SUMMARY OF THE INVENTION

There is a need for a solution that allows broader application of altering, by electrochemical treatment, a substrate comprising an electrical circuit,

In accordance with an aspect of the invention as defined in claim 1, a method of processing a substrate is provided. The substrate has a front side comprising an electrical circuit and a rear side comprising an exposed zone that faces the electrical circuit. In an electrochemical treatment step, an electrical potential is laterally applied at least to the exposed zone of the rear side of the substrate, while the exposed zone is in contact with a chemically reactive substance. The electrical potential causes ~~a lateral flow of~~an electrical current ~~at least~~that flows laterally in the exposed zone ~~of~~and passes through the ~~substrate. The lateral flow of~~chemically reactive substance, so that the electrical current and the chemically reactive substance alter the substrate starting from the exposed zone on the rear side inwardly toward the front side.

Thus, unlike the background art, in the method defined hereinbefore, an electrical potential is laterally applied to the rear side of the substrate, rather than transversally applied between the front side and the rear side. Consequently, in the method, there will be a lateral flow of current through the substrate rather than a transversal flow of current as in the background art.

The inventors of the present invention have found that although the electrical current flows laterally, rather than transversally, this does not preclude achieving an alteration of the substrate in a targeted volume. The targeted volume may extend inwardly from the rear side into the substrate, sufficiently deep, for example, to closely reach the electrical circuit. The alteration may comprise formation of pores, as in the background art, which may reduce losses induced by the substrate, at least locally, in the vicinity of the electrical circuit.

What is more, in the method defined hereinbefore, there is no need to provide for electrical contact between the front side and the rear side of the substrate, which is required in the background art for achieving an alteration of the substrate by electrochemical treatment. In general, unlike the background art, the method defined hereinbefore does not necessarily impose design constraints, such as providing for electrical contact between the front side and the rear side of the substrate.

In principle, there are no specific features that the substrate needs to have in order to alter the substrate, at least partially, by electrochemical treatment in accordance with the method defined hereinbefore. In fact, the method defined hereinbefore may, in principle, be applied to any substrate that comprises an electrical circuit on its front side.

CLAIMS:

1. A method of processing a substrate having a front side comprising an electrical circuit and a rear side comprising an exposed zone that faces the electrical circuit, the method comprising:

- an electrochemical treatment step in which an electrical potential is laterally applied at least to the exposed zone on the rear side of the substrate, while the exposed zone is in contact with a chemically reactive substance, the electrical potential causing ~~a lateral flow of~~an electrical current ~~at least~~that flows laterally in the exposed zone~~, the lateral flow of~~ and passes through the chemically reactive substance, so that the electrical current and the chemically reactive substance ~~altering~~alter the substrate starting from the exposed zone on the rear side inwardly toward the front side.

2. A method of processing a substrate according to claim 1, wherein the electrical potential is laterally applied to at least to the exposed zone on the rear side of the substrate by means of:

- an electrode arrangement disposed on the rear side of the substrate; and
- an electrode arrangement within the chemically reactive substance that faces the exposed zone on the rear side of the substrate.

3. A method of processing a substrate according to any of claims 1 and 2, wherein, throughout the electrochemical treatment step, the electrical potential is laterally applied to the exposed zone in a non-homogenous fashion in at least one of the following dimensions: space and time, so as to define at least one of the following characteristics: a volume within the substrate where the substrate is altered, a varying degree of alteration throughout the volume, and a varying form of alteration throughout the volume.

4. A method of processing a substrate according to ~~claims~~claim 2~~ and 3~~, wherein the electrode arrangement within the chemically reactive substance has a shape that causes the electrical potential to be applied to the exposed zone in a non-homogenous fashion.

5. A method of processing a substrate according to claim 2 ~~and 3~~, wherein the electrode arrangement within the chemically reactive substance has a shape that changes at least one time during the electrochemical treatment step.

6. A method of processing a substrate according to claim 2 ~~and 3~~, wherein the electrode arrangement within the chemically reactive substance comprises an array of electrodes, whereby, in the electrochemical treatment step, at least a part of respective voltages applied to respective electrodes in the array of electrodes change at least one time during the electrochemical treatment step.

7. A method of processing a substrate according to any of claim 1 to 6, wherein the substrate comprises, at least in the exposed zone, a material that, when in contact with the chemically reactive substance while an electrical current flows through the material, alters depending on radiation applied to the material, wherein, in the electrochemical treatment step, radiation is non-homogenously applied to the exposed zone.

8. A method of processing a substrate according to claim 2, wherein the exposed zone on the rear side of the substrate comprises at least one electrochemical treatment cell, an electrochemical treatment cell comprising a set of cavities disposed around an electrode that forms part of the electrode arrangement on the rear side of the substrate, wherein, in the electrochemical treatment step, the chemically reactive substance enters the set of cavities.

9. A method of processing a substrate according to any of claims 1 to 8, wherein the substrate comprises an alteration stop layer at least disposed between the electrical circuit at the front side and the exposed zone on the rear side, the alteration stop layer comprising a material that is relatively resistant to the chemically reactive substance.

10. A method of processing a substrate according to claim 9, wherein the alteration stop layer comprises a semiconductor material.

11. A method of processing a substrate according to any of claims 1 to 10, wherein the substrate comprises an electrically insulating layer disposed between the electrical circuit at the front side and the rear side.

12. A method of processing a substrate according to any of claims 9 and 10 and according to claim 11, wherein the electrically insulating layer is disposed between the electrical circuit at the front side and alteration stop layer.

13. A method of processing a substrate according to any of claims 1 to 12, wherein the lateral flow of current and the chemically reactive substance cause pores to be formed in the substrate inwardly from at least the exposed zone.

~~14. An integrated circuit device that includes a substrate having a front side comprising an electrical circuit and a rear side on which a zone faces the electrical circuit, whereby the substrate has been altered by applying a method in accordance with any of claims 1 to 13 at least in a volume comprised between the electrical circuit and the zone on the rear side that faces the electrical circuit.~~

~~15. An integrated circuit device according to claims 14, wherein the volume comprises pores that have been formed by applying a method in accordance with any of claims 1 to 13.~~