnitz (DE); **Andreas Karl**, Tegernheim (DE)

Correspondence Address:
DARBY & DARBY P.C.
P. O. BOX 5257
NEW YORK, NY 10150-5257 (US)

(73) Assignee: **Infineon Technologies AG**, Munich (DE)

(21) Appl. No.: **10/916,308**

(22) Filed: **Aug. 11, 2004**

Related U.S. Application Data

(63) Continuation of application No. PCT/DE02/03916, filed on Oct. 16, 2002.

(30) **Foreign Application Priority Data**

Oct. 25, 2001 (DE)..... 101 53 056.0
Jul. 30, 2002 (DE)..... 102 34 705.0

Publication Classification

(51) **Int. Cl.**[7] **C25D 17/00**
(52) **U.S. Cl.** **204/203**; 204/204

(57) **ABSTRACT**

Electrodeposition device for electrodepositing an electrically conductive layer on a substrate having an electrolyte bath in which an anode device and at least one contact-making unit are arranged, each contact-making unit having a plurality of electrically conductive regions of which at least one is connected cathodically and at least one is connected anodically.

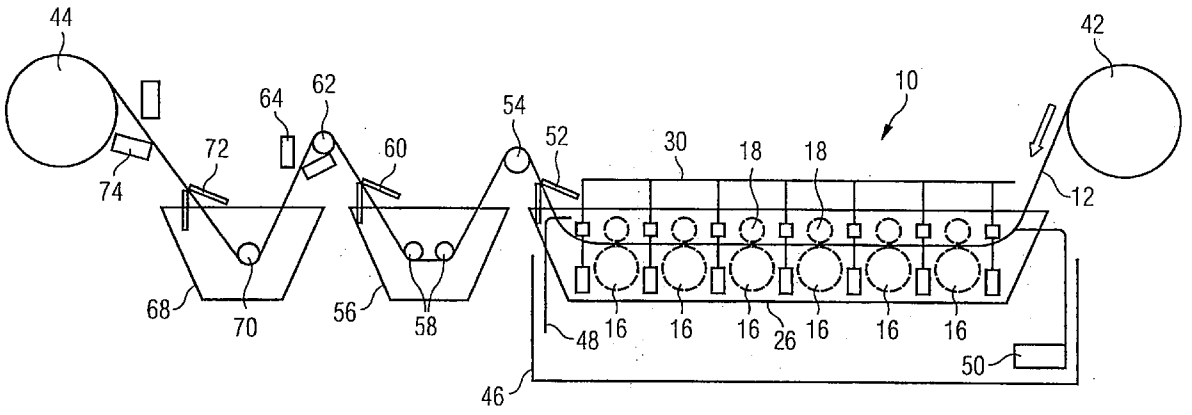


FIG 1

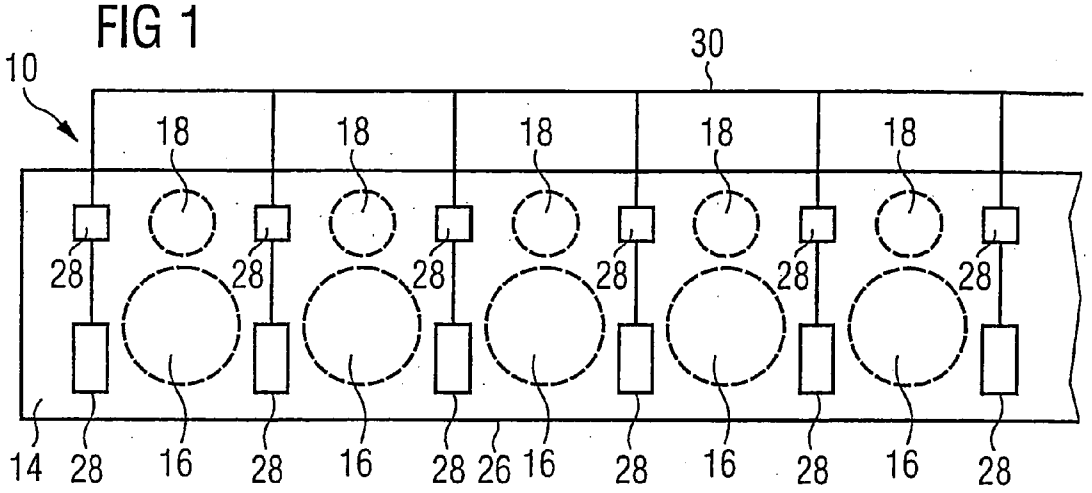


FIG 2

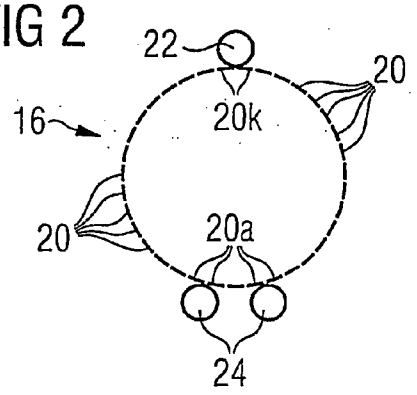
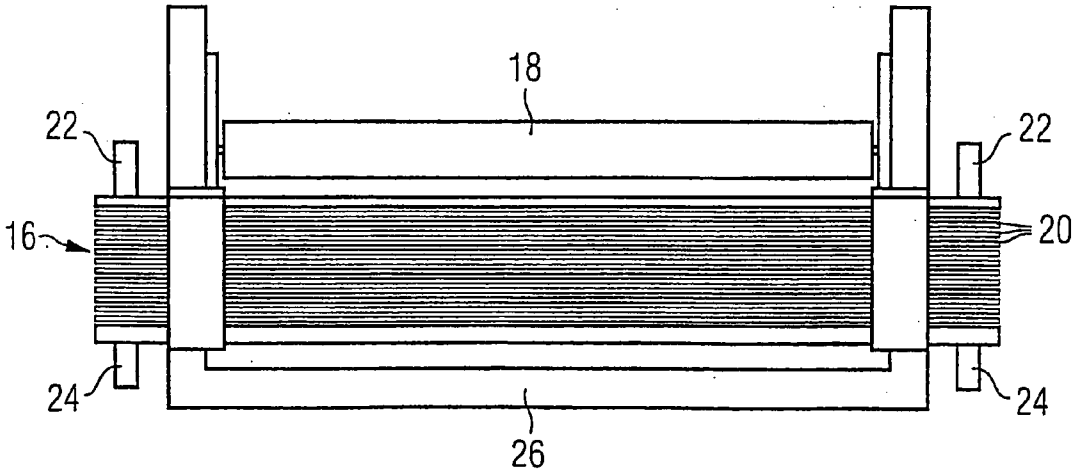


FIG 3



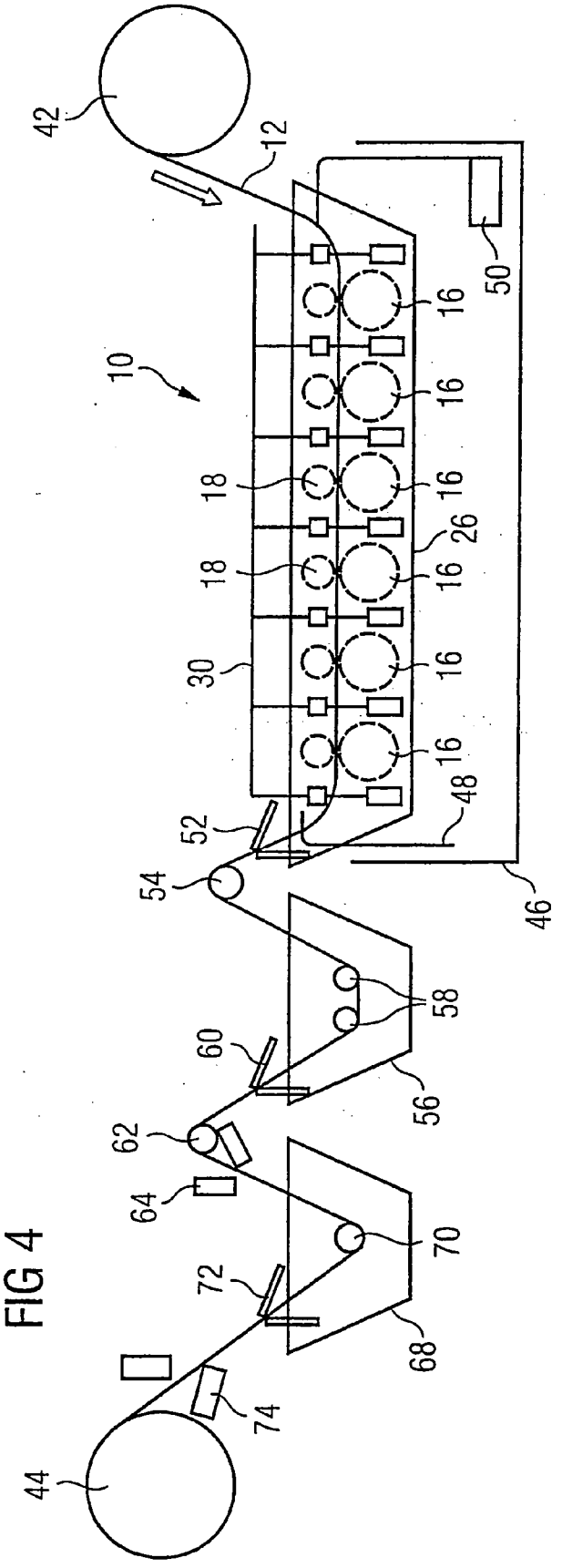


FIG 4

FIG 5

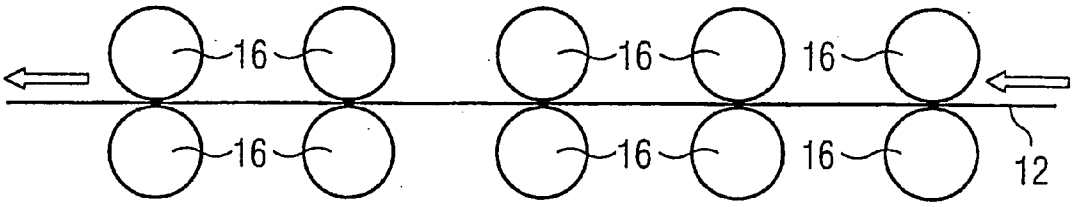


FIG 6

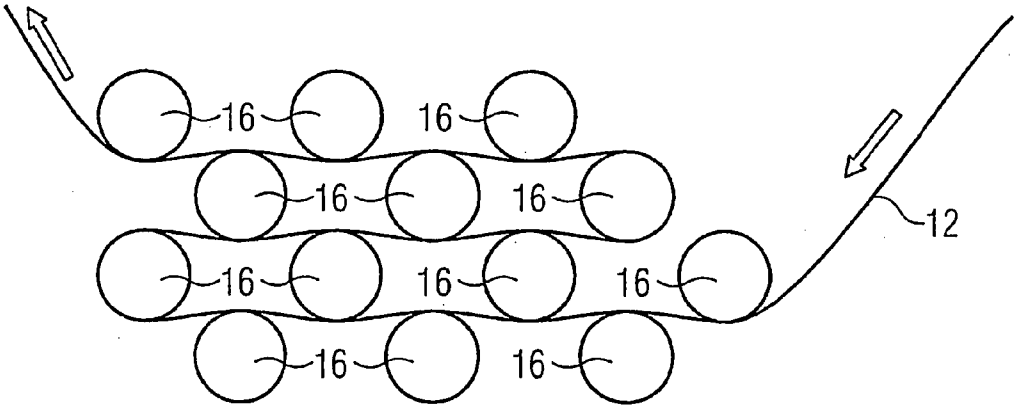


FIG 7

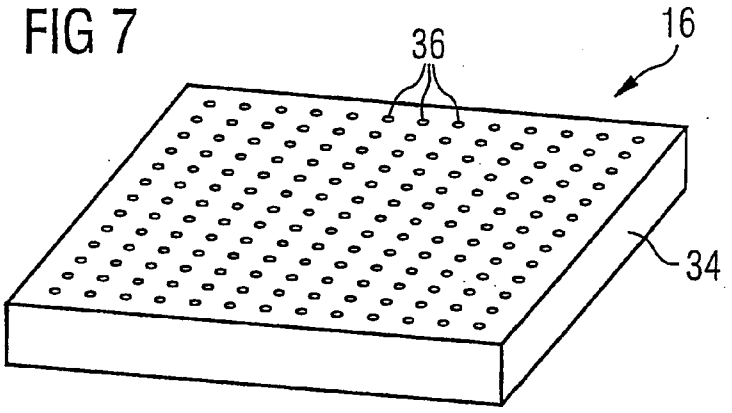


FIG 8

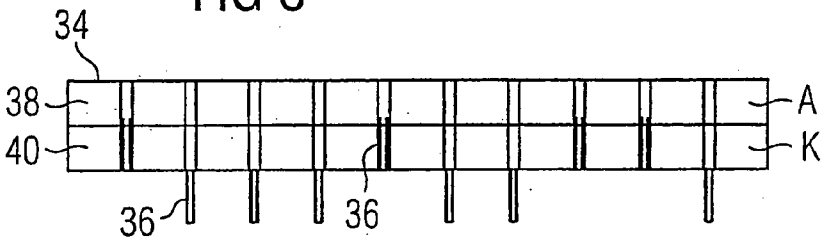


FIG 9

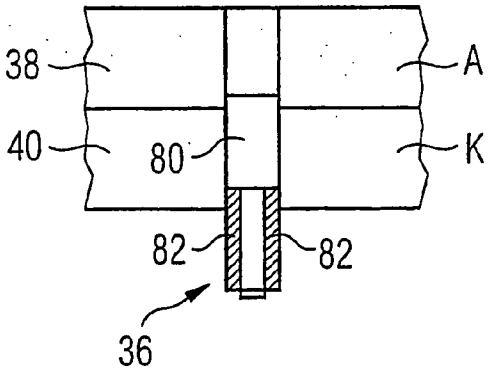


FIG 10

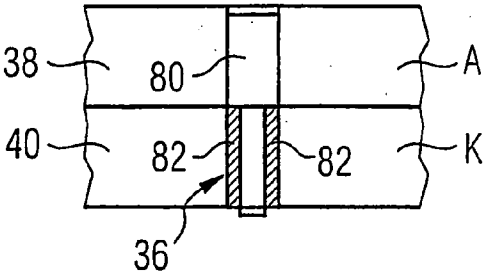


FIG 11

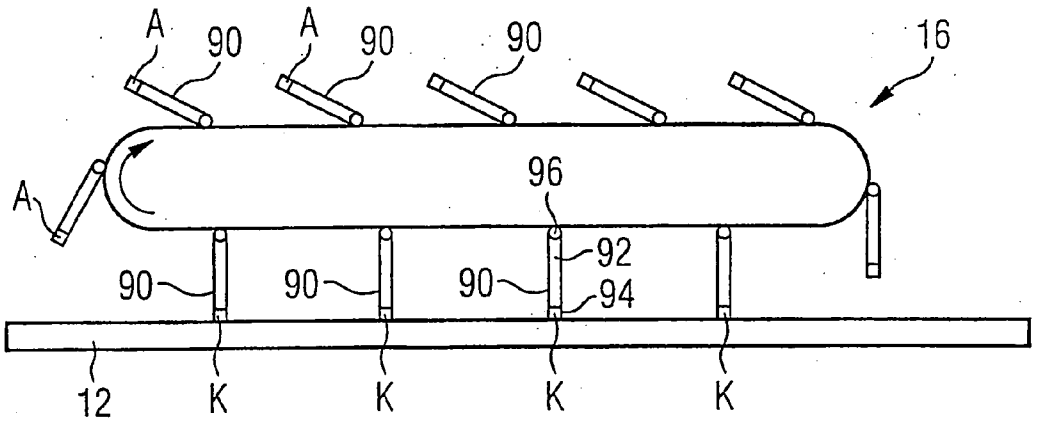
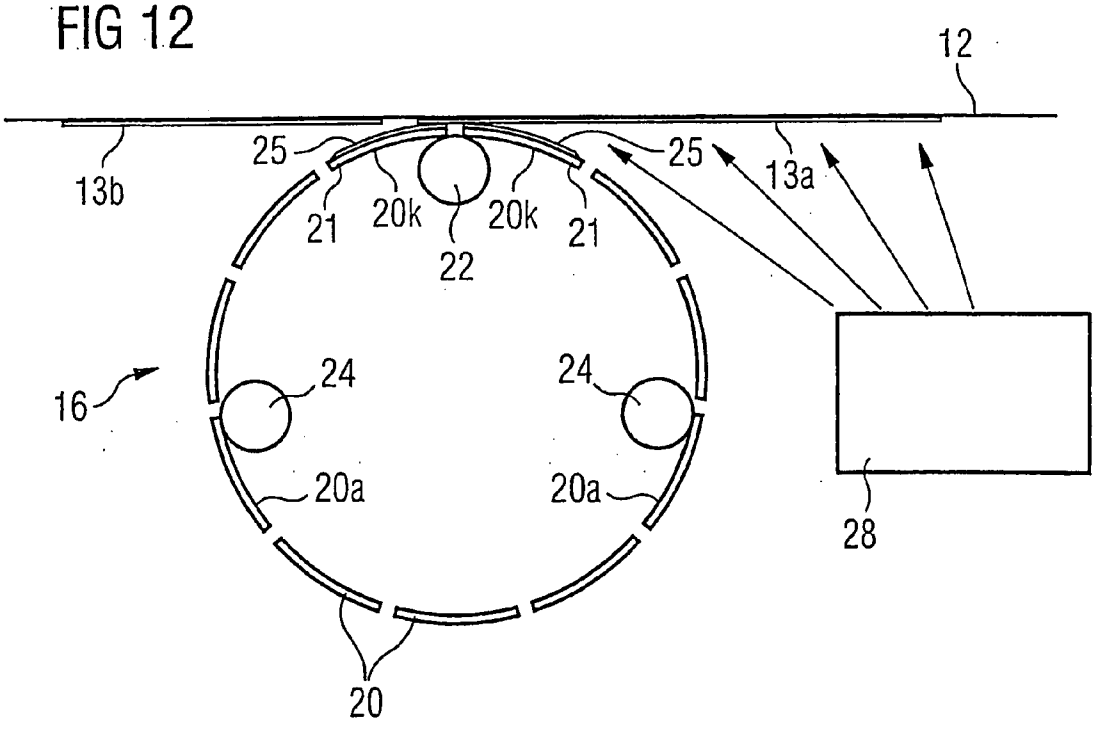

A
90
A
90
90
16
A
96
92
90
90
90
94
12
K
K
K
K

FIG 12


12
13b
25
25
13a
21
20k
20k
21
22
16
24
24
20a
20a
28
20

ELECTRODEPOSITION DEVICE AND ELECTRODEPOSITION SYSTEM FOR COATING STRUCTURES WHICH HAVE ALREADY BEEN MADE CONDUCTIVE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a continuation of International Patent Application Serial No. PCT/DE02/03916, filed Oct. 16, 2002, which published in German on May 8, 2003 as WO 03/038158, and is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0002] The invention relates to an electrodeposition device and to an electrodeposition system for the electrodeposition of an electrically conductive layer on a substrate.

BACKGROUND OF THE INVENTION

[0003] Electrodeposition devices and electrodeposition systems are used to produce conductor structures or conductor layers which cover the entire surface. By way of example, antenna coils, printed circuit boards, chip card modules or the like are produced using devices of this type. Hitherto, conductor structures of this type have been produced using subtractive processes.

[0004] For this purpose, a metal cylinder, which is continuously connected as cathode, is at least partially immersed in an electrolyte bath in which there is an electrolyte and is set in rotation. There is an anode device in the electrolyte bath. Depending on the electrolyte used, a metal layer is deposited on the slowly rotating cathode, and outside the electrolyte this metal layer is laminated onto a nonconductive sheet which is referred to as the substrate.

[0005] In the method in which a metal layer can be produced only on a single side of the carrier substrate, there are limits on the minimum thickness of metal which can be achieved, since the metal foil, which is generally made from copper, is peeled off the cathode and applied to the sheet, which consists of plastic. The minimum sheet thickness is limited to approximately 17 μm by the subsequent further processing, on account of the possibility of cracks then forming.

[0006] After a sheet-like metal layer has been laminated onto the sheet, this metal layer having a thickness in the range from 17 μm to 75 μm, an etching resist is applied to the metal layer and is then exposed using photolithographic techniques. The subsequent etching step is used to etch away those regions of the metal layer which covers the entire surface which are not required for patterning with conductor runs. After the etching resist which remains on the patterned metalization has been removed, the desired conductor structure is complete. The method described, which makes use of the subtractive principle referred to in the introduction, firstly has the drawback that only low throughput rates can be achieved, a high consumption of chemicals is required and large amounts of the raw materials used (metal layer) are wasted on account of the subtractive method.

[0007] A further drawback is the fact that anodic cleaning of the cylindrical cathode has to take place at regular intervals. The anodic cleaning may take place either with nitric acid, so that it is necessary to completely drain the electrolyte out of the electrolyte bath. During this time, the electrodeposition device cannot be used for production. Alternatively, a cathodic-anodic pulsed switching is known for cleaning purposes. In a device of this type, however, very high demands are imposed on the rectifier, since it has to apply very high currents for very short times in pulsed mode. Therefore, an installation of this type is very expensive in terms of procurement and maintenance costs.

SUMMARY OF THE INVENTION

[0008] The invention is therefore based on an object of providing an electrodeposition device and an electrodeposition system which, compared to the prior art, allows more rapid and simpler as well as less expensive production of an electrically conductive layer on a substrate.

[0009] This object is achieved by the features of claim **1** (electrodeposition device) and by the features of claim **13** (electrodeposition system). Advantageous configurations will in each case emerge from the dependent claims.

[0010] The production of the electrically conductive layer by means of the electrodeposition device according to the invention takes place on a substrate which has structures which have already been made conductive. The conductive structures preferably consist of conductive particles which have been applied to a surface of the substrate and -are fixed to the substrate. The conductive particles are applied to the surface of the substrate in "uncovered" form, i.e. without an embedding material surrounding them. The conductive particles are applied, for example, by being blown, sprayed, rolled or brushed on. To achieve sufficient bonding between the conductive particles and the surface of the substrate, the particles may have been applied to the substrate body thermally and/or statically and/or magnetically and/or by means of a bonding layer. The conductive particles may, for example, consist of metal, preferably of copper, iron, nickel, gold, silver, aluminum, brass or an alloy, of graphites or of conductive polymer particles. During application to the substrate, the particles are preferably in powder form.

[0011] The substrate preferably consists of a nonconductive material, the surface of the substrate having adhesive properties. The adhesive properties of the surface may be activated, for example, by the surface being softened or by the application of an adhesive. The softening of the surface may be brought about by means of thermal radiation, ultrasound or a solvent. The surface may for this purpose have been treated with a solvent in advance, i.e. before the application of the conductive particles. Alternatively or in addition, the conductive particles may also be pretreated with a solvent before they are applied to the substrate body.

[0012] The application of the conductive particles to the substrate, i.e. before the actual electrodeposition operation, means that the desired conductor structure, which may, of course, also cover the entire surface, is already defined. The pretreatment of the substrate ensures that the conductive particles continue to adhere to the substrate only at those locations at which a bonding agent is provided. The electrodeposition device or the electrodeposition system therefore serves to thicken the conductive particles by electrodeposition. It can be seen from this description that in the electrodeposition device according to the invention it is

possible to dispense with a supply belt—the sheet described in the introduction—since only the layout which is actually desired, i.e. for example a conductor structure, is subjected to electrodeposition.

[0013] The electrodeposition device according to the invention for the electrodeposition of an electrically conductive layer on the substrate has an electrolyte bath in which an anode device and at least one contact-making unit are arranged, each contact-making unit having a plurality of electrically conductive regions, of which in each case at least one is connected cathodically and anodically.

[0014] Unlike in the prior art, in which the contact-making device comprises an element (metal cylinder) which is connected exclusively cathodically, the electrodeposition device according to the invention has a contact-making unit which can be connected both cathodically and anodically. The electrodeposition device which is thereby defined is therefore self regenerating. This means that the electrodeposition device no longer has any down times which are required in standard devices for the anodic cleaning of the cathodically connected roller. As a result, it is possible to achieve significantly higher throughput rates, with the result that the unit costs of the conductor structures which are to be produced also fall.

[0015] Since the conductive particles which accumulate at a cathodically connected electrically conductive region can only in part be used to thicken the conductive particles on the substrate by electrodeposition, over the course of time the electrically conductive regions become contaminated. Since each of the electrically conductive regions is connected anodically at least once after it has been connected cathodically, the contact-making unit is self-cleaning. The object which is to undergo electrodeposition serves as an auxiliary cathode.

[0016] Therefore, the anodic cleaning of the contact-making device in the manner which has been known hitherto can be dispensed with, since each electrically conductive region of a contact-making device can be connected both as cathode or as anode. The conductive regions are connected cathodically or anodically depending on their position. In particular, various electrically conductive regions can simultaneously be connected cathodically or anodically.

[0017] Since there is then always at least one electrically conductive region which is connected both cathodically and anodically, the electrodeposition device can operate continuously.

[0018] The conductor structures are, for example, the antenna coils or chip modules which were referred to in the introduction. Inexpensive production is also made possible by the fact that after the thickening by electrodeposition using the electrodeposition device, there is no need for any further processing steps apart from that of dividing up individual conductor structures. Therefore, the procedure according to the invention is an additive or semi-additive process for production of a conductor structure.

[0019] Furthermore, the qualitative metal structure of the electrically conductive layer results in a uniform thickness which can be controlled accurately and is extremely homogeneous. Furthermore, it is possible to use the electrodeposition device according the invention to produce a double-sided metalization on the substrate. For this purpose, it is necessary for the substrate to have been provided with the conductive particles in structured form on both sides before the treatment with the electrodeposition device. In addition to the advantage of the simultaneous formation of a double-sided metal layer, the self-generating formation of electrical through-contacts is then also possible. These contacts, together with the associated conductor structures on the opposite main sides of the substrate, form a metallic unit with a more or less uniform layer thickness.

[0020] A further advantage is that it is also possible to produce different layer thicknesses in a single operation in the electrodeposition device by varying the current intensity of the electrodeposition device and/or the rate of passage of the substrate through the electrodeposition device.

[0021] It is sufficient for in each case one electrically conductive region to be connected cathodically and anodically. However, it is also conceivable for adjacent electrically conductive regions to be simultaneously connected cathodically. This makes it possible to accelerate the thickening of the substrate by electrodeposition. In a corresponding way, it is also possible for a plurality of electrically conductive regions—which are not necessarily arranged directly adjacent to one another—to be simultaneously connected anodically. It is preferable for the electrically conductive region(s) of the contact making unit which is/are connected as anode to be arranged in the vicinity of the electrically conductive region connected as cathode. The electrically conductive regions which are connected as anode then form an auxiliary anode.

[0022] In principle, the contact-making unit may be of any desired form and in particular may be matched to the substrates which are to undergo electrodeposition. This is because it is possible to thicken by electrodeposition not only two-dimensional substrates but also substrates in three-dimensional form.

[0023] Furthermore, in a refinement of the invention the contact-making unit may be connected into a pulsed process.

[0024] It is preferable for the contact-making unit to be of cylindrical design. The electrically conductive regions then extend the lateral surface of the cylindrical contact-making unit, from one base surface toward the other base surface.

[0025] It is preferable if the electrically conductive regions are spaced apart from one another and run in the shape of waves, zigzags or obliquely. The electrically conductive regions may also be straight. The wavy, zigzag or oblique shape, however, has the advantage that the regions of the substrate which are to undergo electrodeposition can be reached uniformly with a high level of reliability, with the result that uniform growth of the conductive layer is ensured.

[0026] If there is a pronounced wavy, zigzag or oblique profile of the electrically conductive regions, it is expedient if sections of the electrically conductive regions which are connected cathodically are shielded from the anode device, e.g. by a shielding device. Those sections which are not located in the immediate vicinity of the substrate and are therefore not required to transmit current should be shielded. The shielding device may be designed in the form of wing like profiles above the cathodically connected regions, avoiding deposits directly on the cathodically connected electrical region.

[0027] It is preferable to provide a fixture which presses the substrate onto the at least one contact-making unit. The fixture may be a nonconductive roller. The fixture may also be designed as a further contact-making unit. The substrate which is to undergo electrodeposition is pressed onto the electrically conductive regions of a contact-making unit which are connected as cathode by the fixture.

[0028] In an alternative configuration, the contact-making arrangement may have slides which are intended to make contact with regions of the substrate which are to undergo electrodeposition. In particular, the slides can be used to reach regions of a three-dimensional substrate which are difficult to gain access to, e.g. undercut regions. The slides can be removed from and put back onto the object which is to undergo electrodeposition by means of pneumatic or hydraulic control means. A slide is then connected cathodically or anodically depending on its position.

[0029] In another configuration, the contact-making unit has pins which can move with respect to a base plate and which can be actuated differently as desired, the pins being connected cathodically or anodically depending on their position. The contact-making unit described is suitable in particular for thickening printed circuit boards by electrodeposition. The pins are arranged in a grid at a distance from one another. The pins are "extended" out of the base plate according to the conductor structure which is to be electrodeposited, so that cathodic connection is made possible at the locations of the conductor structures. Retracting the pins into the base plate causes them to be connected anodically, resulting in cleaning of the pins which have previously been connected cathodically.

[0030] This is made possible by the fact that the base plate is of two-layer structure and the first layer is connected anodically and the second layer is connected cathodically. Therefore, the pins are connected anodically or cathodically depending on which of the limit positions they are currently in.

[0031] The pins, which form the electrically conductive regions, can be retracted and extended by means of conventional techniques, e.g. pneumatics, hydraulics or electrical actuation.

[0032] The electrodeposition system according to the invention has at least one electrodeposition device of the type described above, a feed device, which feeds the substrate which is to undergo electrodeposition to the at least one electrodeposition device, and a receiving device which receives the substrate which has completed electrodeposition. In particular, the substrate can be fed to the at least one electrodeposition unit in continuous form. This allows efficient, inexpensive and reliable manufacture, since the electrodeposition device is not subject to any down times.

[0033] It is preferable for the electrodeposition unit to be arranged in a collection vessel, into which an electrolyte which is displaced in the electrolyte bath by a filtered electrolyte can overflow, so that a self regenerating electrolyte is present in the electrolyte bath. For this purpose, the collection vessel is equipped via an overflow with the electrolyte bath of the electrodeposition device. In a corresponding way, the collection vessel has a pump and a filter which pumps the treated electrolyte back into the electrolyte bath.

[0034] In a preferred configuration, the electrodeposition system according to the invention has at least two electrodeposition units which are connected in series and are operated using the same electrolyte or a different electrolyte.

[0035] The electrodeposition system according to the invention may therefore be a modular structure. The working and throughput rate is then determined solely by the number of modules. A further advantage of the electrodeposition device according to the invention is that it can be operated with different current intensities in the same electrolyte, and in particular the anode device and the auxiliary anodes can be operated with different current intensities.

BRIEF DESCRIPTION OF THE DRAWINGS

[0036] The invention is explained in more detail with reference to the following figures, in which:

[0037] **FIG. 1** shows an outline of an exemplary embodiment of an electrodeposition device according to the invention in cross section,

[0038] **FIG. 2** shows the structure and method of operation of the contact-making unit used in the electrodeposition device,

[0039] **FIG. 3** shows a section through the first exemplary embodiment of the electrodeposition device according to the invention,

[0040] **FIG. 4** shows an electrodeposition system which comprises the electrodeposition device described in FIGS. **1** to **3**,

[0041] **FIGS. 5 and 6** show various arrangements of contact-making units for the electrodeposition of a continuous substrate,

[0042] **FIG. 7** shows a perspective view of a second exemplary embodiment of an electrodeposition device,

[0043] **FIG. 8** shows a section through the electrodeposition device shown in **FIG. 7**,

[0044] **FIGS. 9 and 10** each show an excerpt which illustrates the configuration of the electrically conductive regions of the second exemplary embodiment,

[0045] **FIG. 11** shows a third exemplary embodiment of an electrodeposition device in which the electrically conductive regions are designed in the form of lamellae, and

[0046] **FIG. 12** shows the arrangement of shielding devices above the cathodically connected regions of a contact-making unit as shown in **FIG. 2**.

DETAILED DESCRIPTION OF A PREFERRED MODE OF THE INVENTION

[0047] **FIG. 1** shows a first exemplary embodiment of an electrodeposition device **10** according to the invention. Purely by way of example, there are five contact-making units **16** arranged next to one another in an electrolyte bath **14**, in which a tank **26** is filled with an electrolyte. These are circular in cross section. Once again purely by way of example, electrodes **28** of an anode device **30** are illustrated between or next to a respective contact-making unit **16**. The anodes **28** of the anode device **30** can in principle be arranged in any desired way. A roller **18** which consists of nonconductive material and represents the fixture for press-

ing the substrate onto the contact-making unit is arranged above each of the contact-making units **16**. The substrate which is to undergo electrodeposition (and is not illustrated in **FIG. 1**) would in each case be conveyed between a roller **18** and a contact-making unit **16**. The substrate could be in continuous form and could be introduced into the electrolyte bath **14** from above and discharged again on the other side.

[**0048**] The structure of the contact-making unit **16** can be seen more clearly from **FIG. 2**. It becomes clear from this figure that the lateral surface of the cylindrical contact-making unit is provided over its entire circumference with electrically conductive regions **20** which are spaced apart from one another. While the electrodeposition device is operating, the contact-making unit is set in rotation, either driven by a motor or moved by the substrate itself. The electrically conductive regions **20** which are brought into contact with a cathode device **22** and are denoted by **20***k* in **FIG. 2** are then connected cathodically, while the electrically conductive regions **20** which are brought into contact with the two anode devices **24** illustrated by way of example (these regions being denoted as **20***a*) are connected anodically in order to clean the contact-making unit.

[**0049**] When the contact-making unit **16** is rotated through 360 degrees, each conductive region **20** is connected at least once as cathode and twice as anode. The cathode device **22** and the anode devices **24** may, for example, be designed in the form of wheels or rollers which are placed onto the contact-making device **16**.

[**0050**] In the present exemplary embodiment shown in **FIG. 2**, the cathode device and the anode devices **24** are arranged opposite one another. The anode devices **24** may in principle be arranged at any desired location and, contrary to what is illustrated in the drawing, are preferably connected as auxiliary anode just after the cathode. The term "just after the cathode" is to be understood as meaning an angular offset of at most 90°. The preferred offset is approx. 90° with respect to the cathode **22**.

[**0051**] The fact that the contact-making unit **16** has a plurality of electrically conductive regions **20**, of which different conductive regions are simultaneously connected anodically or cathodically, allows the electrodeposition device according to the invention to be operated continuously. The conductive particles which are deposited on the electrically conductive regions **20**k which are connected cathodically are automatically cleaned off by the anodic connection by means of the anode device **24**. This procedure allows the electrodeposition device to operate continuously without interruption or having to be shut down.

[**0052**] **FIG. 12** shows the contact-making unit shown in **FIG. 2** in a modification, in which, first of all, by way of example an anode device **28** and the substrate **12** which is to be metalized are illustrated. The fact that the cathode device **22** and the anode device **30** are arranged along the internal circumference of the cylindrical contact-making unit **16** merely represents one structural configuration which is of no importance to the invention. The significant difference with respect to **FIG. 12** is the shielding devices **25** which are arranged above the cathodically connected regions **20***k*. These shielding devices are intended to prevent deposits of metal on the sections of the regions **20***k* which are not required to transmit current. These sections are indicated by the reference numeral **21** and are remote from the contact point between the regions **20***k* and the substrate **12**. The shielding devices **25** are expedient in particular if the electrically conductive regions **20** have a very pronounced wavy or zigzag profile or run very obliquely. By way of example, the shielding devices **25** have the wing-like profile illustrated in **FIG. 12** and force a flow of ions indicated by the arrows between the substrate **12** which is to be metalized (the conductive structures which have previously already been formed on the substrate are denoted by **13***a*, the layer formed after the electrodeposition is denoted by **13***b*) and the shielding device **25**.

[**0053**] **FIG. 3** once again illustrates the arrangement of the cathode and anode devices **22**, **24** with respect to the electrolyte bath **14** and the contact-making unit **16**. Both the cathode device **22** and the anode devices **24** are, by way of example, arranged outside the electrolyte bath **14**. The rotation results in different conductive regions **20** being connected anodically and cathodically. The nonconductive roller **18** is arranged above the contact-making unit **16**. The substrate which is to undergo electrodeposition is passed through the slot which is formed between the roller **18** and the contact-making unit **16** and is clearly visible, the roller **18** providing the pressure which is required to press the preconfigured substrate onto the cathodically connected electrically conductive regions.

[**0054**] In principle, the electrodeposition device may comprise only a single contact-making unit **16**. However, arranging a plurality of contact-making units **16** in an electrolyte bath increases the rate of growth of an electrically conductive layer by electrodeposition on the substrate which has already been provided with conductive particles.

[**0055**] **FIG. 4** shows an electrodeposition system according to the invention which is constructed using the electrodeposition device described in FIGS. **1** to **3**. The electrodeposition device **10** is arranged in a collection vessel **46**. An overflow **48** which projects into the electrolyte bath **14** conveys overflowing electrolyte into the collection vessel **46**. The collection vessel **46** has a pump with filter **50**, which pumps treated electrolyte back into the electrolyte bath **14**.

[**0056**] The electrodeposition system shown in **FIG. 4** is particularly suitable for processing a substrate which is in continuous form. The substrate, which has already been structured with conductive particles, has been wound onto a feed device **42** in drum form. The substrate is guided into the electrodeposition device **10** from the feed device **42** in the direction indicated by the arrow and is passed between respective contact-making devices **16** and rollers **18** and is then removed again from the electrodeposition device **10** on the left-hand side. The substrate which has been thickened by electrodeposition is dried at a squeegee **52** in order to prevent electrolyte from being entrained. The substrate, which is still in continuous form, is introduced via a guide roller **54** into a rinsing device **56**. Having been diverted via two guide rollers **58**, it is introduced via a further squeegee **60**, a further guide roller **62** and a spray rinse **64** into a passivation **68**. After it has passed through a further squeegee **72** and been guided past a drying blower **74**, the substrate is finally wound back onto a receiving device **44** in drum form. The substrates which have been thickened by electrodeposition can now be divided up in a further step. It should be emphasized once again that the conductor struc-

tures are already in their final form, i.e. there is no longer any need for any etching process or further structuring process to be carried out.

[0057] **FIG. 5** illustrates an exemplary embodiment in which the roller **18** which produces the pressure has been replaced by a further contact-making device **16**. In this case, two respective contact-making units **16** are arranged opposite one another, so that once again the substrate can be passed between them. For the sake of simplicity, the electrolyte bath and the anode device **30** have been omitted in **FIG. 5**.

[0058] The same is true of **FIG. 6**, in which, by way of example, contact-making units **16** are arranged in four offset rows. The substrate **12** is therefore passed in meandering form between the contact-making units **16**. The pressure required is in each case ensured by the offset arrangement.

[0059] Substrates which are metalized on two sides can be produced by means of the arrangements of contact-making units **16** illustrated in **FIGS. 5 and 6** even if these metalized substrates do not have through-contacts. If the substrate does have through-contacts and if it has been provided with electrically conductive structures in the form described above prior to the treatment in the electrodeposition device according to the invention, it is sufficient for only one side of the substrate to be connected to a contact-making unit **16**. Nevertheless, it is ensured that two-sided metalization is possible, since through-contacts are automatically enriched with electrically conductive material, with the result that they form a metallic unit with the associated conductor structures on the side remote from the contact-making unit **16**. This results in the formation of a conductive structure with a more or less constant layer thickness. Through-contacts and associated conductors then form a metallic unit.

[0060] **FIG. 7** shows a further exemplary embodiment of a contact-making unit **16** according to the invention. This contact-making unit is now in sheet-like form. It has a multiplicity of pins **36** which are arranged next to and spaced apart from one another and can be lowered into the base plate **34**. The pins **36** can be moved out of the base plate **34** into a limit position, in which the electrodeposition of a substrate can take place, by means of control mechanisms, which are not illustrated in more detail in **FIG. 7**.

[0061] All this can be seen more clearly from **FIG. 8**, in which six pins **36** have been moved out of the base plate **34** into their limit positions. The base plate **34** comprises two layers **38**, **40**, the first layer **38** being connected as anode and the second layer **40** being connected as cathode. Of course, the first and second layers **38**, **40** are electrically isolated from one another. The position of a pin **36** alone determines whether it is connected cathodically or anodically.

[0062] This can be seen more clearly from **FIGS. 9 and 10**, which illustrate a pin **36** in its limit position outside the base plate **34** (**FIG. 9**) and a pin **36** in its limit position within the base plate **34** (**FIG. 10**). Over a length which is greater than the thickness of the second layer **40**, the pin **36** has an insulation **82**. A conductive region **80**, which corresponds to the diameter of the pin **36**, is in contact with the walls of the recess within which it is moved. If the pin **36** is in its limit position shown in **FIG. 9**, it is connected cathodically. By contrast, if the pin **36** is completely recessed in the base plate **34**, it is connected anodically.

[0063] The contact-making unit **16** illustrated in FIGS. **7** to **10** is particularly suitable for thickening a printed circuit board with any desired conductor structure by electrodeposition. Since the pins **36** are arranged at regular intervals with respect to one another, it is in principle possible to reproduce any desired conductor structure by moving the pins **36** into their limit position shown in **FIG. 9**. Regular retracting of the pins into their limit position as shown in **FIG. 10** ensures that the electrically conductive region **80** which is connected to the substrate which is to undergo electrodeposition is regularly cleaned anodically.

[0064] **FIG. 11** shows a further exemplary embodiment of a contact-making unit **16**. The contact-making unit **16** is constructed in the form of a conveyor belt, along which a multiplicity of lamellae **90** are arranged. The lamellae **90** are connected to the conveyor belt via an articulated joint **96**. The lamellae only have an electrically conductive region **94** at their end which is remote from the articulated joint **96**. Otherwise, they have an insulation **92**. The electrically conductive regions **94** are alternately connected cathodically and anodically as a result of the conveyor belt being set in rotation. As long as the lamellae **90** are in contact with the substrate **12** which is to undergo electrodeposition, they are connected cathodically, which is intended to be indicated by the designation K. As soon as a lamella reaches a predetermined position along the conveyor belt, it is connected anodically (A) and in this way is cleaned.

[0065] In principle, there are no restrictions whatsoever with regard to the design of a contact-making unit. In particular, the contact-making unit may be matched to the shape of the substrate which is to undergo electrodeposition, so that even electrodeposition on undercut regions is possible.

[0066] The electrodeposition device described can also be operated in the known pulsed mode. The device can be used with all known, commercially available electrolytes.

[0067] It has become apparent from the description that the electrodeposition device according to the invention allows extremely inexpensive production combined with the highest possible, constant quality and with high throughput rates. One advantage is that only the parts which are required for production of the desired conductor structure have to undergo electrodeposition. A further advantage is the simple production and maintenance of the electrodeposition device described, since all the devices which are relevant for control purposes can be arranged outside the electrolyte bath.

[0068] In particular, it is possible for a plurality of the electrodeposition systems shown in **FIG. 4** to be arranged in series,. The working rate is then dependent solely on the number of modules and on the required application thickness of the conductive layer. In this case, it is possible to produce substrates with a hitherto unseen quality and uniformity, combined, at the same time, with the lowest possible costs, both in the standing process and in the continuous process.

1. An electrodeposition device for electrodepositing an electrically conductive layer on a substrate, comprising:

an electrolyte bath;

an anode device arranged in the electrolyte bath;

at least one contact-making unit arranged near the anode device in the electrolyte bath and having a plurality of electrically conductive regions,

wherein at least one of the electrically conductive regions is connected cathodically and at least one of the electrically-conductive regions is connected anodically.

2. The electrodeposition device as claimed in claim 1, wherein the plurality of the electrically conductive regions are simultaneously connected cathodically or anodically.

3. The electrodeposition device as claimed in claim 1, wherein each electrically conductive region of the at least one contact-making unit is connected as cathode or anode.

4. The electrodeposition device as claimed in claim 1, wherein the electrically conductive region(s) of the at least one contact-making unit which is/are connected as anode is/are arranged in a vicinity of the electrically conductive region(s) connected as cathode and form(s) auxiliary anode(s).

5. The electrodeposition device as claimed in claim 1, wherein the at least one contact-making unit is of cylindrical design.

6. The electrodeposition device as claimed in claim 5, wherein the electrically conductive regions extend on the lateral surface of the cylindrical contact-making unit from one base surface toward the other base surface.

7. The electrodeposition device as claimed in claim 5, wherein the electrically conductive regions are spaced apart from one another and run in a shape of waves, zigzags, or obliquely.

8. The electrodeposition device as claimed in claim 7, wherein sections of the electrically conductive regions that are connected cathodically are shielded from the anode device.

9. The electrodeposition device as claimed in claim 1, further comprising a fixture which presses the substrate onto the at least one contact-making unit.

10. The electrodeposition device as claimed in claim 9, wherein the fixture is a further contact-making unit or a nonconductive roller.

11. The electrodeposition device as claimed in claim 1, wherein the contact-making unit has slides which contact substrate regions that are to undergo electrodeposition.

12. The electrodeposition device as claimed in claim 1, wherein the contact-making unit has pins which move with respect to a base plate and which are actuated independently, with each of the pins being connected cathodically or anodically depending on its position.

13. The electrodeposition device as claimed in claim 12, wherein the base plate is of two-layer structure, the first layer being connected anodically and the second layer being connected cathodically.

14. An electrodeposition system comprising:

at least one electrodeposition device as claimed in claim 1;

a feed device which feeds a substrate to undergo electrodeposition to the at least one electrodeposition device; and

a receiving device which receives the substrate after it has been electrodeposed.

15. The electrodeposition system as claimed in claim 14, wherein the substrate is fed to the at least one electrodeposition device in continuous form.

16. The electrodeposition system as claimed in claim 14, wherein the electrodeposition device is arranged in a collection vessel, into which an electrolyte which is displaced in the electrolyte bath by filtered electrolyte can overflow, so that a self-regenerating electrolyte is present in the electrolyte bath.

17. The electrodeposition system as claimed in claim 14, wherein at least two electrodeposition devices, which can be operated with the same electrolyte or a different electrolyte, are connected in series.

* * * * *