INKJET PRINTHEAD ASSEMBLY HAVING BACKSIDE ELECTRICAL CONNECTION

FIELD OF THE INVENTION

The present invention relates to printers and in particular inkjet printers. It is has been developed primarily for providing improved mounting of printhead integrated circuits so as to facilitate printhead maintenance.

BACKGROUND OF THE INVENTION

The Applicant has previously demonstrated that pagewidth inkjet printheads may be constructed using a plurality of printhead integrated circuits ('chips'), which are abutted end-on-end along the width of a page. Although this arrangement of printhead integrated circuits has many advantages (*e.g.* minimizing the width of a print zone in the paper feed direction), each printhead integrated circuit must still be connected to other printer electronics, which supply power and data to each printhead integrated circuit.

Hitherto, the Applicant has described how a printhead integrated circuit may be connected to an external power/data supply by wirebonding bond pads on each printhead integrated circuit to a flex PCB (see, for example, US 7,441,865). However, wirebonds protrude from the ink ejection face of the printhead and can, therefore, have a deleterious effect on both print maintenance and print quality.

It would be desirable to provide a printhead assembly in which printhead integrated circuits are connected to an external power/data supply without these connections affecting print maintenance and/or print quality.

SUMMARY OF THE INVENTION

Accordingly, in a first aspect there is provided an inkjet printhead assembly comprising: an ink supply manifold; one or more printhead integrated circuits, each printhead integrated circuit comprising: a silicon substrate having a frontside, a backside attached to said ink manifold, and at least one ink supply channel providing fluid communication between said backside and said frontside; at least one CMOS layer at said frontside comprising drive circuitry; and a MEMS layer disposed on said CMOS layer such that said CMOS layer is positioned between said silicon substrate and said MEMS layer, said MEMS layer comprising a plurality of inkjet nozzle assemblies; and at least one connector film for supplying power to said drive circuitry, wherein a connection end of said connector film is sandwiched between at least part of said ink supply manifold and said one or more printhead integrated circuits, wherein a plurality of through-silicon connectors provide electrical connection between said drive circuitry and said connection end of said connector film, and wherein each through-silicon connector extends linearly from a contact pad in said MEMS layer, through said CMOS layer and towards said backside, said contact pad being electrically connected to said CMOS layer.

In an embodiment, there is provided an inkjet printhead assembly comprising:

an ink supply manifold;

one or more printhead integrated circuits, each printhead integrated circuit having a frontside comprising drive circuitry and a plurality of inkjet nozzle assemblies, a backside attached to the ink supply manifold, and at least one ink supply channel for providing fluid communication between the backside and the inkjet nozzle assemblies; and

at least one connector film for supplying power to the drive circuitry,

wherein a connection end of the connector film is sandwiched between at least part of the ink supply manifold and the one or more printhead integrated circuits.

Inkjet printhead assemblies according to the present invention advantageously provide a convenient means for attaching printhead integrated circuits to an ink supply manifold whilst accommodating electrical connections to the printhead. Furthermore, the frontside face of the printhead is fully planar along its entire extent.

Optionally, the connector film comprises a flexible polymer film having a plurality of conductive tracks.

Optionally, the connector film is a tape-automated bonding (TAB) film.

Optionally, the backside has a recessed portion for accommodating the connector film.

Optionally, the recessed portion is defined along a longitudinal edge region of each printhead integrated circuit.

A~~Optionally, a~~ plurality of through-silicon connectors provide electrical connection between the drive circuitry and the connection end of the connector film.

Each~~Optionally, each~~ through-silicon connector extends linearly from the frontside towards the backside.

Optionally, each through-silicon connector is tapered towards the backside.

Optionally, each through-silicon connector is comprised of copper.

Each~~Optionally, each~~ printhead integrated circuit comprises:

a silicon substrate;

at least one CMOS layer comprising the drive circuitry; and

a MEMS layer comprising the inkjet nozzle assemblies,

wherein the CMOS layer is positioned between the silicon substrate and the MEMS layer.

Each~~Optionally, each~~ through-silicon connector extends linearly from a contact pad in the MEMS layer, through the CMOS layer and towards the backside, the contact pad being electrically connected to the CMOS layer.

Optionally, the printhead assembly comprises one or more conductor posts extending linearly between the contact pad and the CMOS layer.

Optionally, each through-silicon connector is electrically insulated from the CMOS layer.

Optionally, each through-silicon connector has outer sidewalls comprising an insulating film.

Optionally, the outer sidewalls comprise a diffusion barrier layer between the insulating film and a conductive core of the through-silicon connector.

Optionally, each through-silicon connector is connected to the connection end of the film with solder.

Optionally, the film is bonded to the ink supply manifold together with a plurality of the printhead integrated circuits.

Optionally, the plurality of printhead integrated circuits are positioned in an end-on-end butting arrangement to provide a pagewidth printhead assembly.

Optionally, a frontside face of the printhead is planar and free of any wirebond connections.

Optionally, the frontside face is coated with a hydrophobic polymer layer (e.g. PDMS).

In another embodiment ~~second aspect~~, there is provided a printhead integrated circuit having:

a frontside comprising drive circuitry and a plurality of inkjet nozzle assemblies;

a backside for attachment to an ink supply manifold; and

at least one ink supply channel for providing fluid communication between the backside and the inkjet nozzle assemblies,

wherein the backside has a recessed portion for accommodating at least part of a connector film supplying power to the drive circuitry.

Optionally, a connection end of the connector film is sandwiched between at least part of the ink supply manifold and the printhead integrated circuit when the backside is attached to the ink supply manifold.

Optionally, the recessed portion is defined along a longitudinal edge region of the printhead integrated circuit.

Optionally, the recessed portion comprises a plurality of integrated circuit contacts, each integrated circuit being connected to the drive circuitry.

Optionally, the connector film is a tape-automated bonding (TAB) film, and wherein the integrated circuit contacts are positioned for connection to corresponding contacts of the TAB film.

Optionally, a plurality of through-silicon connectors extend linearly from the frontside towards the backside, each through-silicon connector providing an electrical connection between the drive circuitry and a corresponding integrated circuit contact.

Optionally, each integrated circuit contact is defined by an end of a respective through-silicon connector.

Optionally, the backside has a plurality of ink supply channels extending longitudinally along the printhead integrated circuit, each ink supply channel defining one or more ink inlets for receiving ink from the ink supply manifold. Optionally, each ink supply channel supplies ink to a plurality of frontside inlets. Optionally, each frontside inlet supplies ink to one or more of the inkjet nozzle assemblies.

Optionally, each ink supply channel has a depth corresponding to a depth of the recessed portion.

In another embodiment ~~third aspect~~, there is provided a printhead integrated circuit comprising:

a silicon substrate defining a frontside and a backside;

a plurality of inkjet nozzle assemblies positioned at the frontside;

drive circuitry for supply power to the inkjet nozzle assemblies; and

one or more through-silicon connectors extending from the frontside towards the backside, the through-silicon connectors providing electrical connections between the drive circuitry and one or more corresponding integrated circuit contacts,

wherein the integrated circuit contacts are positioned for connection to a backside-mounted connector film supplying power to the drive circuitry.

Optionally, each integrated circuit contact is defined by an end of a respective through-silicon connector.

In a further embodiment ~~fourth aspect~~, there is provided a method of fabricating an inkjet printhead assembly having backside electrical connections, the method comprising the steps of:

providing one or more printhead integrated circuits, each printhead integrated circuit having a frontside comprising drive circuitry and a plurality of inkjet nozzle assemblies, a backside having one or more ink inlets and a recessed edge portion, and one or more connectors extending through the integrated circuit, each connector having a head connected to the drive circuitry and a base in the recessed edge portion;

positioning a connection end of a connector film in the recessed edge portion of at least one of the printhead integrated circuits, the connector film comprising a plurality of conductive tracks, each conductive track having a respective film contact at the connection end;

connecting each film contact to the base of a corresponding connector; and

attaching the backside of each printhead integrated circuit together with the connector film to an ink supply manifold so as to provide the inkjet printhead assembly having backside electrical connections.

Optionally, the attaching step sandwiches the connection end of the connector film between part of the ink supply manifold and the one or more printhead integrated circuits.

Optionally, the film is a tape-automated bonding (TAB) film.

Optionally, the connecting step comprises soldering each film contact to the base of its corresponding connector.

Optionally, the attaching step is performed using an adhesive film.

Optionally, the adhesive film has a plurality of ink supply apertures defined therein.

Optionally, the attaching step comprises aligning each printhead integrated circuit with the adhesive film such that each ink supply aperture is aligned with an ink inlet, bonding the printhead integrated circuits to one side of the adhesive film, and bonding an opposite side of the film to the ink supply manifold.

Optionally, in the connecting step, each printhead integrated circuit is connected to a respective connector film.

Optionally, in the connecting step, a plurality of printhead integrated circuits are connected to the same connector film.

Optionally, the plurality of printhead integrated circuits are attached to the ink supply manifold in an end-on-end butting arrangement to provide a pagewidth printhead assembly.

In yet another embodiment~~a fifth aspect~~, there is provided a method of fabricating a printhead integrated circuit configured for backside electrical connections, the method comprising the steps of:

providing a wafer comprising a plurality of partially-fabricated nozzle assemblies on a frontside of the wafer and one or more through-silicon connectors extending from the frontside towards a backside of the wafer;

depositing a conductive layer on the frontside of the wafer and etching the conductive layer so as to form, concomitantly, an actuator for each nozzle assembly and a frontside contact pad over a head of each through-silicon connector, the frontside contact pad connecting the through-silicon connector to drive circuitry in the wafer;

performing further MEMS processing steps to complete formation of the nozzle assemblies, ink supply channels for the nozzle assemblies and the through-silicon connectors; and

Optionally, each of the predefined vias has a diameter proportionate with a depth such that the all the vias are filled evenly by the deposition.

Optionally, the conductive material is copper.

Optionally, the further MEMS processing steps comprise coating a frontside face with a hydrophobic polymer layer.

Optionally, the hydrophobic polymer layer is comprised of PDMS.

Optionally, the further MEMS processing steps comprise oxidatively removing sacrificial material.

In a second aspect, there is provided a printhead integrated circuit comprising: a silicon substrate having a frontside, a backside for attachment to an ink manifold, and at least one ink supply channel providing fluid communication between said backside and said frontside; at least one CMOS layer at said frontside comprising drive circuitry; and a MEMS layer disposed on said CMOS layer such that said CMOS layer is positioned between said silicon substrate and said MEMS layer, said MEMS layer comprising a plurality of inkjet nozzle assemblies, wherein a plurality of through-silicon connectors extend linearly from contact pads in said MEMS layer, through said CMOS layer and towards said backside, said contact pad being electrically connected to said CMOS layer.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will now be described in detail with reference to following drawings in which:-

Figure 1 is a front perspective of a printhead integrated circuit;

Figure 2 is a front perspective of a pair of butting printhead integrated circuits;

Figure 3 is a rear perspective of the printhead integrated circuit shown in Figure 1;

Figure 4 is a cutaway perspective of an inkjet nozzle assembly having a floor nozzle inlet;

Figure 5 is a cutaway perspective of an inkjet nozzle assembly having a sidewall nozzle inlet;

Figure 6 is a side perspective of a printhead assembly;

Figure 7 is a lower perspective of the printhead assembly shown in Figure 6;

Figure 8 is an exploded upper perspective of the printhead assembly shown in Figure 6;

Figure 9 is an exploded lower perspective of the printhead assembly shown in Figure 6;

Figure 10 is overlaid plan view of a printhead integrated circuit attached to an ink supply manifold;

Figure 11 is a magnified view of Figure 10;

Figure 12 is a perspective of an inkjet printer;

Figure 13 is a schematic cross-section of the printhead assembly shown in Figure 6;

Figure 14 is a schematic cross-section of a printhead assembly according to the present invention;

Figure 15 is a schematic cross-section of an alternative printhead assembly according to the present invention;