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(54) METHOD FOR FORMING IMPRINTING ROLLER

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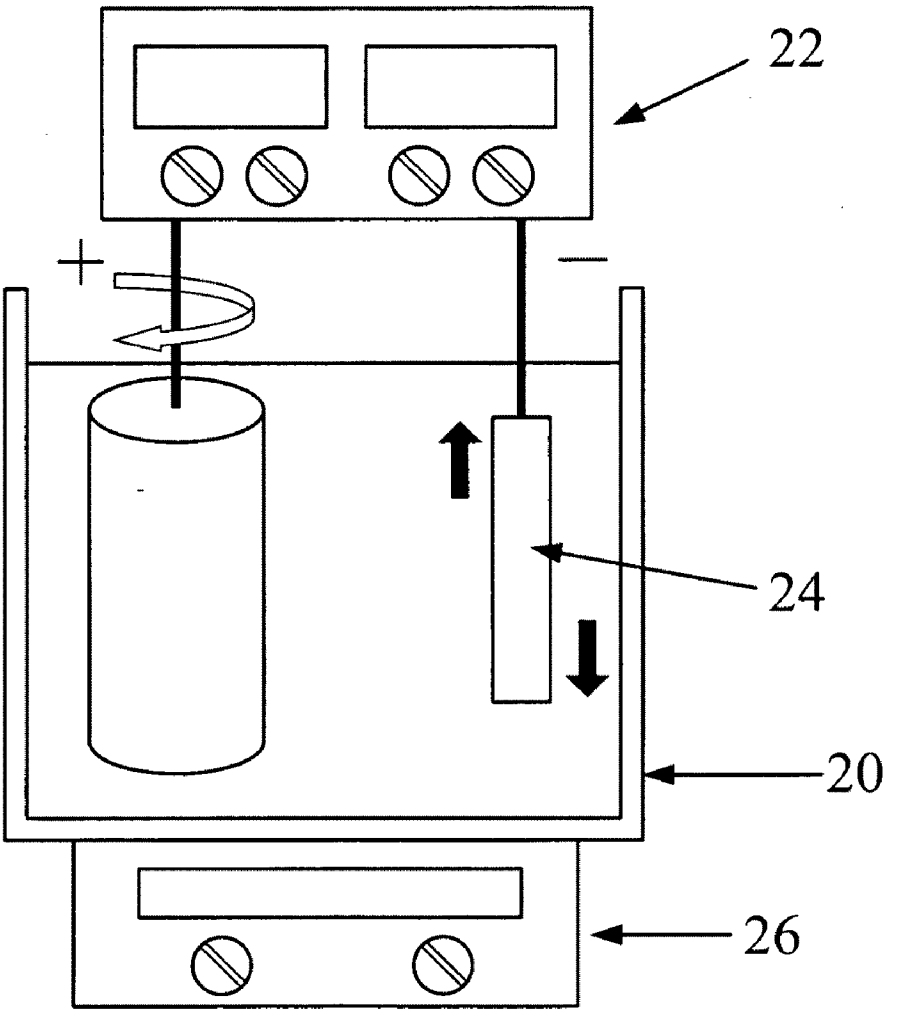
(57) **ABSTRACT**

The invention relates to a forming method for imprinting roller. A photoresist layer is coated on an aluminum roller with cylindrical surface. After a pattern is transferred on the photoresist layer, the photoresist layer with the pattern is formed on the aluminum roller. Then the anodic oxidization treatment conducted for the photoresist layer with the pattern on the aluminum roller. Repeat the above-mentioned steps to obtain the roller with nanopore structure. When the roll-to-roll process is applied, the motherboard of roller with arbitrary size can be formed to facilitate the transfer printing of large area.



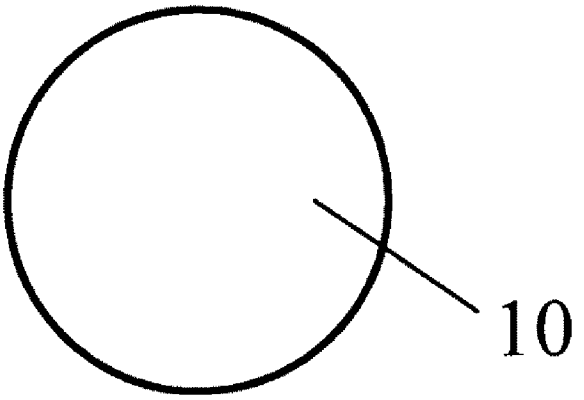


Figure 1A

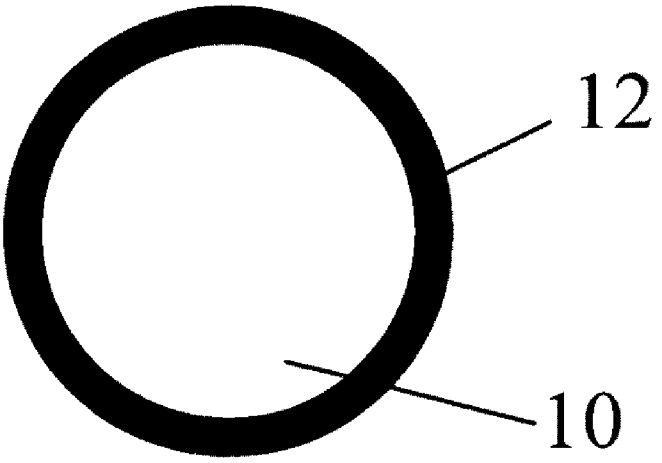


Figure 1B

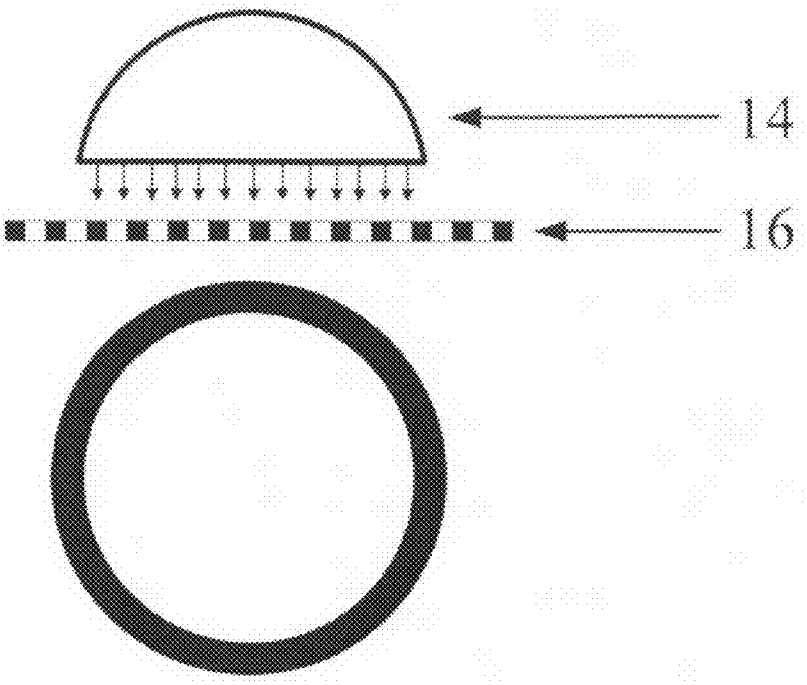


Figure 1C

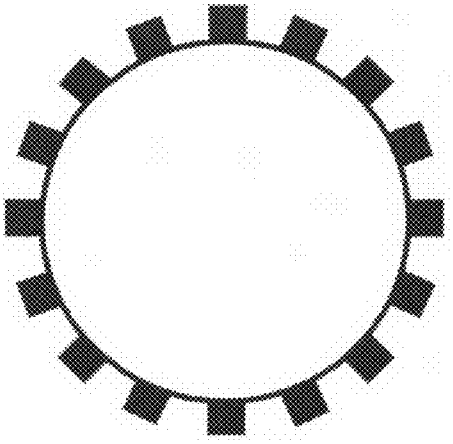


Figure 1D

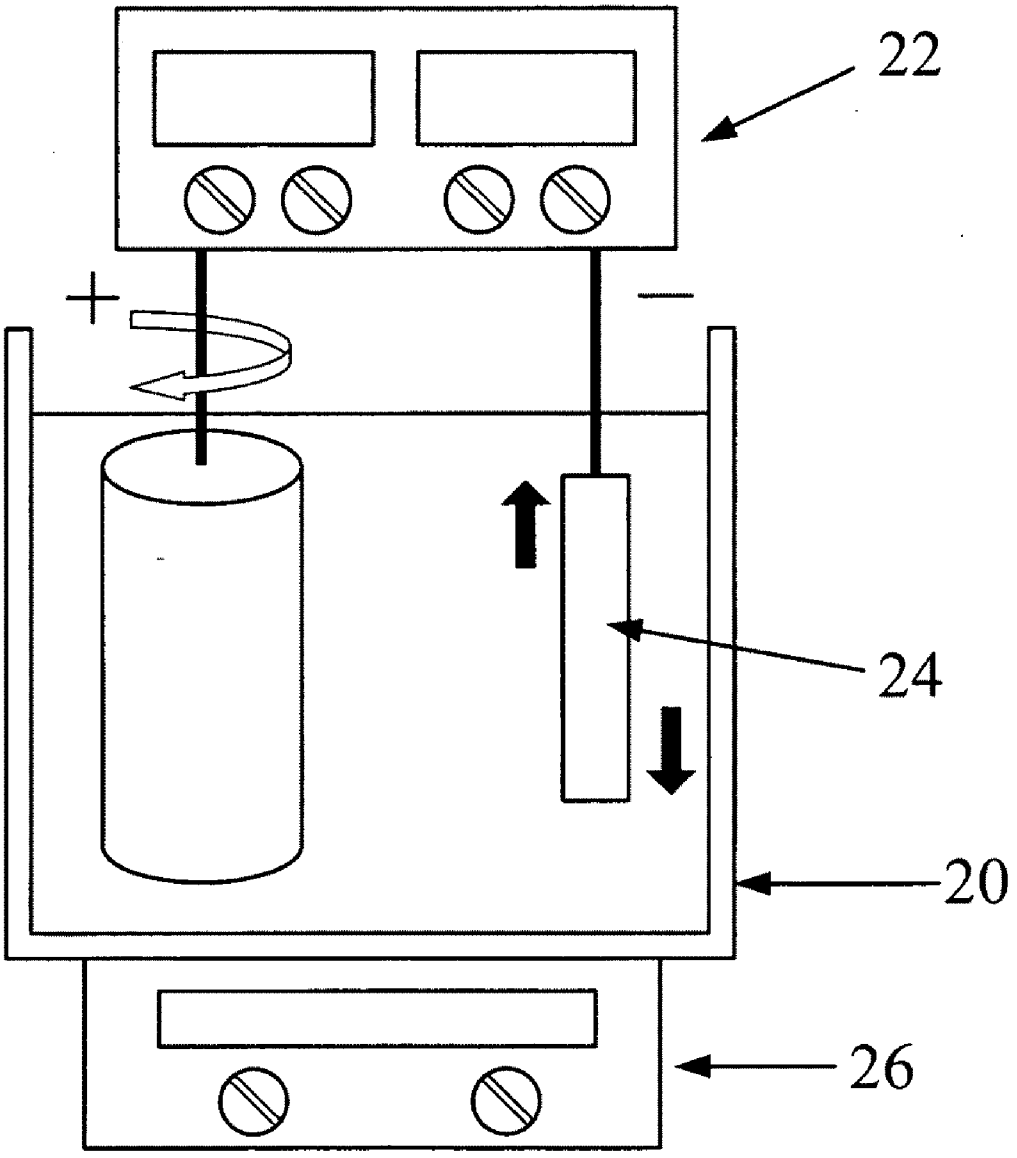


Figure 2

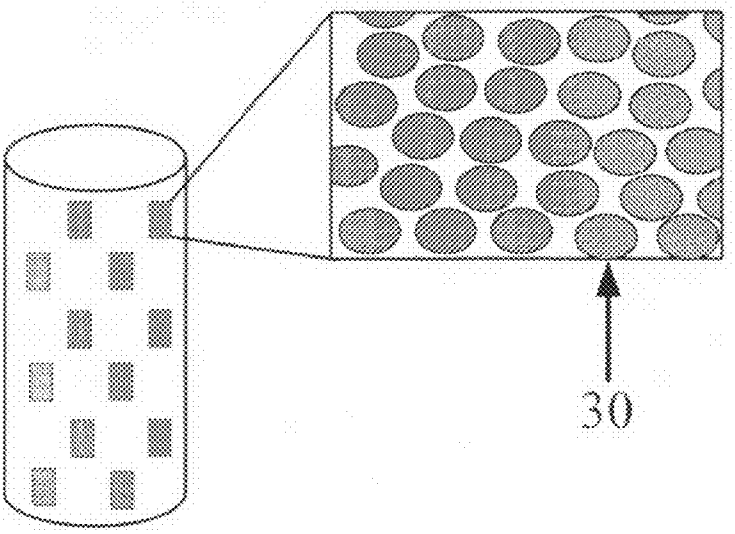


Figure 3

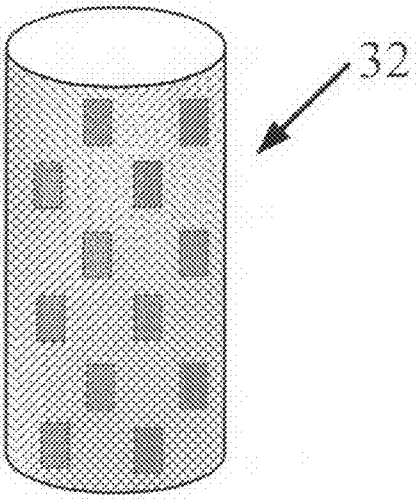


Figure 4

METHOD FOR FORMING IMPRINTING ROLLER

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The invention relates to a method for forming imprinting roller, particularly to a method for forming nano-imprinting roller.

[0003] 2. Description of the Prior Art

[0004] The imprinting technology has been evolved from microimprinting to nano-imprinting. In recent years, different processes have been developed successively. For example, in the photoresist coating technology, the structure on the flat motherboard is printed on the photoresist layer of substrate, and then it is cured by ultraviolet radiation. However, this process is time consuming, and the size of product in limited by the dimension of motherboard. Thus, the fast and continuous production is unable to be achieved.

[0005] In addition, in another example, the structure is formed on the roller by roller imprinting, or wrapped by thin metal sheet with micro-structure, or formed by the molding process, and then the structure is transferred onto substrate.

[0006] The roller microimprinting has the advantages of fast process, mass and continuous production, its importance is increased day by day, wherein the formation or roller is the key technology. Most rollers with micro-structure need very expensive equipments, and the process is very tedious. However, as for the roller wrapped by thin metal sheet normally, the adherence of thin metal sheet will not be very close and tight. Thus, the problems such as mold displacement, warping and the like during imprinting will be occurred usually. There are problems such as insufficient strength and high-temperature deterioration during imprinting for the flexible roller formed by the molding process.

[0007] In addition, the anodic oxidization treatment is required to be conducted for microimprinting roller. The micropores or nanopores can be formed on the surface of aluminum by the anodic oxidization treatment. But because the anodic oxidization treatment needs a uniform electric field, so the micropores or nanopores will not be easy to be formed on the curved surface of cylinder or roller.

[0008] Therefore, in order to get better and more efficient nanoimprinting technology, it is necessary to develop the innovative nano-imprinting method to raise the efficiency, reduce the fabrication time and cost.

SUMMARY OF THE INVENTION

[0009] The invention provides a method for forming imprinting roller. The anodic oxidization treatment of aluminum is employed to produce the roller mold with tight adherence.

[0010] Moreover, the invention provides a method for forming nano-imprinting roller, wherein the micro or submicro structure is generated on the surface of aluminum roller. It can solve the problem of flexible roller formed by the molding process, in which the surface structure is easy to be peeled off.

[0011] According to the above-mentioned description, as a method for forming nano-imprinting roller, an aluminum roller with cylindrical surface is provided, a photoresist layer is coated on the cylindrical surface, then a pattern is transferred onto the photoresist layer; the part of photoresist layer is removed to form the photoresist layer with pattern on the cylindrical surface; and an anodic oxidization treatment is carried on the aluminum roller with patterned photoresist layer. Repeat the above steps to obtain the nano-imprinting roller with nanopore structure.

[0012] Therefore, the advantage and spirit of the invention can be understood further by the following detail description of invention and attached Figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same becomes better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

[0014] FIG. **1**A is a drawing illustrating the cross-section of roller according to an embodiment of the invention.

[0015] FIG. **1**B is a drawing illustrating the cross-section of roller with photoresist layer according to an embodiment of the invention.

[0016] FIG. **1**C is a drawing illustrating the cross-section of roller with photoresist layer, photo mask and ultraviolet source according to an embodiment of the invention.

[0017] FIG. **1**D is a drawing illustrating the cross-section of roller with patterned photoresist layer according to an embodiment of the invention.

[0018] FIG. **2** is a drawing illustrating the anodic oxidization treatment for roller with patterned photoresist layer according to an embodiment of the invention.

[0019] FIG. **3** is a drawing illustrating the side view of roller with the anodic oxidization treatment according to an embodiment of the invention.

[0020] FIG. **4** is a drawing illustrating the side view of finished roller according to an embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0021] FIG. **1**A, FIG. **1**B, FIG. **1**C and FIG. **1**D show the cross-sectional diagram of roller according to the embodiment of the invention. The detail is described as follows.

[0022] The method for forming imprinting roller as shown in FIG. **1**A, a conductive roller **10** is provided. The geometrical shape is cylindrical, thus the cross-section is circular. The cylinder may be solid cylinder or hollow cylinder. The collected material may be aluminum or the aluminum alloy, the electroplated aluminum materials, the conductive materials, or the other alloy formed on the surface of conductive roller **10**. In the embodiment of the invention, the aluminum made conductive roller **10** is used for the description, however, the invention is not limited by the above-mentioned. Moreover, in order to obtain better structure in the follow-up procedure, a polishing treatment is conducted on the surface of conductive roller **10**.

[0023] Referring to FIG. **1**B, a photoresist layer **12** is formed on the surface of conductive roller **10**. In an embodiment, a photoresist agent is coated on the surface of conductive roller **10** to form a photoresist layer **12**, the coating methods include the immersing coating, electrostatic coating, blade coating, and T-type extrusion coating etc.

[0024] Referring to FIG. **1**C, an ultraviolet source **14** is set near the conductive roller **10** with the photoresist layer **12** on the surface. A photo mask **16** is placed between the conductive roller **10** and the ultraviolet source **14**. In an embodiment, the geometrical shape of the photo mask **16** is rectangular, and

there is a pattern on it. After the ultraviolet is passed through the photo mask **16** from the ultraviolet source **14**, it is irradiated on the photoresist layer **12** of conductive roller **10**. The photoresist layer **12** is exposed, and the pattern on the photo mask **16** is transferred to the photoresist layer **12**. Upon exposing, the conductive roller **10** is rotated at constant speed along the axle of cylinder to achieve uniform exposure, but the invention is not limited by the above-mentioned. If required, the ultraviolet source **14** and the photo mask **16** may rotate with respect the conductive roller **10** at the constant speed.

[0025] Then, as shown in FIG. **1**D, the photoresist layer **12** with transferred pattern is treated by suitable way, such as the etching treatment, to remove part of photoresist layer **12**, in order to form the patterned photoresist layer **12** on the conductive roller **10**.

[0026] Referring to FIG. **2**, the conductive roller **10** with the patterned photoresist layer **12** is placed in the reaction equipment **20**, in order to carry out the anodic oxidization treatment for the conductive roller **10** with the patterned photoresist layer **12**. In an embodiment, the anodic oxidization treatment is conducted. The conductive roller **10** is set on the anode of a power supply **22**, and the cathode is a graphite electrode **24**. The reaction equipment **20** is heated by a heating controller **26**, in order to get the acceleration and convection effect. Moreover, during the reacting process, a constant distance is kept between the conductive roller **10** and the graphite electrode **24**. The conductive roller **10** is kept in a self-rotating motion at constant speed (i.e. rotating along the axle of cylinder at constant speed), and the graphite electrode **24** moves up and down at the constant linear speed relative to the conductive roller **10**. As shown in FIG. **3**, during the electrolytic process, the photoresist layer **12** protected by the pattern will not be removed by the chemical reaction of electrolytic solution, thus the nanopore structure **30** is formed.

[0027] It is further described that the steps of FIG. **1**B, FIG. **1**C FIG. **1**D, FIG. **2** and FIG. **3** can be repeated to obtain more uniform nanopore structure.

[0028] Then, as shown in FIG. **4**, the patterned photoresist layer **12** on the conductive roller **10** is removed to obtain the setting area of imprinting roller required by the invention. Furthermore, carry out the anodic oxidization treatment to form the micropores or nanopores in local area where the photoresist layer **12** with pattern has been removed. The photoresist layer **12** is removed again, and the coating, development, and partial removal of the photoresist layer **12** are carried on for the second time. The micropores or nanopores are formed in the area without the micropores or nanopores originally. According to the design, the micropores or nanopores can be formed in the designed area on the surface of roller **32**. Several repeated processes may be applied to fully cover the surface of roller by the micropores or nanopores.

[0029] The invention utilizes a limited area on the surface of roller or a defined local area which is exposed in the anodic treatment tank. The anodic oxidization treatment is carried on for the limited area or the defined local area to form the micropores or nanopores on the surface of roller. Due to it is not easy to control the electric field, thus the area can be divided into several parts for the anodic treatment. After the treatment, all parts with micropores or nanopores are combined to cover the defined area or full area on the surface of roller.

[0030] According to the above description, the anodic oxidization treatment of aluminum is applied. Thus, it is not necessary to use expensive equipment to fabricate the imprinting roller of the invention and it is not time-consuming. The large-area nanopore structure can be formed on the surface of cylinder to overcome the loose adherence of traditional thin metal sheet wrapping and the defect of conventional molding process. The roll-to-roll production process can be applied for the fabrication of optical elements, in order to carry out fast and continuous transfer printing production on the flexible board, such as PET, PC or photoresist agent.

[0031] It is understood that various other modifications will be apparent to and can be readily made by those skilled in the art without departing from the scope and spirit of this invention. Accordingly, it is not intended that the scope of the claims appended hereto be limited to the description as set forth herein, but rather that the claims be construed as encompassing all the features of patentable novelty that reside in the present invention, including all features that would be treated as equivalents thereof by those skilled in the art to which this invention pertains.

What is claimed is:

1. A method for forming imprinting roller, comprising:
providing a conductive roller having a cylindrical surface;
forming a patterned photoresist layer on the cylindrical surface; and
carrying out an anodic oxidization treatment for the conductive roller having the patterned photoresist layer to form the imprinting roller.

2. The method according to claim **1**, wherein the forming the patterned photoresist layer on the cylindrical surface, comprising:
coating a photoresist agent on a cylindrical surface;
transferring a pattern onto the photoresist agent; and
removing a part of photoresist agent from the transferred pattern.

3. The method according to claim **2**, wherein transferring the pattern onto the photoresist agent comprises kept in a self-rotating motion at a constant speed upon the transfer treatment of pattern.

4. The method according to claim **1**, wherein carrying out an anodic oxidization treatment comprises placing the conductive roller having the patterned photoresist layer in a reaction equipment, in which the conductive roller being set on an anode of a power supply and a cathode being a graphite electrode.

5. The method according to claim **4**, wherein the conductive roller having the patterned photoresist layer comprises kept in a self-rotating motion at a constant speed.

6. The method according to claim **4**, wherein the graphite electrode moves up and down at a constant linear speed relative to the conductive roller, and a constant distance being kept between the conductive roller and the graphite electrode.

7. A method for forming a nanoimprinting roller, comprising:
providing an aluminum roller having a cylindrical surface;
coating an photoresist layer on a surface of the aluminum roller;
transferring a pattern onto the photoresist layer;
removing a part of the photoresist layer from the transferred pattern to form the photoresist layer with pattern on the cylindrical surface; and
carrying out an anodic oxidization treatment for the aluminum roller having the patterned photoresist layer.

8. The method according to claim **7**, wherein transferring the pattern onto the photoresist agent comprises kept in a self-rotating motion at a constant speed upon the transfer treatment of pattern.

9. The method according to claim **1**, wherein carrying out an anodic oxidization treatment comprises placing the conductive roller having the patterned photoresist layer in a reaction equipment, in which the conductive roller being set on an anode of a power supply and a cathode being a graphite electrode.

10. The method according to claim **9**, wherein the aluminum roller having the patterned photoresist layer comprises kept in a self-rotating motion at constant speed.

11. The method according to claim **10**, wherein the graphite electrode moves up and down at a constant linear speed relative to the aluminum roller, and a constant distance is kept between the aluminum roller and the graphite electrode.

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