Claims

1. An electrohydrodynamic print head comprising

a nozzle carrier ~~(6)~~,

a plurality of nozzles ~~(4)~~ arranged on said nozzle carrier ~~(6)~~,

a plurality of ejection electrodes ~~(38)~~ associated with said nozzles ~~(4)~~ and located on a front side of said nozzles ~~(4)~~,

wherein said print head comprises at least one multilayer structure ~~(109)~~ with a bottom layer ~~(110)~~, a top layer ~~(112)~~, and at least one intermediate layer ~~(114)~~ between said bottom layer ~~(110)~~ and said top layer ~~(112)~~, wherein said intermediate layer(s) ~~(114)~~ form(s) walls ~~(116)~~ extending between the bottom layer ~~(110)~~ and the top layer ~~(112)~~,

and wherein a plurality of cavities ~~(118, 120)~~ are located in the intermediate layer ~~(114)~~ between the bottom layer ~~(110)~~ and said top layer ~~(112)~~.

2. The print head of claim 1, wherein at least part of said cavities ~~(118)~~ are closed cavities.

3. The print head of claim 2, wherein ~~particular~~ a majority of said cavities ~~(118),~~ are closed cavities.

~~3~~4. The print head of any of the preceding claims, wherein at least part of said cavities ~~(118)~~ form a repetitive, regular pattern.

~~4~~5. The print head of any of the preceding claims, wherein said walls ~~(116)~~ form a honeycomb structure between the bottom layer ~~(110)~~ and the top layer ~~(112)~~.

~~6~~5. The print head of any of the preceding claims, wherein said walls ~~(116)~~ have a thickness (m) of less than 25% of a minimum diameter (M) of the cavities ~~(118)~~.

~~7~~6. The print head of any of the preceding claims, wherein a minimum diameter (M) of the cavities ~~(118)~~ is larger than a thickness (t) of the intermediate layer ~~(114)~~.

87. The print head of any of the preceding claims, wherein said walls (116) extend perpendicularly to the bottom layer (110) and the top layer (112).

98. The print head of any of the preceding claims, wherein at least some of said cavities (71, 71', 71", 120) communicate with and are adjacent to exit passages (5) located at said nozzles (4).

109. The print head of any of the preceding claims, wherein at least some of said cavities (71) are arranged between different electrodes (38, 40, 42, 122) of said print head.,

11. The print head of claim 10,and in particular wherein any straight line extending between two neighboring electrodes (38, 40, 42, 122) extends through at least one of the cavities (71, 71', 71").

1210. The print head of any of the preceding claims, wherein at least some of said cavities (71', 71") are arranged between an electrode (38, 42, 122) of the print head and an ink retainer (66) of the print head.

1311. The print head of any of the claims 9 or 10 to 12, wherein said different electrodes (38, 40, 42, 122) are separated from the cavity or cavities (118, 120) by one or more solid dielectric layers (124a, 124b, 126).

1412. The print head of any of the claims 1210 or 1311, wherein said electrodes (38, 40, 42, 122) are mounted to the bottom layer (110) and/or the top layer (112) of the multilayer structure (109).

1513. The print head of claim 1412, wherein the electrodes (38, 40, 42, 122) are embedded into the bottom layer (110) and/or the top layer (112) of the multilayer structure (109), with the bottom layer (110) and/or top layer (112) forming dielectric solid layers covering the electrodes (38, 40, 42, 122) from the bottom and top sides.

1614. The print head of any of ~~the~~ claims 1311 to 1513, wherein said one or more solid dielectric layers ~~(124a, 124b, 126)~~ comprise a polymer layer ~~(124a, 124b)~~ and/or an inorganic layer ~~(126)~~.

17. The print head of claim 16, ~~and in particular~~ wherein said polymer layer ~~(124a, 124)~~ is arranged between said electrode ~~(122)~~ and said inorganic layer ~~(126)~~.

1815. The print head of any of ~~the~~ claims 1210 to 1714, further comprising guard electrodes ~~(42)~~ arranged at a level behind the ejection electrodes ~~(38)~~, wherein at least some of the cavities ~~(71')~~ are arranged between at least one of said ejection electrodes ~~(38)~~ and at least one of said guard electrodes ~~(42)~~.

1916. The print head of any of ~~the~~ claims 1210 to 1815, further comprising at least one shielding electrode ~~(40)~~ arranged at a level in front of the ejection electrodes ~~(38)~~, wherein at least some of the cavities ~~(71")~~ are arranged between at least one of said ejection electrodes ~~(38)~~ and said shielding electrode ~~(42)~~.

2017. The print head of any of the preceding claims, wherein the nozzle carrier ~~(6)~~ comprises at least the intermediate layer ~~(114)~~ of the multilayer structure ~~(109)~~.

2118. The print head of any of the preceding claims, wherein the nozzle carrier ~~(6)~~ comprises:

- a front layer ~~(10)~~, wherein said nozzles ~~(4)~~ are mounted to a front side ~~(36)~~ of the front layer ~~(10)~~, and
- a backing layer ~~(12)~~ located at a back side of the front layer ~~(10)~~,
- electrical vias ~~(14)~~ connected to the ejection electrodes ~~(38)~~ and extending through the front layer ~~(10)~~ and the backing layer ~~(12)~~, and
- ink feed ducts ~~(15, 16)~~ arranged in the front layer ~~(10)~~,

wherein the front layer ~~(10)~~ comprises at least the intermediate layer ~~(114)~~.~~,~~

22. The print head of claim 21, ~~and in particular~~ wherein there are closed cavities ~~(118)~~ not communicating with the ink ducts ~~(15, 16)~~.

2319. The print head of any of the preceding claims, further comprising a support structure (8) supporting said ejection electrodes (38) on said nozzle carrier (6), wherein said support structure (8) comprises a plurality of support elements (76, 78) arranged between said nozzles (4),

and wherein said support structure (8) comprises at least the intermediate layer (114) of the multilayer structure (109).

2420. The print head of claim 2319, further comprising a plurality of ink retainers (66) arranged between said nozzles (4) and said support elements (76, 78), wherein, along an ejection direction (X) of the print head, the front surfaces (68) of the ink retainers (66) are located at a level behind the front ends (70) of the nozzles (4).

2521. The print head of any of the preceding claims, wherein a thickness (t) of said intermediate layer (114) is at least 1 µm, in particular at least 10 µm.

2622. The print head of any of the preceding claims, wherein said intermediate layer (114) is a polymer layer.

2723. The print head of any of the preceding claims, comprising at least one material layer of a material different from the intermediate layer (114), in particular a semiconductor or glass layer.

2824. A method for manufacturing the print head of any of the preceding claims, comprising the steps of

applying a material layer on said bottom layer (110),

removing part of said material layer for forming said cavities (118), and

applying the top layer (112) above the material layer.

2925. The method of claim 2824, wherein said material layer is a photoresist, in particular SU-8, and said method comprises the steps of

illuminating the material layer with collimated light through a mask, thereby defining illuminated and non-illuminated regions in said material layer, and

selectively removing the illuminated or the non-illuminated regions from the material layer.

30~~26~~. The method of ~~any of the~~ claim~~s~~ 28~~24~~ or 29~~25~~, comprising the step of applying the top layer ~~(112)~~ above the material layer using lamination.