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Hsiang et al.

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(54) **METHOD OF TRANSFERRING MICRO DEVICES AND MICRO DEVICE TRANSFER APPARATUS**

(71) Applicant: **Acer Incorporated**, New Taipei (TW)

(72) Inventors: **Jui-Chieh Hsiang**, New Taipei (TW);
Chih-Chiang Chen, New Taipei (TW)

(73) Assignee: **Acer Incorporated**, New Taipei (TW)

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H01L 33/62 (2010.01)
H01L 33/00 (2010.01)

(52) **U.S. Cl.**
CPC **H01L 21/6835** (2013.01); **H01L 25/0753** (2013.01); **H01L 33/00** (2013.01); **H01L 33/62** (2013.01); **H01L 2221/68363** (2013.01); **H01L 2221/68381** (2013.01); **H01L 2933/0066** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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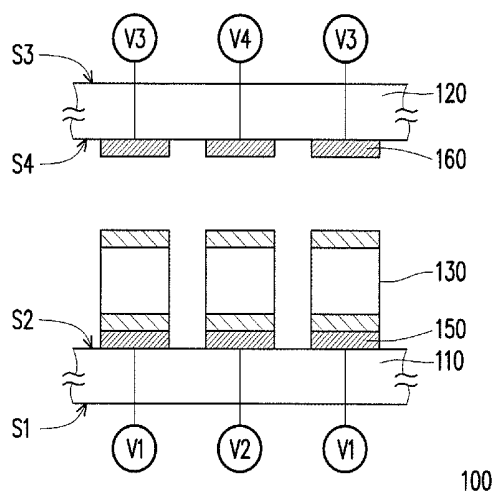
Primary Examiner — Asok K Sarkar

(74) Attorney, Agent, or Firm — JCIPRNET

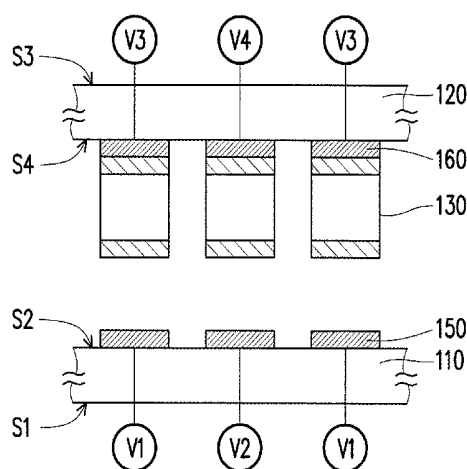
(57) **ABSTRACT**

A method of transferring micro devices is provided. A carrier substrate including a plurality of first electrodes and a plurality of micro devices is provided. The micro devices are separated from each other and respectively electrically connected to the first electrodes. A receiving substrate is made to relatively close to the carrier substrate. The receiving substrate includes a plurality of second electrodes, and the second electrodes and the first electrodes are opposite in electrical property. A first voltage and a second voltage are applied to a portion of the adjacent two first electrodes, so that the micro devices are released from the carrier substrate to the receiving substrate and bonded to the receiving substrate. The first voltage is different from the second voltage. In addition, a micro devices transfer apparatus is also provided.

17 Claims, 16 Drawing Sheets



100



100

FIG. 1B

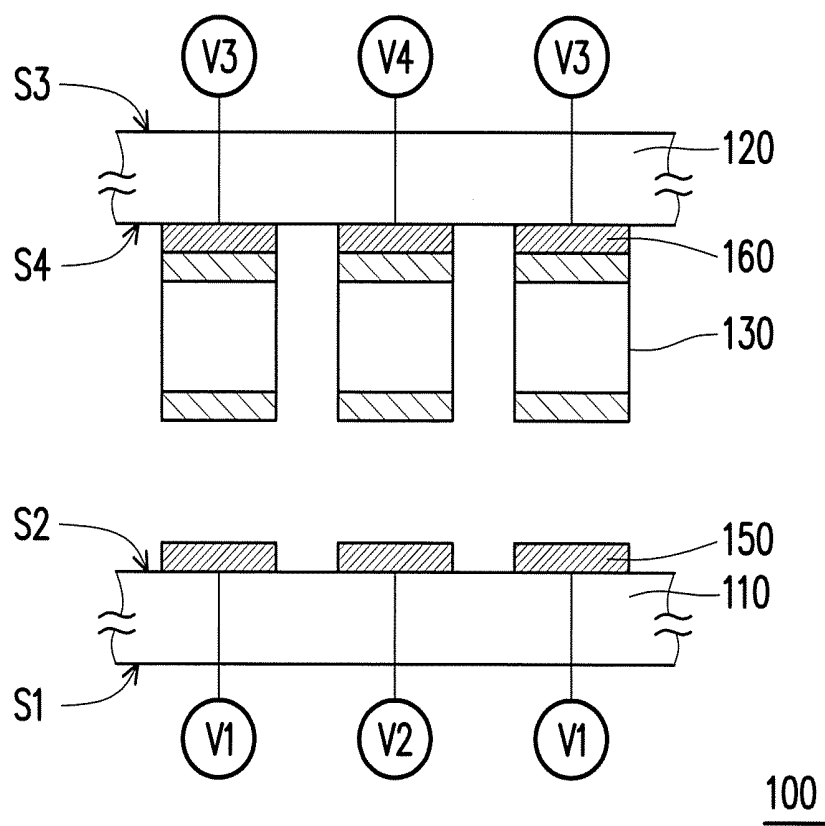


FIG. 1C

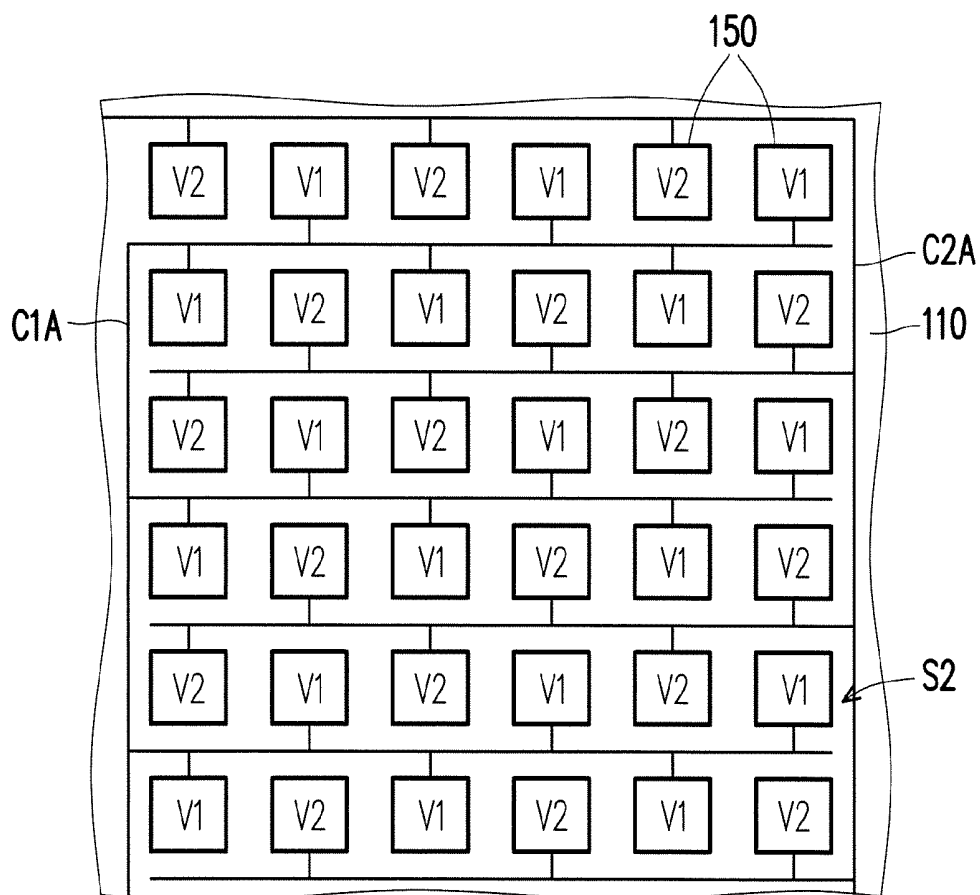


FIG. 1D

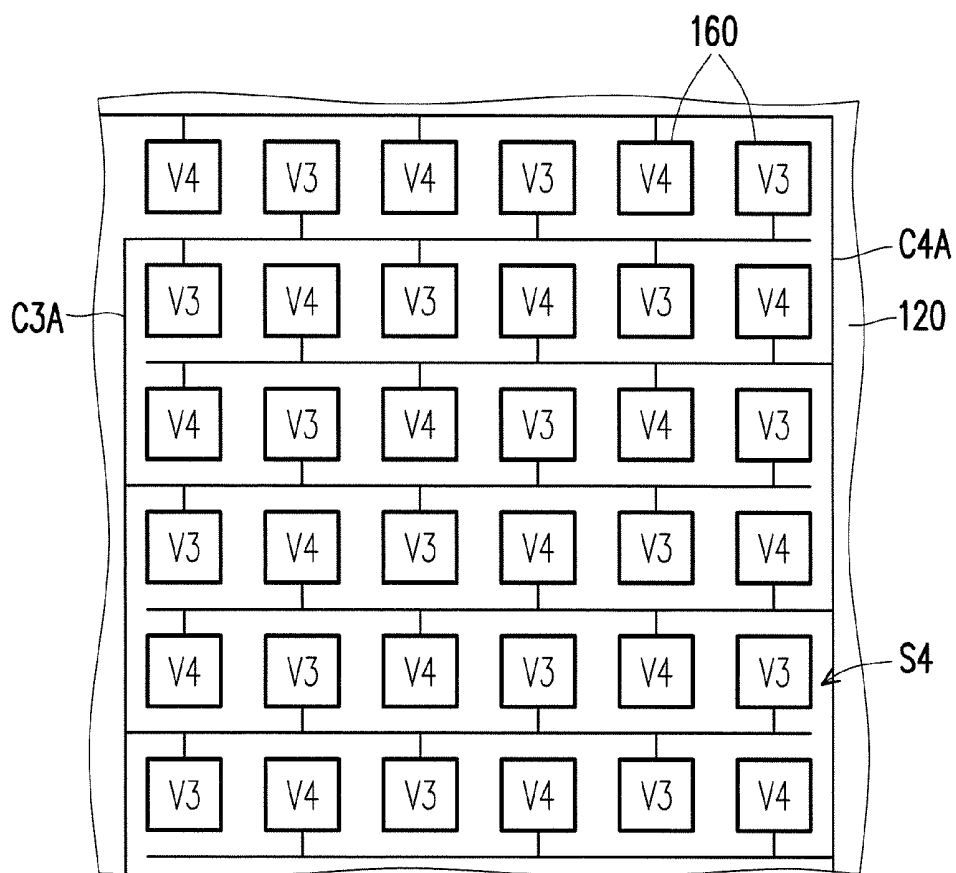


FIG. 1E

FIG. 3

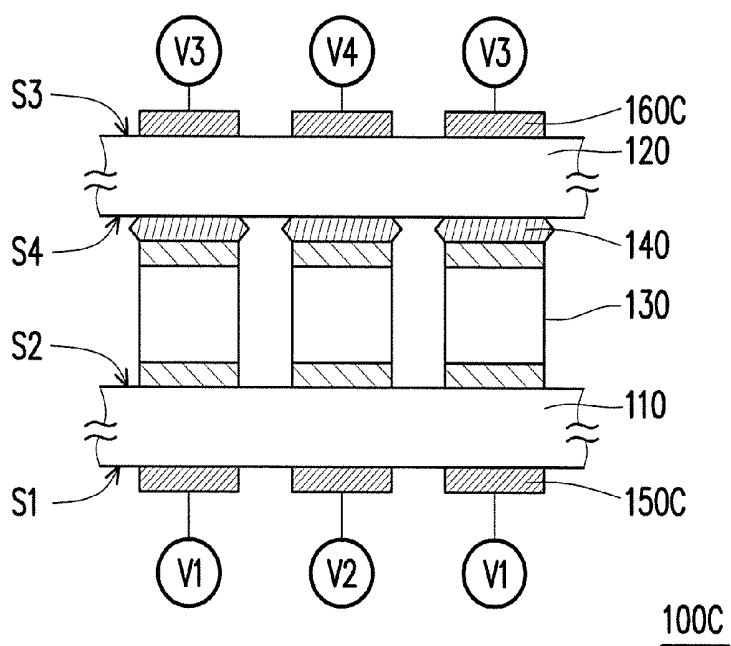


FIG. 4

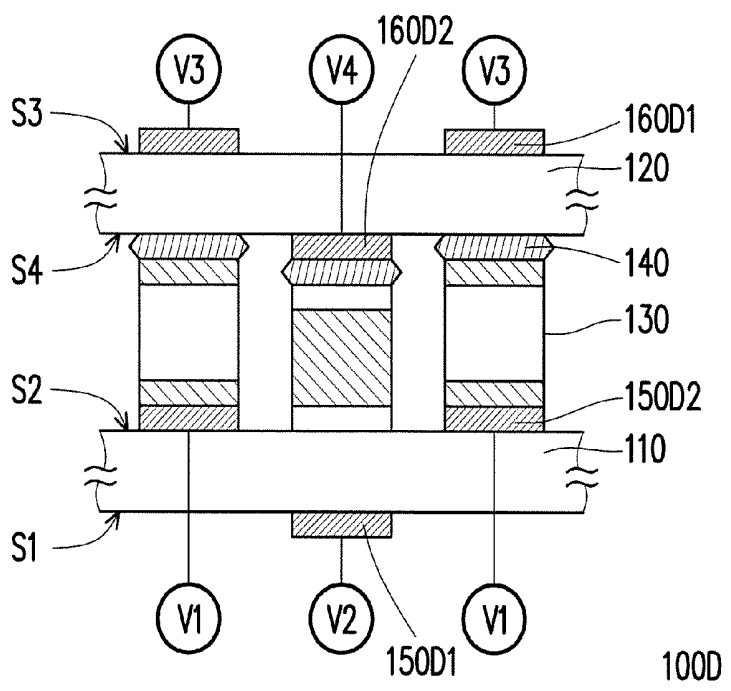


FIG. 5

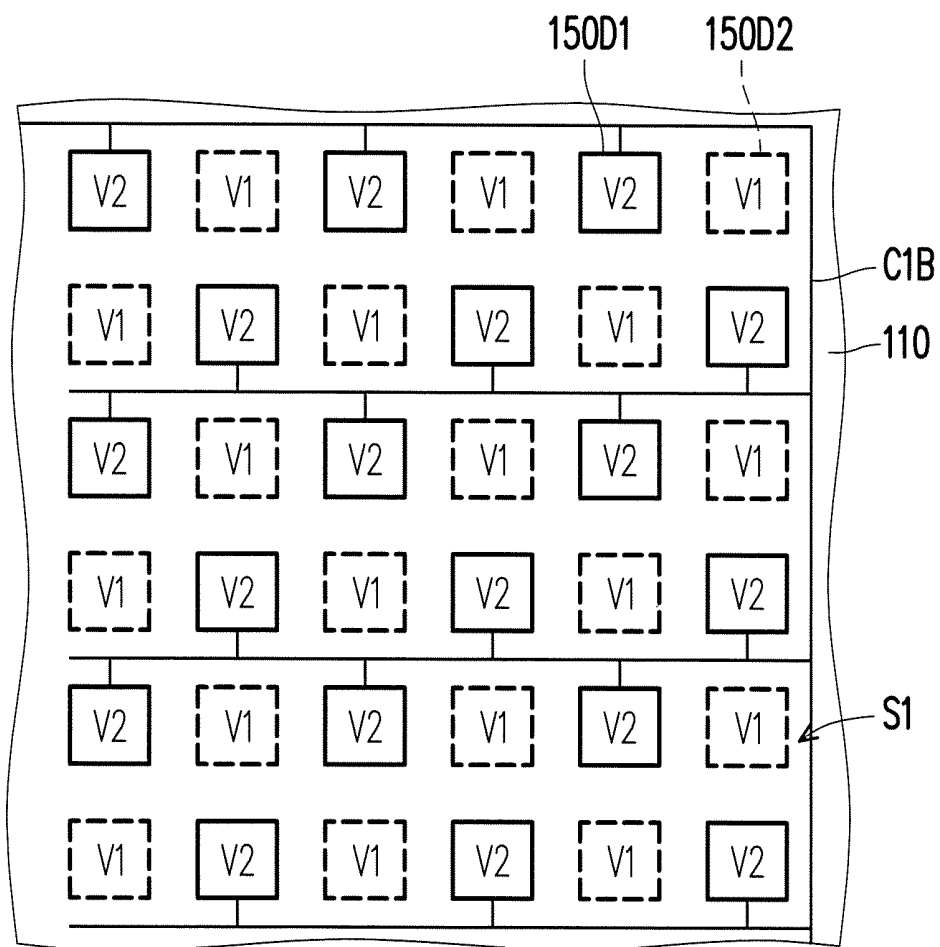


FIG. 6A

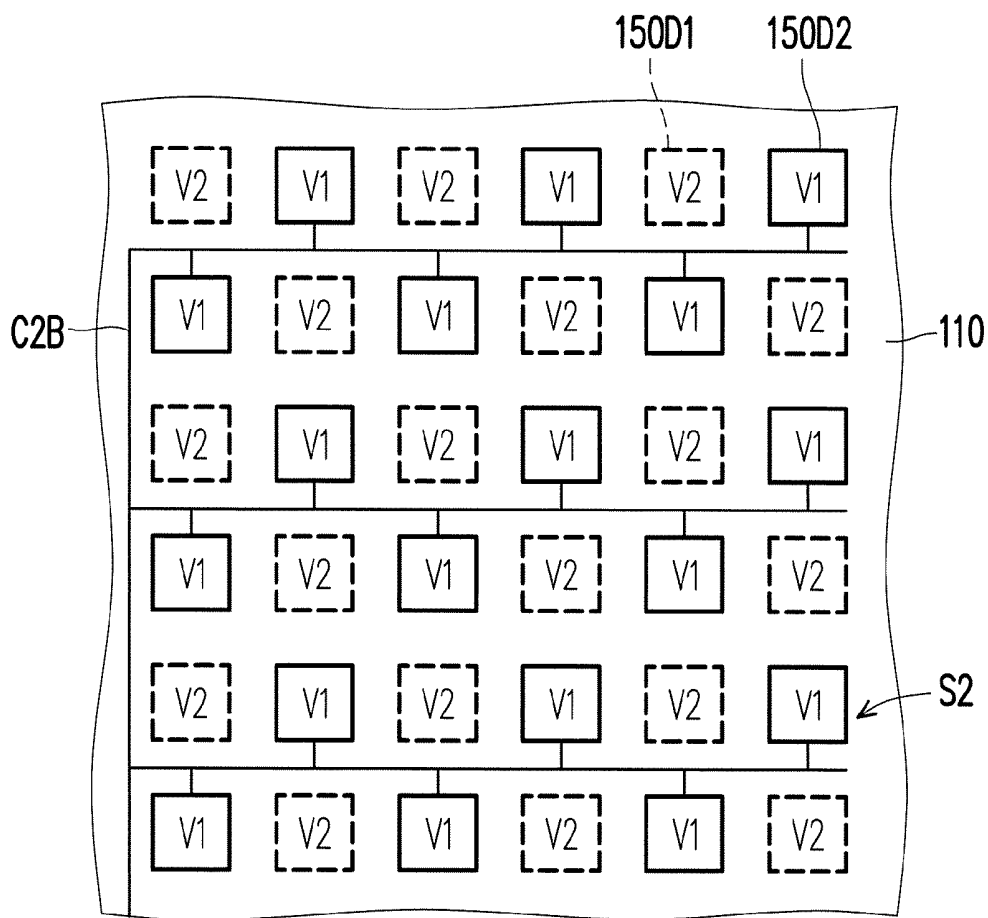


FIG. 6B

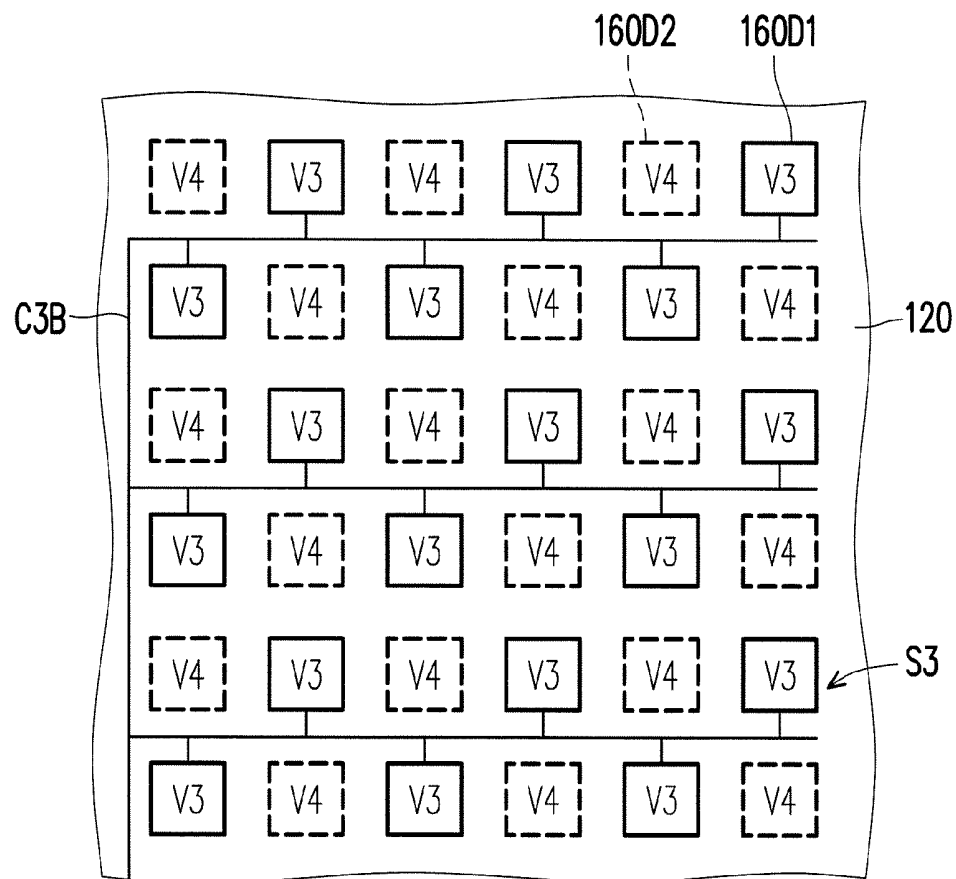


FIG. 6C

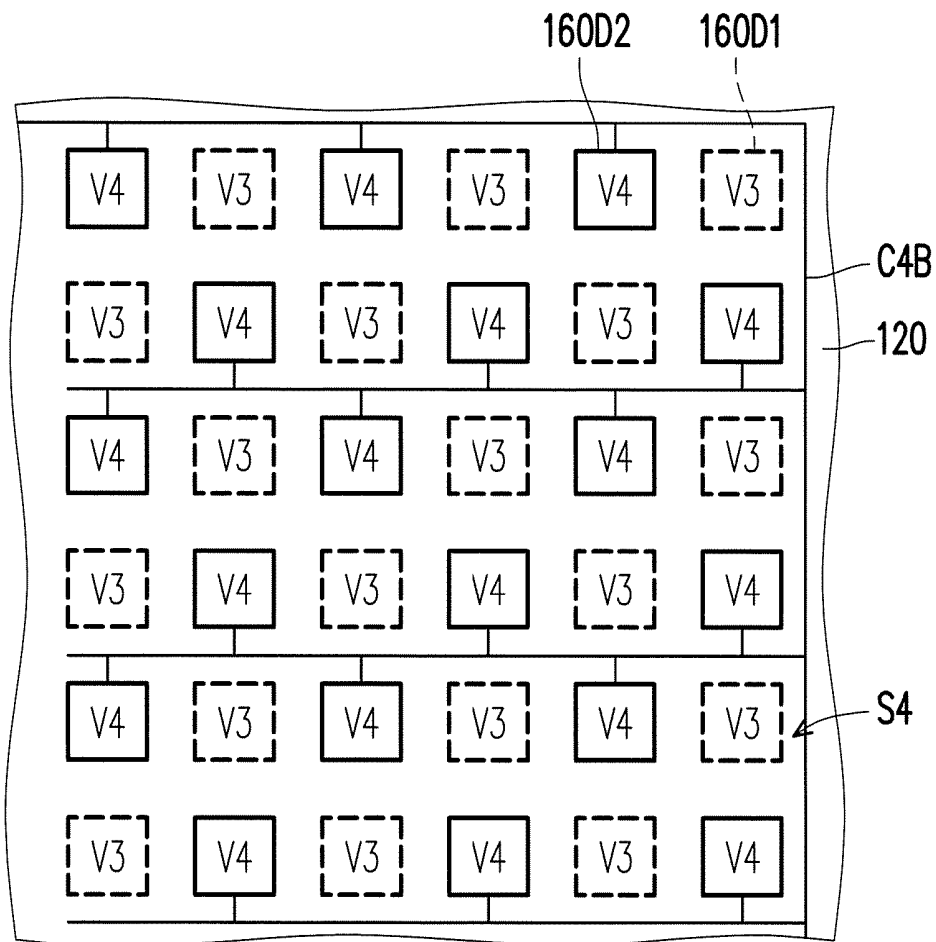


FIG. 6D

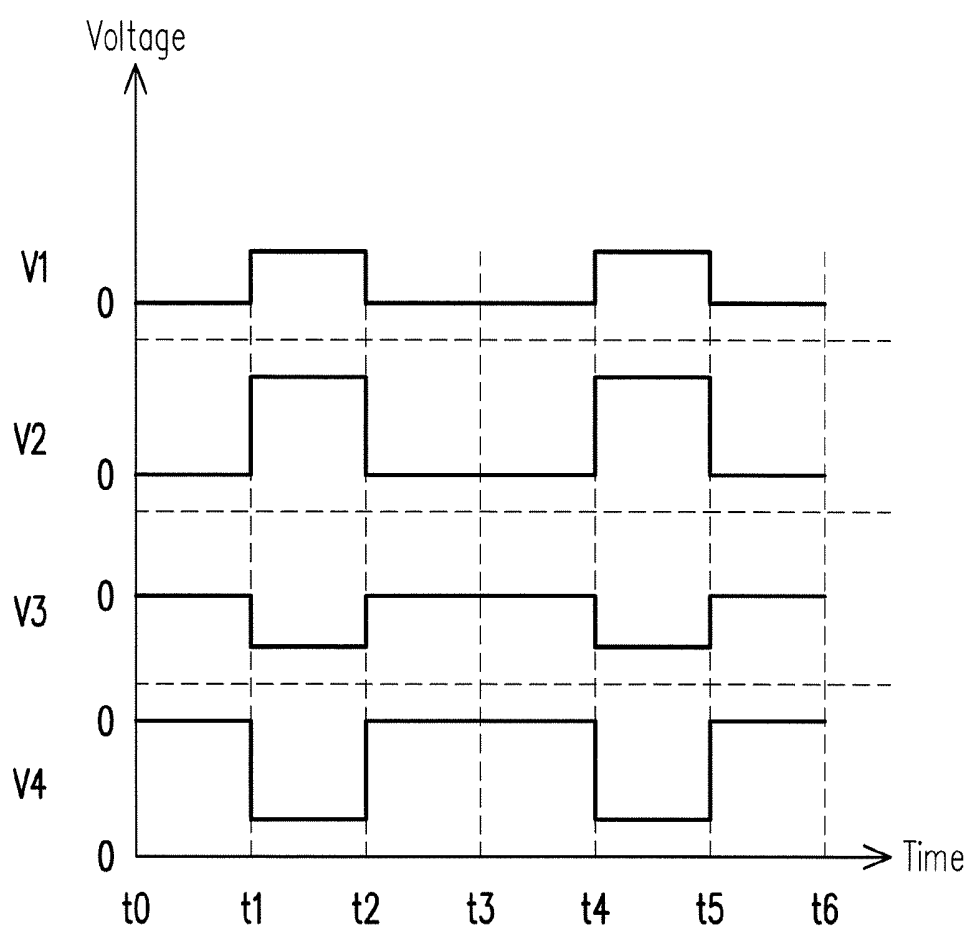


FIG. 7A

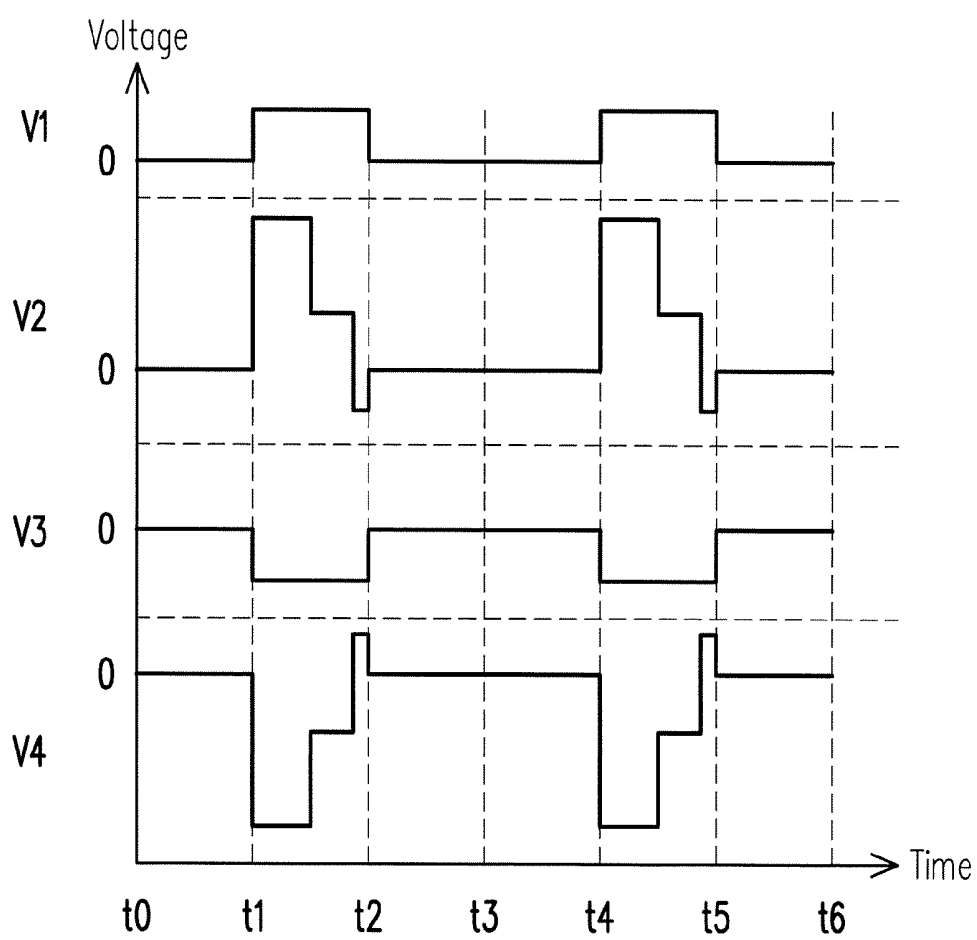


FIG. 7B

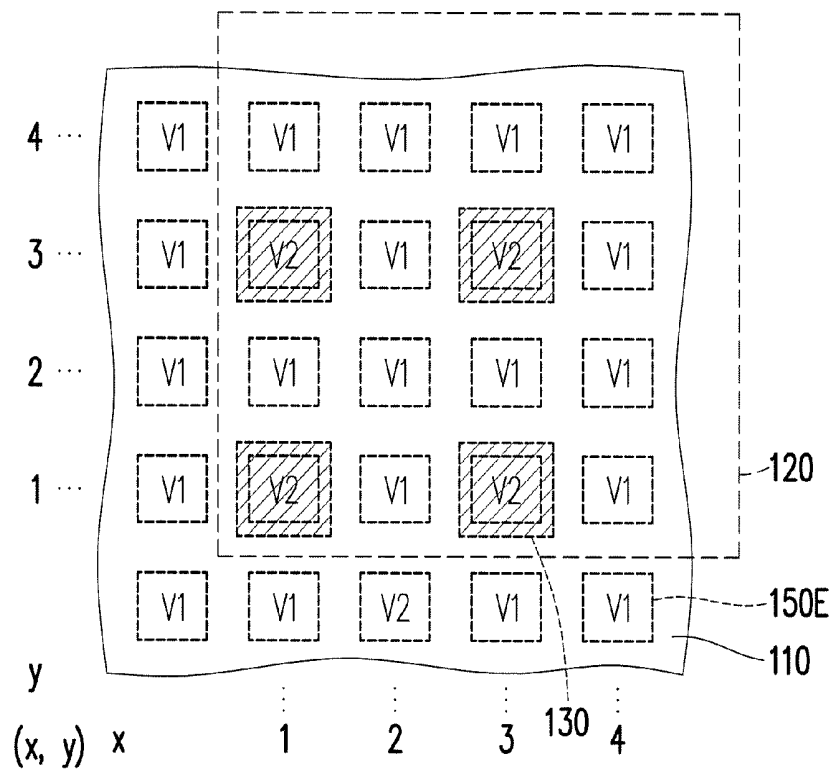


FIG. 8A

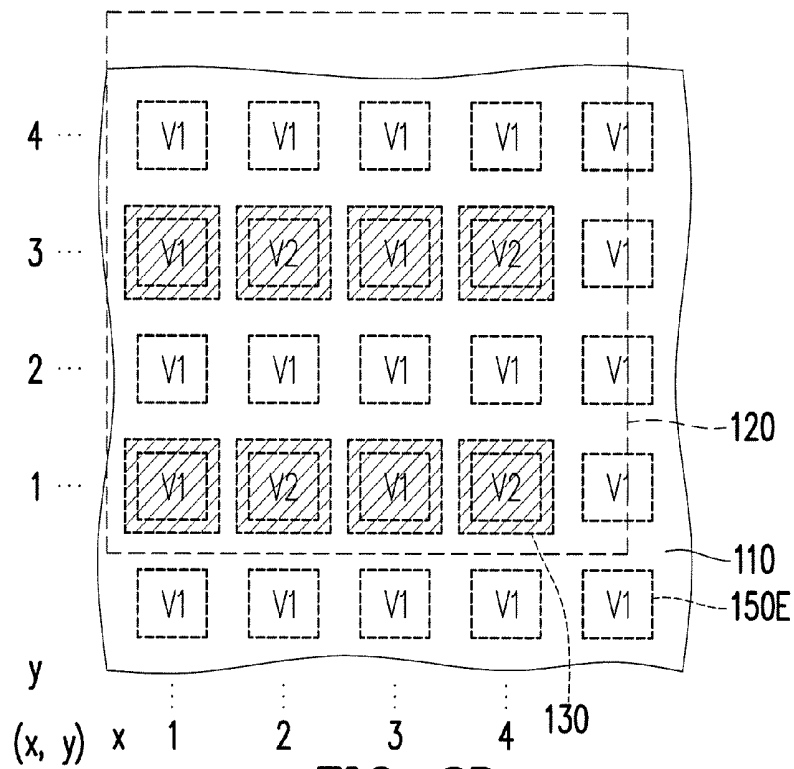


FIG. 8B

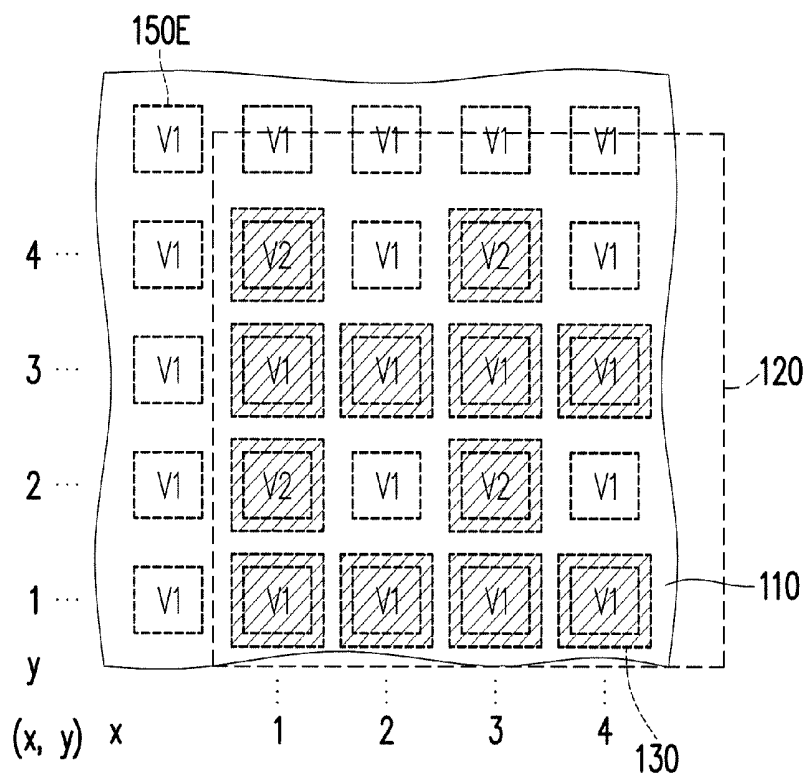


FIG. 8C

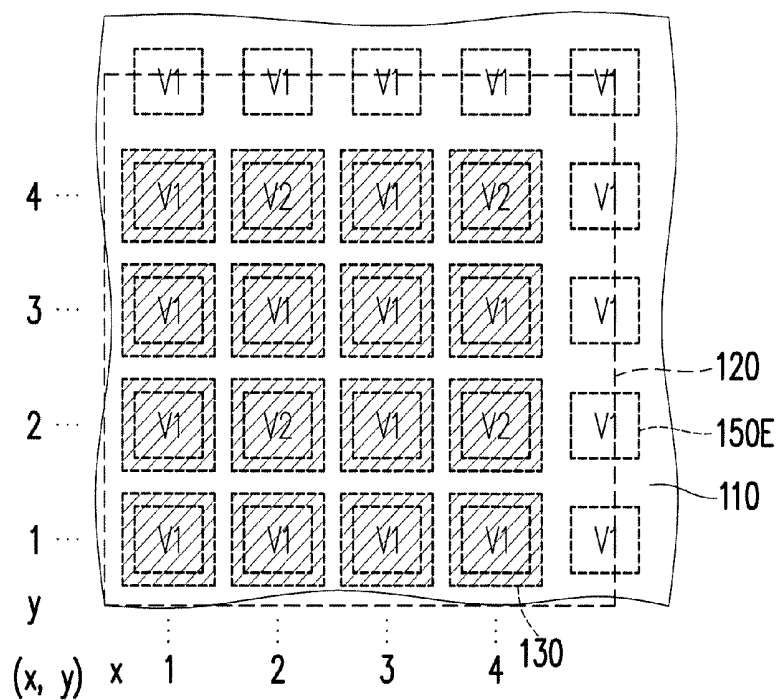


FIG. 8D

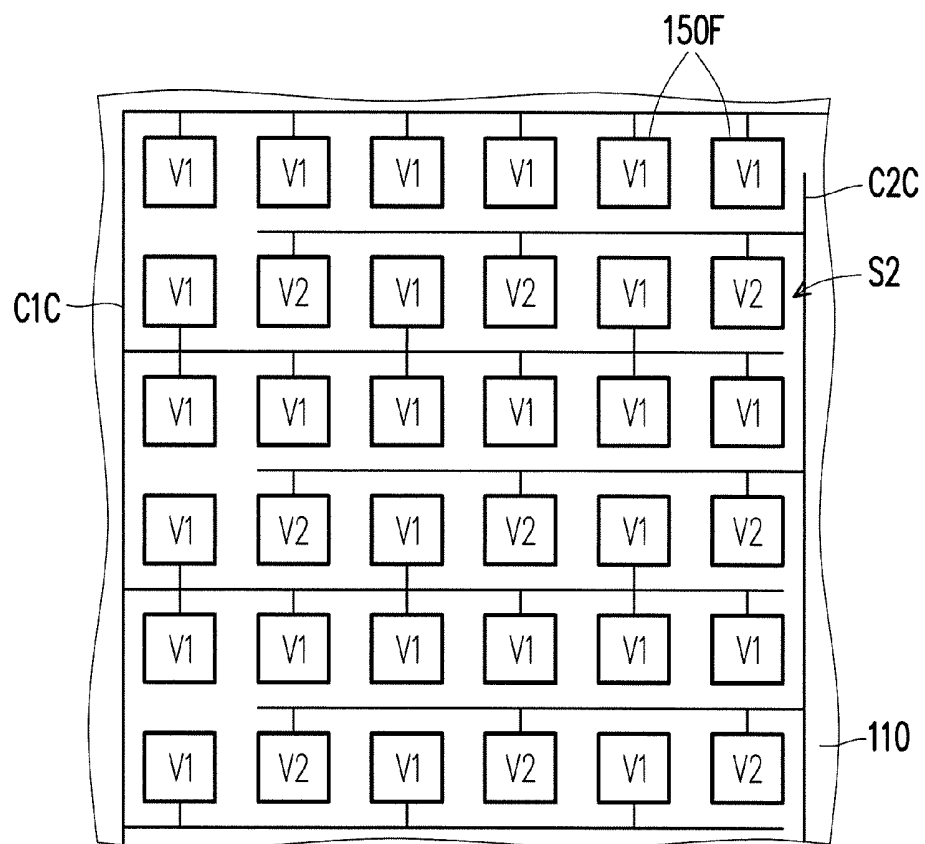


FIG. 9A

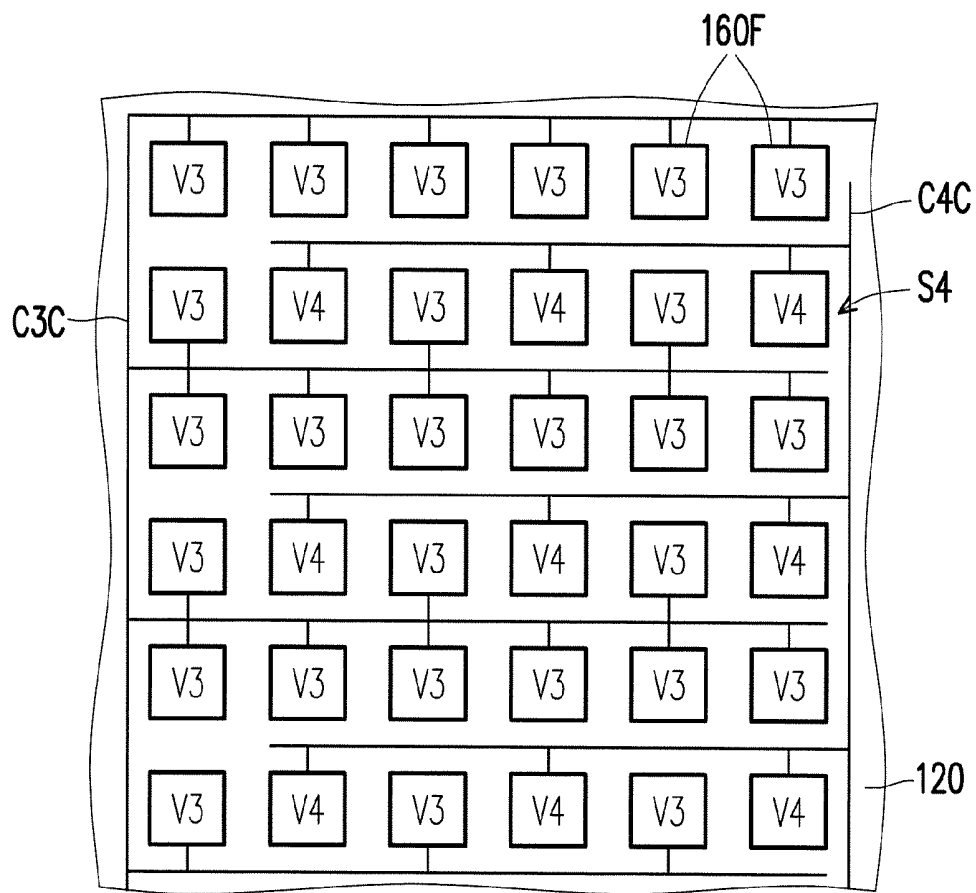


FIG. 9B

1

METHOD OF TRANSFERRING MICRO DEVICES AND MICRO DEVICE TRANSFER APPARATUS

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the priority benefit of Taiwan application serial no. 106112113, filed on Apr. 12, 2017. The entirety of the above-mentioned patent application is hereby incorporated by reference herein and made a part of this specification.

BACKGROUND OF THE INVENTION

Field of the Invention

The invention relates to a transfer method and a transfer apparatus, and particularly relates to a method of transferring micro devices and a micro device transfer apparatus.

Description of Related Art

Micro light-emitting diode (LED) display device has advantages of high brightness, high contrast, wide viewing angle, long service life, low power consumption, etc., and has become a focus in development of future display techniques. Since process variation is generally encountered in a current manufacturing process to cause a problem of poor brightness/chroma uniformity of LED, a massive transfer method is gradually developed to resolve the aforementioned problem.

Presently, the massive transfer method has to transfer micro LEDs from a carrier substrate to a receiving substrate through a transfer transmission head with high alignment accuracy. Since a size of the transfer transmission head has to be accurately matched to a size of the LED in order to achieve high alignment accuracy transfer, it is difficult in implementation, an alignment shift of the transfer is generally occurred during a transfer process, which causes errors of the transfer process. Therefore, how to achieve the purpose of massively transferring micro devices, and meanwhile improve the alignment accuracy to decrease the errors of the transfer process is currently one of the issues of concern in the industry.

SUMMARY OF THE INVENTION

The invention is directed to a method of transferring micro devices and a micro device transfer apparatus, which have higher alignment accuracy and errors occurred in a transfer process are decreased.

The invention provides a method of transferring micro devices including following steps. A carrier substrate is provided, the carrier substrate is configured with a plurality of first electrodes and a plurality of micro devices, where the micro devices are separated from each other and respectively electrically connected to the first electrodes. A receiving substrate is made to relatively close to the carrier substrate, the receiving substrate is configured with a plurality of second electrodes, and the second electrodes and the first electrodes are opposite in electrical property. A first voltage and a second voltage are applied to a portion of the adjacent two first electrodes, so that the micro devices are released from the carrier substrate to the receiving substrate and bonded to the receiving substrate. The first voltage is different to the second voltage.

2

In an embodiment of the invention, while the first voltage and the second voltage are applied to the portion of the adjacent two first electrodes, a third voltage and a fourth voltage are applied to a portion of adjacent two second electrodes.

The invention provides a micro device transfer apparatus including a carrier substrate and a receiving substrate. The carrier substrate is adapted to carry a plurality of micro devices and includes a plurality of first electrodes, where the micro devices are separated from each other and respectively electrically connected to the first electrodes. The adjacent two first electrodes are adapted to receive a first voltage and a second voltage, and the first voltage is different to the second voltage. The receiving substrate includes a plurality of second electrodes, where the second electrodes and the first electrodes are opposite in electrical property, and the adjacent two second electrodes are adapted to receive a third voltage and a fourth voltage.

In an embodiment of the invention, each of the micro devices is a light emitting diode.

In an embodiment of the invention, the first voltage and the second voltage are the same or opposite in electrical property.

In an embodiment of the invention, the carrier substrate has a first surface and a second surface opposite to each other, the second surface is located adjacent to the receiving substrate, and the micro devices are disposed on the second surface, and the first electrodes are disposed on the first surface or the second surface, or a part of the first electrodes is disposed on the first surface, and another part of the first electrodes is disposed on the second surface.

In an embodiment of the invention, the receiving substrate has a third surface and a fourth surface opposite to each other, the fourth surface is located adjacent to the carrier substrate, and the second electrodes are disposed on the third surface or the fourth surface, or a part of the second electrodes is disposed on the third surface, and another part of the second electrodes is disposed on the fourth surface.

In an embodiment of the invention, the receiving substrate is further configured with a plurality of transfer heads, and the transfer heads respectively and directly contact the micro devices.

In an embodiment of the invention, the carrier substrate is a sapphire substrate, and the receiving substrate is a glass substrate.

In an embodiment of the invention, the carrier substrate is a glass substrate, and the receiving substrate is a driving substrate.

In an embodiment of the invention, the adjacent two second electrodes are adapted to receive a third voltage and a fourth voltage.

In an embodiment of the invention, one of the first electrodes receiving the second voltage is surrounded by a plurality of the first electrodes receiving the first voltage.

According to the above description, in the method of transferring micro devices of the present invention, after the receiving substrate and the carrier substrate relatively close to each other, the first voltage and the second voltage of different levels are applied to the adjacent first electrodes, such that the micro devices are released from the carrier substrate to the receiving substrate and bonded to the receiving substrate to complete the operation of transferring the micro devices. Namely, when the micro devices are transferred, the carrier substrate assumes a charged state. In this way, by applying different voltages to the adjacent two first electrodes, alignment accuracy in the transfer process is

improved to decrease a transfer error, so as to achieve an effect of high alignment accuracy.

In order to make the aforementioned and other features and advantages of the invention comprehensible, several exemplary embodiments accompanied with figures are described in detail below.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the invention, and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

FIG. 1A to FIG. 1C are cross-sectional views of a method of transferring micro devices according to an embodiment of the invention.

FIG. 1D and FIG. 1E are respectively top views of a carrier substrate and a receiving substrate of FIG. 1A.

FIG. 2 is a cross-sectional view of a micro device transfer apparatus according to another embodiment of the invention.

FIG. 3 is a cross-sectional view of a micro device transfer apparatus according to another embodiment of the invention.

FIG. 4 is a cross-sectional view of a micro device transfer apparatus according to another embodiment of the invention.

FIG. 5 is a cross-sectional view of a micro device transfer apparatus according to another embodiment of the invention.

FIG. 6A to FIG. 6B are respectively a bottom view and a top view of a carrier substrate of the micro device transfer apparatus of FIG. 5.

FIG. 6C to FIG. 6D are respectively a bottom view and a top view of a receiving substrate of the micro device transfer apparatus of FIG. 5.

FIG. 7A and FIG. 7B are schematic diagrams illustrating variations of voltages along with time when the voltages are applied to the micro device transfer apparatus according to another embodiment of the invention.

FIG. 8A to FIG. 8D are bottom views of a method of transferring micro devices according to another embodiment of the invention.

FIG. 9A and FIG. 9B are top views of a carrier substrate and a receiving substrate of a micro device transfer apparatus according to another embodiment of the invention.

DESCRIPTION OF EMBODIMENTS

FIG. 1A to FIG. 1C are cross-sectional views of a method of transferring micro devices according to an embodiment of the invention. FIG. 1D and FIG. 1E are respectively top views of a carrier substrate and a receiving substrate of FIG. 1A. For simplicity's sake, micro devices 130 are omitted in FIG. 1D. Referring to FIG. 1A and FIG. 1D first, according to the method of transferring micro devices of the invention, a carrier substrate 110 is provided, where the carrier substrate 110 is configured with a plurality of first electrodes 150 and a plurality of micro devices 130. The carrier substrate 110 has a first surface S1 and a second surface S2 opposite to each other, the first electrodes 150 and the micro devices 130 are disposed on the second surface S2, and the micro devices 130 are separated from each other and respectively electrically connected to the first electrodes 150. The carrier substrate 110 is, for example, a sapphire substrate,

and each of the micro devices 130 is a light emitting diode (LED), though the invention is not limited thereto.

Then, referring to FIG. 1A and FIG. 1E, a receiving substrate 120 is provided, and the receiving substrate 120 is made to relatively close to the carrier substrate 110, where the receiving substrate 120 is configured with a plurality of second electrodes 160. The receiving substrate 120 has a third surface S3 and a fourth surface S4 opposite to each other, where the fourth surface S4 is opposite to the second surface S2 of the carrier substrate 110, and the second electrodes 160 are separated from each other and disposed on the fourth surface S4. Particularly, the second electrodes 160 and the first electrodes 150 are opposite in electrical property. The receiving substrate 120 is, for example, a glass substrate, though the invention is not limited thereto.

Then, referring to FIG. 1B and FIG. 1C, a first voltage V1 and a second voltage V2 are applied to the adjacent two first electrodes 150, and a third voltage V3 and a fourth voltage V4 are applied to the adjacent two second electrodes 160, such that the micro devices 130 are released from the carrier substrate 110 to the receiving substrate 120 and bonded to the receiving substrate 120, where the first voltage V1 is different to the second voltage V2.

Due to the difference of the first voltage V1 and the second voltage V2, each of the first electrodes 150 has a different attraction force on the corresponding one micro device 130, by which alignment accuracy in a transfer process is improved to decrease a transfer error, so as to achieve a characteristic of having higher alignment accuracy. Moreover, since the second electrodes 160 and the first electrodes 150 are opposite in electrical property, each of the micro devices 130 disposed on the carrier substrate 110 is attracted by each of the second electrodes 160 disposed on the receiving substrate 120, so as to implement the micro device transfer. In detail, by applying the different voltages to the corresponding two electrodes, an electric field of a specific direction is produced between the corresponding two electrodes, and the micro devices 130 are guided to a specific direction under the influence of the electric field. Moreover, regarding a method of applying the voltages, besides the voltages can be directly provided to the electrodes, induced voltage can be produced through a method of electromagnetic coil induction, though the invention is not limited thereto.

To be specific, the first voltage V1 and the second voltage V2 of the present embodiment are the same in electrical property, for example, the first voltage V1 and the second voltage V2 are all positive voltages, though a voltage value of the first voltage V1 is different to a voltage value of the second voltage V2. Alternatively, the first voltage V1 and the second voltage V2 are opposite in electrical property, for example, the first voltage V1 is a positive voltage, and the second voltage V2 is a negative voltage, though the voltage value of the first voltage V1 can be the same or different to the voltage value of the second voltage V2. For example, when the first voltage V1 is the positive voltage, and the second voltage V2 is the positive voltage, the third voltage V3 is the negative voltage, and the fourth voltage V4 is the negative voltage, and the micro devices 130 can be transferred through a variation of the voltage difference between the first voltage V1 and the second voltage V2. On the other hand, when the first voltage V1 is the positive voltage, and the second voltage V2 is the negative voltage, the third voltage V3 is the negative voltage, and the fourth voltage V4 is the positive voltage, and the alignment accuracy of the

second electrodes **160** and the micro devices **130** can be further improved to decrease errors occurred in the transfer process.

Referring to FIG. 1D, the first electrodes **150** disposed on the second surface **S2** of the carrier substrate **110** can be respectively electrically connected to other first electrodes **150** applied with the same voltage to form a line **C1A** and a line **C2A** according to the first voltage **V1** and the second voltage **V2** applied thereto. In this way, a part of the first electrodes **150** can be simultaneously applied with the first voltage **V1** through the line **C1A**, and the other part of the first electrodes **150** can be simultaneously applied with the second voltage **V2** through the line **C2A**, so that the voltages can be effectively supplied to the first electrodes **150**. Similarly, referring to FIG. 1E, the second electrodes **160** disposed on the fourth surface **S4** of the receiving substrate **120** can be respectively electrically connected to other second electrodes **160** applied with the same voltage to form a line **C3A** and a line **C4A** according to the third voltage **V3** and the fourth voltage **V4** applied thereto. In this way, a part of the second electrodes **160** can be simultaneously applied with the third voltage **V3** through the line **C3A**, and the other part of the second electrodes **160** can be simultaneously applied with the fourth voltage **V4** through the line **C4A**, so that the voltages can be effectively supplied to the second electrodes **160**.

It should be noted that besides the aforementioned method of applying the voltages, in other embodiments, a plurality of different voltage values can be preset for applying to the first electrodes **150** and the second electrodes **160**. Namely, the first electrodes **150** on the carrier substrate **110** may receive voltages with the same electrical property and different voltages values, voltages with different electrical properties and the same or different voltages values, or voltages with partially the same electrical property and different voltage values. Similarly, the second electrodes **160** on the receiving substrate **120** may receive voltages with the same electrical property and different voltages values, voltages with different electrical properties and the same or different voltages values, or voltages with partially the same electrical property and different voltage values. In brief, the first electrodes **150** and the second electrodes **160** may achieve the purpose of transferring the micro devices **130** through the diversified matches of electrical properties and voltage values.

Moreover, in other embodiments that are not illustrated, arrangement of the voltages applied to the electrodes can be progressive voltage arrangement, for example, the voltage is progressively increased or progressively decreased. In this way, through a progressive guiding effect of the electrodes on the micro device **130**, a shift phenomenon occurred during the transfer process due to transient electric field instability caused by non-synchronization of the signals between the electrodes and the micro devices **130** is avoided, such that occurrence of the transfer shift is minimized to improve the alignment accuracy.

Moreover, in other embodiments that are not illustrated, arrangement of the voltages applied to the electrodes can be a multiple voltage level arrangement, for example, the voltage is first increased and then decreased, or first decreased and then increased. In this way, after a high voltage or a low voltage is applied to the electrodes or a transfer head (referring to **140** of FIG. 3), or when electrostatic charges are adsorbed to the electrodes or the transfer head due to an ambient environment, voltages with opposite electrical properties can be provided to eliminate the

residual charges through the multiple voltage level arrangement, so as to facilitate smooth proceeding of a next transfer process.

In view of a structure, referring to FIG. 1B, the micro device transfer apparatus **100** of the present embodiment includes the carrier substrate **110** and the receiving substrate **120**. The carrier substrate **110** is adapted carry the micro devices **130** and includes the first electrode **150**, where the micro devices **130** are separated from each other and respectively electrically connected to the first electrodes **150**. The adjacent two first electrodes **150** are adapted to receive the first voltage **V1** and the second voltage **V2** different from each other. The receiving substrate **120** includes the second electrodes **160**, where the second electrodes **160** and the first electrodes **150** are opposite in electrical property, and the adjacent two second electrodes **160** are adapted to receive the third voltage **V3** and the fourth voltage **V4**.

Although the aforementioned carrier substrate **110** and the receiving substrate **120** are respectively a sapphire substrate and a glass substrate, in other embodiments, the carrier substrate **110** can also be a glass substrate, and the receiving substrate **120** can be a driving substrate. In other words, after the micro devices **130** are transferred to the receiving substrate **120**, the receiving substrate **120** may serve as the carrier substrate **110** in another process of transferring the micro devices **130**, so that the micro devices **130** can be transferred to another receiving substrate **120** (i.e. the driving substrate, for example, a thin-film transistor (TFT) substrate) through the same transfer process for driving the micro devices **130**.

It should be noted that reference numbers of the components and a part of contents of the aforementioned embodiment are also used in the following embodiment, wherein the same reference numbers denote the same or like components, and descriptions of the same technical contents are omitted. The aforementioned embodiment can be referred for descriptions of the omitted parts, and detailed descriptions thereof are not repeated in the following embodiment.

FIG. 2 is a cross-sectional view of a micro device transfer apparatus according to another embodiment of the invention. Referring to FIG. 1B and FIG. 2, the micro device transfer apparatus **100A** of the present embodiment is similar to the micro device transfer apparatus **100** of FIG. 1B, and a difference there between is that the micro devices **130** of the present embodiment are disposed on the second surface **S2** of the carrier substrate **110**, and the first electrodes **150A** are disposed on the first surface **S1**. In other words, in the micro device transfer apparatus **100A**, the first electrodes **150A** disposed on the carrier substrate **110** can be provided by an external electrode carrier. Electrical connection of the first electrodes **150A** and the micro devices **130** is, for example, implemented by configuring conductive through vias on the carrier substrate **110** to electrically connect the first electrodes **150A** and the micro devices **130**, or external electrodes and the micro device **130** may form capacitors to produce induced voltages, and the electrical connection method and the method for generating the induced voltages are not limited by the invention.

FIG. 3 is a cross-sectional view of a micro device transfer apparatus according to another embodiment of the invention. Referring to FIG. 1B and FIG. 3, the micro device transfer apparatus **100B** of the present embodiment is similar to the micro device transfer apparatus **100** of FIG. 1B, and a difference there between is that the second electrodes **160B** of the present embodiment are disposed on the third surface **S3** of the receiving substrate **120**. Besides, in the present embodiment, the receiving substrate **120** is further

configured with a plurality of transfer heads **140**, where the transfer heads **140** respectively directly contact the micro devices **130**, and each of the second electrodes **160B** is respectively electrically connected to each of the transfer heads **140**. In other words, in the micro device transfer apparatus **100B**, the second electrodes **160B** disposed on the receiving substrate **120** can be provided by an external electrode carrier. In this way, the second electrodes **160B** disposed on the third surface **S3** can be electrically connected to the transfer heads **140** disposed on the fourth surface **S4**, so that the micro devices **130** are adsorbed by the transfer heads **140** and released from the carrier substrate **110** to the receiving substrate **120** and bonded to the receiving substrate **120** to complete transferring the micro devices **130**.

FIG. **4** is a cross-sectional view of a micro device transfer apparatus according to another embodiment of the invention. Referring to FIG. **3** and FIG. **4**, the micro device transfer apparatus **100C** of the present embodiment is similar to the micro device transfer apparatus **100B** of FIG. **3**, and a difference there between is that the first electrodes **150C** of the present embodiment are disposed on the first surface **S1** of the carrier substrate **110**. In other words, in the micro device transfer apparatus **100C**, the first electrodes **150C** disposed on the carrier substrate **110** and the second electrodes **160C** disposed on the receiving substrate **120** can all be provided by external electrode carriers, so as to achieve the effect of releasing the micro devices **130** from the carrier substrate **110** to the receiving substrate **120** and bonding the same to the receiving substrate **120**.

FIG. **5** is a cross-sectional view of a micro device transfer apparatus according to another embodiment of the invention. Referring to FIG. **3** and FIG. **5**, the micro device transfer apparatus **100D** of the present embodiment is similar to the micro device transfer apparatus **100B** of FIG. **3**, and a difference there between is that the first electrodes **150D1** of the present embodiment are disposed on the first surface **S1**, and the first electrodes **150D2** are disposed on the second surface **S2**. The second electrodes **160D1** are disposed on the third surface **S3**, and the second electrodes **160D2** are disposed on the fourth surface **S4**. In this way, voltages can be respectively provided to the first electrodes **150D1** and the first electrodes **150D2** through the carrier substrate **110** and an external electrode carrier, and voltages can be respectively provided to the second electrodes **160D1** and the second electrodes **160D2** through the receiving substrate **120** and an external electrode carrier, so as to save a power supplying amount of the carrier substrate **110** and the receiving substrate **120**.

FIG. **6A** to FIG. **6B** are respectively a bottom view and a top view of the carrier substrate of the micro device transfer apparatus of FIG. **5**. Referring to FIG. **5**, FIG. **6A** and FIG. **6B**, in the present embodiment, the first electrodes **150D1** disposed on the first surface **S1** of the carrier substrate **110** and the first electrodes **150D2** disposed on the second surface **S2** of the carrier substrate **110** respectively form a line **C1B** and a line **C2B**. In this way, the first electrodes **150D1** and the first electrodes **150D2** respectively disposed on the first surface **S1** and the second surface **S2** can be applied with the first voltage **V1** and the second voltage **V2** through the line **C1B** and the line **C2B**.

Similarly, FIG. **6C** to FIG. **6D** are respectively a bottom view and a top view of the receiving substrate of the micro device transfer apparatus of FIG. **5**. Referring to FIG. **5**, FIG. **6C** and FIG. **6D**, in the present embodiment, the second electrodes **160D1** disposed on the third surface **S3** of the receiving substrate **120** and the second electrodes **160D2**

disposed on the fourth surface **S4** of the receiving substrate **120** respectively form a line **C3B** and a line **C4B**. In this way, the second electrodes **160D1** and the second electrodes **160D2** respectively disposed on the third surface **S3** and the fourth surface **S4** can be applied with the third voltage **V3** and the fourth voltage **V4** through the line **C3B** and the line **C4B**.

Moreover, in other embodiments that are not illustrated, technicians of the field may also design circuit layouts on the carrier substrate and the receiving substrate according to principles of applying the first voltage and the second voltage to the adjacent first electrodes, where the first voltage is different to the second voltage, and the second electrodes and the first electrodes are opposite in electrical property, etc. with reference of the descriptions of the aforementioned embodiments, so as to achieve the required technical effects.

FIG. **7A** and FIG. **7B** are schematic diagrams illustrating variations of voltages along with time when the voltages are applied to the micro device transfer apparatus according to another embodiment of the invention. Referring to FIG. **1B** and FIG. **7A**, in the present embodiment, the method of applying voltages to the corresponding electrodes of FIG. **7A** can be applied to the micro device transfer apparatus **100** of FIG. **1B**. In other words, in the present embodiment, regarding the operation of applying the first voltage **V1** and the second voltage **V2** to the first electrodes **150**, and applying the third voltage **V3** and the fourth voltage **V4** to the second electrodes **160**, the voltages can be applied to or stopped being applied to each of the electrodes along with time. For example, during the transfer process, the first voltage **V1** of a fixed value and the second voltage **V2** greater than the first voltage **V1** are applied to the first electrodes **150**, and the third voltage **V3** of a fixed value and the fourth voltage **V4** smaller than the third voltage **V3** are applied to the second electrodes **160**. After the transfer process is completed, the voltages are stopped being applied to each of the electrodes to continue a transfer process of a next stage, as that shown in FIG. **7A**.

Referring to FIG. **1B**, FIG. **7A** and FIG. **7B**, in the present embodiment, the method of applying voltages to the corresponding electrodes of FIG. **7B** can be applied to the micro device transfer apparatus **100** of FIG. **1B**. In other words, compared to the method of applying voltages of FIG. **7A**, the method of applying voltages of FIG. **7B** may further change a magnitude of the applied voltage along with time during the same transfer process. For example, in the transfer process, the first voltage **V1** of a fixed value is applied to the first electrodes **150** and the third voltage **V3** of a fixed value is applied to the second electrodes **160**, and the second voltage **V2** varied along with time is applied to the first electrodes **150** and the fourth voltage **V4** varied along with time is applied to the second electrodes **160**, by which the alignment accuracy of the second electrodes **160** and the micro devices **130** is further improved to decrease the errors in the transfer process.

FIG. **8A** to FIG. **8D** are bottom views of a method of transferring micro devices according to another embodiment of the invention. Referring to FIG. **8A** to FIG. **8D**, in the invention, the first voltage **V1** and the second voltage **V2** can only be applied to a portion of the adjacent two first electrodes **150E**, so that the micro devices **130** are released from the carrier substrate **110** to the receiving substrate **120** and bonded to the receiving substrate **120**. For example, in the present embodiment, one of the first electrodes **150E** receiving the second voltage **V2** is surrounded by the first electrodes **150E** receiving the first voltage **V1**. Therefore, in

the transfer process, transfer of the micro devices **130** located at positions (1,1), (1,3), (3,1) and (3,3) can be first performed, as that shown in FIG. **8A**. Then, transfer of the micro devices **130** located at positions (2,1), (2,3), (4,1) and (4,3) are performed, as that shown in FIG. **8B**. Then, transfer of the micro devices **130** located at positions (1,2), (1,4), (3,2) and (3,4) are performed, as that shown in FIG. **8C**. Finally, transfer of the micro devices **130** located at positions (2,2), (2,4), (4,2) and (4,4) are performed, as that shown in FIG. **8D**, so as to complete transferring the micro devices **130**. In this way, transfer of the micro devices **130** can be implemented by only applying a single-side voltage.

In the transfer process of the micro devices **130** shown in FIG. **8A** to FIG. **8D**, four transfer steps (i.e. voltages are applied by four times) are adopted to complete the transfer with high accuracy, though the invention is not limited thereto. FIG. **9A** and FIG. **9B** are top views of the carrier substrate and the receiving substrate of the micro device transfer apparatus according to another embodiment of the invention. Referring to FIG. **9A** and FIG. **9B**, the first electrodes **150F** disposed on the second surface **S2** of the carrier substrate **110** can be respectively electrically connected to other first electrodes **150F** applied with the same voltage to form a line **C1C** and a line **C2C** according to the first voltage **V1** and the second voltage **V2** applied thereto. Similarly, the second electrodes **160F** disposed on the fourth surface **S4** of the receiving substrate **120** can be respectively electrically connected to other second electrodes **160F** applied with the same voltage to form a line **C3C** and a line **C4C** according to the third voltage **V3** and the fourth voltage **V4** applied thereto. In this way, a part of the first electrodes **150F** is simultaneously applied with the first voltage **V1**, the other part of the first electrodes **150F** is simultaneously applied with the second voltage **V2**, and a part of the second electrodes **160F** is simultaneously applied with the third voltage **V3**, and the other part of the second electrodes **160F** is simultaneously applied with the fourth voltage **V4** through the lines.

In summary, in the method of transferring micro devices, after the receiving substrate and the carrier substrate relatively close to each other, the voltages are only applied to the substrate of one side, for example, the first voltage and the second voltage of different voltage values are applied to the adjacent first electrodes; alternatively, the voltages are applied to the substrates of two sides, for example, the first voltage and the second voltage of different voltage values are applied to the adjacent first electrodes, and the third voltage and the fourth voltage are applied to the adjacent second electrodes, such that the micro devices are released from the carrier substrate to the receiving substrate and bonded to the receiving substrate to complete transferring the micro devices. Namely, when the micro devices are transferred, at least one of the electrodes on the carrier substrate and the receiving substrate assumes a charged state. In this way, by applying different voltages to the adjacent two first electrodes, alignment accuracy in the transfer process is improved to decrease a transfer error, so as to achieve an effect of high alignment accuracy.

It will be apparent to those skilled in the art that various modifications and variations can be made to the structure of the invention without departing from the scope or spirit of the invention. In view of the foregoing, it is intended that the invention cover modifications and variations of this invention provided they fall within the scope of the following claims and their equivalents.

What is claimed is:

1. A method of transferring micro devices, comprising: providing a carrier substrate, the carrier substrate being configured with a plurality of first electrodes and a plurality of micro devices, wherein the micro devices are separated from each other and respectively electrically connected to the first electrodes; making a receiving substrate to relatively close to the carrier substrate, wherein the receiving substrate is configured with a plurality of second electrodes, and the second electrodes and the first electrodes are opposite in electrical property; and applying a first voltage and a second voltage to a portion of the adjacent two first electrodes, so that the micro devices are released from the carrier substrate to the receiving substrate and bonded to the receiving substrate, wherein the first voltage is different from the second voltage.
2. The method of transferring micro devices as claimed in claim 1, wherein each of the micro devices is a light emitting diode.
3. The method of transferring micro devices as claimed in claim 1, wherein the first voltage and the second voltage are the same or opposite in electrical property.
4. The method of transferring micro devices as claimed in claim 1, wherein the carrier substrate has a first surface and a second surface opposite to each other, the second surface is located adjacent to the receiving substrate, the micro devices are disposed on the second surface, and the first electrodes are disposed on the first surface or the second surface, or a part of the first electrodes is disposed on the first surface, and another part of the first electrodes is disposed on the second surface.
5. The method of transferring micro devices as claimed in claim 1, wherein the receiving substrate has a third surface and a fourth surface opposite to each other, the fourth surface is located adjacent to the carrier substrate, and the second electrodes are disposed on the third surface or the fourth surface, or a part of the second electrodes is disposed on the third surface, and another part of the second electrodes is disposed on the fourth surface.
6. The method of transferring micro devices as claimed in claim 1, wherein the receiving substrate is further configured with a plurality of transfer heads, and the transfer heads respectively and directly contact the micro devices.
7. The method of transferring micro devices as claimed in claim 1, further comprising: applying a third voltage and a fourth voltage to a portion of adjacent two second electrodes while applying the first voltage and the second voltage to the portion of the adjacent two first electrodes.
8. A micro device transfer apparatus, comprising: a carrier substrate, adapted to carry a plurality of micro devices and comprising a plurality of first electrodes, wherein the micro devices are separated from each other and respectively electrically connected to the first electrodes, a portion of the adjacent two first electrodes is adapted to receive a first voltage and a second voltage, and the first voltage is different from the second voltage; and a receiving substrate, comprising a plurality of second electrodes, wherein the second electrodes and the first electrodes are opposite in electrical property.
9. The micro device transfer apparatus as claimed in claim 8, wherein each of the micro devices is a light emitting diode.

11

10. The micro device transfer apparatus as claimed in claim 8, wherein the first voltage and the second voltage are the same or opposite in electrical property.

11. The micro device transfer apparatus as claimed in claim 8, wherein the carrier substrate has a first surface and a second surface opposite to each other, the second surface is located adjacent to the receiving substrate, the micro devices are disposed on the second surface, and the first electrodes are disposed on the first surface or the second surface, or a part of the first electrodes is disposed on the first surface, and another part of the first electrodes is disposed on the second surface.

12. The micro device transfer apparatus as claimed in claim 8, wherein the receiving substrate has a third surface and a fourth surface opposite to each other, the fourth surface is located adjacent to the carrier substrate, and the second electrodes are disposed on the third surface or the fourth surface, or a part of the second electrodes is disposed on the third surface, and another part of the second electrodes is disposed on the fourth surface.

12

13. The micro device transfer apparatus as claimed in claim 8, wherein the receiving substrate is further configured with a plurality of transfer heads, and the transfer heads respectively and directly contact the micro devices.

14. The micro device transfer apparatus as claimed in claim 8, wherein the carrier substrate is a sapphire substrate, and the receiving substrate is a glass substrate.

15. The micro device transfer apparatus as claimed in claim 8, wherein the carrier substrate is a glass substrate, and the receiving substrate is a driving substrate.

16. The micro device transfer apparatus as claimed in claim 8, wherein the adjacent two second electrodes are adapted to receive a third voltage and a fourth voltage.

17. The micro device transfer apparatus as claimed in claim 8, wherein one of the first electrodes receiving the second voltage is surrounded by a plurality of the first electrodes receiving the first voltage.

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[标]发明人	HSIANG JUI CHIEH CHEN CHIH CHIANG		
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摘要(译)

提供了一种转移微型器件的方法。提供了包括多个第一电极和多个微型器件的载体基板。微器件彼此分离并分别电连接到第一电极。使接收基板相对靠近载体基板。接收基板包括多个第二电极，并且第二电极和第一电极的电特性相反。第一电压和第二电压被施加到相邻的两个第一电极的一部分，使得微型器件从载体基板释放到接收基板并结合到接收基板。第一电压不同于第二电压。另外，还提供了一种微型器件传输设备。

