

Claims

1. A droplet ejector assembly for a printhead, the droplet ejector assembly comprising: a substrate having a first surface and an opposite second surface, the substrate comprising a CMOS control circuit, a plurality of layers on the first surface of the substrate, a fluid chamber having a droplet ejection outlet, and a piezoelectric actuator element formed by one or more said layers and comprising a piezoelectric body and first and second electrodes in contact with the piezoelectric body, the piezoelectric actuator element defining part of the fluid chamber, at least one said electrode electrically connected to the CMOS control circuit, the droplet ejector comprising a fluid chamber having a droplet ejection outlet, wherein the piezoelectric actuator element is separate to the droplet ejection outlet and the piezoelectric body is formed of one or more piezoelectric materials processable at a temperature below 450°C.
2. A droplet ejector assembly according to claim 1, wherein the piezoelectric body comprises one or more non-ferroelectric piezoelectric materials and the CMOS control circuit is configured to actuate the piezoelectric body by applying an electrical potential gradient to the piezoelectric body in a first direction to cause the piezoelectric body to flex in a first sense and then to apply an electrical potential gradient to the piezoelectric body in the opposite direction to cause it to deform in an opposite second sense.
3. A droplet ejector assembly according to claim 1 or claim 2, wherein the piezoelectric body has a relative permittivity, ϵ_r , of less than 100.
4. A droplet ejector assembly according to any one preceding claim, wherein the piezoelectric body has a breakdown voltage of greater than 100V/ μm and the CMOS control circuit is configured to apply a potential gradient of greater than 100V/ μm within the piezoelectric body.
5. A droplet ejector assembly according to any one preceding claim, wherein the CMOS control circuit comprises one or more of: (a) a digital register, (b) a nozzle trimming calculation circuit and/or register, (c) a temperature measurement circuit, (d) a fluid chamber fill detection circuit.

- 1 6. A droplet ejector assembly according to any one preceding claim, wherein the
2 CMOS control circuit comprises an ejection transistor.
3
- 4 7. A droplet ejector assembly according to any one preceding claim, comprising an
5 electrical input for receiving actuator drive pulses, and wherein the CMOS control
6 circuits are configured to switchedly connect or disconnect at least one electrode
7 of the or each piezoelectric actuator to the received actuator drive pulses to
8 thereby selectively actuate the piezoelectric actuators.
9
- 10 8. A droplet ejector assembly according to any one preceding claim, wherein the
11 CMOS control circuit is configured to individually and selectively actuate at least
12 three said piezoelectric actuator elements formed by one or more said layers on
13 the same substrate and defining part of different respective fluid chambers and
14 droplet ejection outlets, optionally wherein actuators in the said at least three
15 actuator elements are configured for ejecting fluid of different colours or
16 compositions.
17
- 18 9. A droplet ejector assembly according to claim 8, wherein the said at least three
19 actuator elements are located on the substrate and the CMOS control circuit is
20 connected to a flexible printhead cable having one or more electrical signal
21 conductors, wherein the CMOS control circuit is configured to individually and
22 selectively actuate the actuator elements of the at least three actuator elements
23 responsive to actuation commands received through the same signal conductor.
24
- 25 10. A droplet ejector assembly according to claim 8 or claim 9, wherein the CMOS
26 control circuit is configured to individually and selectively actuate at least double
27 the number of piezoelectric actuator elements than signal conductors through
28 which the CMOS control circuit receives actuation control signals.
29
- 30 11. A droplet ejector assembly according to any one of claims 8 to 11, further
31 comprising a fluid supply block in contact with one or more of the said layers and
32 defining at least three separate fluid supply manifolds for supplying fluid of
33 different colours or compositions of liquid to different said fluid chambers.
34
- 35 12. A droplet ejector assembly according to claim 11, wherein the fluid supply
36 manifolds comprise a fluid conduit which is connected to each of a plurality of
37 fluid chambers, to supply fluid of the same composition to each of the plurality of
38 fluid chambers, wherein the piezoelectric actuator elements which define part of

1 each of the plurality of fluid chambers are actuated by the CMOS control circuit,
2 optionally responsive to actuation commands received through the same signal
3 conductor.
4

5 13. A droplet ejector assembly according to any one preceding claim wherein the
6 CMOS control circuit is configured to switchedly connect one or more of ground
7 and a single fixed non-zero voltage line, or multiple fixed voltage lines of different
8 voltages, one or more of which may be ground, to one or more both electrodes
9 of a piezoelectric actuator to cause droplet ejection.
10

11 14. A droplet ejector according to any one preceding claim, wherein the CMOS
12 control circuit is configured to modify the voltage pulses applied to one or more
13 electrodes of one or more piezoelectric actuators responsive to data stored by
14 the CMOS control circuit or measurements from one or more sensors, which are
15 typically within the droplet ejector assembly.
16

17 15. An inkjet printer comprising a controller and one or more droplet ejector
18 assemblies according to claim 7 in electronic communication with and controlled
19 by the controller, wherein the controller further comprises a pulse generator
20 configured to generate a sequence of actuator drive pulses and the electrical
21 input of the droplet ejector assembly receives actuator drive pulses through an
22 electrical connection to the controller, and wherein the CMOS control circuit of
23 the one or more droplet ejector assemblies is configured to switchedly connect
24 or disconnect at least one electrode of the or each of a plurality of piezoelectric
25 actuators to the received actuator drive pulses to thereby selectively actuate the
26 piezoelectric actuators.
27

28 16. An inkjet printer according to claim 15, comprising a plurality of droplet ejector
29 assemblies, wherein pulses from the pulse generator are conducted to a plurality
30 of control circuits which are part of a plurality of droplet ejector assemblies,
31 wherein the controller is further configured to generate digital control signals
32 which are conducted to the droplet ejector assemblies and which are processed
33 in the CMOS control circuits of the droplet ejector assemblies to determine which
34 actuator drive pulses are conducted to at least one electrode of the piezoelectric
35 actuators of the one or more droplet ejector assemblies to cause droplet ejection.
36

- 1 17. A method of manufacturing a droplet ejector assembly for a droplet ejector
2 according to any one preceding claim, the method comprising: providing a
3 substrate having a first surface, forming the CMOS control circuit on the first
4 surface, forming the plurality of layers on the first surface, the plurality of layers
5 comprising the piezoelectric actuator element comprising the first and second
6 electrodes and the piezoelectric body.
7
- 8 18. A method of operating a droplet ejector assembly according to any one of
9 claims 1 to 14, or an inkjet printer according to claim 15 or 16, wherein the
10 CMOS control circuit receives digital actuation control signals and processes
11 the digital actuation control signals to selectively actuate the piezoelectric
12 actuator element to cause droplet ejection.
13
- 14 19. A method according to claim 18, comprising the step of generating actuator
15 drive pulses and conducting them to the droplet ejector assembly through an
16 electrical connection, and switchedly connecting or disconnecting at least one
17 electrode of the or each of a plurality of piezoelectric actuators to the received
18 actuator drive pulses to thereby selectively actuate the piezoelectric actuators.
19
- 20 20. A method according to claim 18 or claim 19 comprising generating a plurality of
21 different sequences of actuator drive pulses and conducting them to the droplet
22 ejector assembly through separate electrical connections, and switchedly
23 connecting or disconnecting at least one electrode of the or each of a plurality
24 of piezoelectric actuators to one or more received actuator drive pulses
25 received from a variable one of the plurality of different sequences of actuator
26 drive pulses.
27
- 28 21. A method according to any one of claims 18 to 20, comprise switching an
29 electrode between a connection to ground and a connection to a fixed voltage
30 or multiple fixed voltage lines of different voltages and back to ground again in
31 order to cause a droplet ejection.
32
- 33 22. A droplet ejector assembly for a printhead, the droplet ejector assembly
34 comprising: a substrate having a first surface and an opposite second surface,
35 the substrate comprising a CMOS control circuit, a plurality of layers on the first
36 surface of the substrate, a fluid chamber having a droplet ejection outlet, and a
37 piezoelectric actuator element formed by one or more said layers and

- 1 comprising a piezoelectric body and first and second electrodes in contact with
2 the piezoelectric body, the piezoelectric actuator element defining part of the
3 fluid chamber, at least one said electrode electrically connected to the CMOS
4 control circuit, the droplet ejector comprising a fluid chamber having a droplet
5 ejection outlet, wherein the piezoelectric body is formed of one or more
6 piezoelectric materials processable at a temperature below 450°C.
7
- 8 23. A droplet ejector assembly according to claim 22, wherein the piezoelectric
9 body has a breakdown voltage of greater than 100V/μm and the CMOS control
10 circuit is configured to apply a potential gradient of greater than 100V/μm within
11 the piezoelectric body.
12
- 13 24. A droplet ejector assembly according to claim 22 or claim 23, comprising an
14 electrical input for receiving actuator drive pulses, and wherein the CMOS
15 control circuits are configured to switchedly connect or disconnect at least one
16 electrode of the or each piezoelectric actuator to the received actuator drive
17 pulses to thereby selectively actuate the piezoelectric actuators, or wherein the
18 CMOS control circuit is configured to switchedly connect one or more of ground
19 and a single fixed non-zero voltage line, or multiple fixed voltage lines of
20 different voltages, one or more of which may be ground, to one or more both
21 electrodes of a piezoelectric actuator to cause droplet ejection.
22
- 23 25. An inkjet printer comprising a controller and one or more droplet ejector
24 assemblies according to any one of claims 22 to 24 in electronic
25 communication with and controlled by the controller, wherein the controller
26 further comprises a pulse generator configured to generate a sequence of
27 actuator drive pulses and the electrical input of the droplet ejector assembly
28 receives actuator drive pulses through an electrical connection to the controller,
29 and wherein the CMOS control circuit of the one or more droplet ejector
30 assemblies is configured to switchedly connect or disconnect at least one
31 electrode of the or each of a plurality of piezoelectric actuators to the received
32 actuator drive pulses to thereby selectively actuate the piezoelectric actuators.
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