

# MicroFab Technologies, Inc.

## Patents

### *Patents Assigned to MicroFab*

1. "Method and Apparatus for Dispensing a Fluid with Dispersed Particles Therein," U.S. Patent 4,812,856, D.B. Wallace, March 14, 1989.
2. "Method and Apparatus for Serializing Printed Circuit Boards and Flex Circuits," U.S. Patent 4,853,317, D.J. Hayes, August 1, 1989.
3. "Method of Making Apparatus for Dispensing Small Amounts of Fluids," D.J. Hayes and J.R. Pies, U.S. Patent 5,053,100, October 1, 1991.
4. "Method and Apparatus for Improved Laser Surgery," U.S. Patent 5,092,864, D.J. Hayes, J.L. Matthews, and M.M. Judy, March 3, 1992.
5. "Method and Apparatus for Soldering without using Flux," D.J. Hayes, U.S. 5,193,738. March 16, 1993.
6. "Method and Apparatus for Dispensing Spherical-Shaped Quantities of Liquid Solder," D.J. Hayes, D.B. Wallace and M.T. Boldman, U.S. Patent 5,229,016, July 20, 1993.
7. "Method of Making Solder Interconnect Arrays," D.J. Hayes, U.S. Patent 5,377,902, January 3, 1995.
8. "Solder Compositions and Methods of Making Same," D.J. Hayes, U.S. Patent 5,411,602, May, 2, 1995.
9. "Method and Apparatus for Forming Microdroplets of Liquids at Elevated Temperatures," D.B. Wallace, U.S. Patent 5,415,679, May 16, 1995.
10. "Method for Producing Micro-Optical Components," D.J. Hayes, U.S. Patent 5,498,444, March 12, 1996.
11. "Controlling Depoling and Aging of Piezoelectric Transducers," D.B. Wallace and R.E. Marusak, U.S. Patent 5,643,353, July 1, 1997.
12. "Method and Apparatus for Making Miniaturized Diagnostic Arrays," D.J. Hayes, D.B. Wallace, and C.J. Frederickson, U.S. Patent 5,658,802, August 19, 1997.
13. "Process for Dispensing Semiconductor Die-bond Adhesive Using a Printhead Having a Microjet Array and the Product Produced by the Process," D.J. Hayes, U.S. Patent 5,681,757, October 28, 1997.
14. "Method for Electro-deposition Passivation of Ink Channels in Ink Jet Printhead," D.J. Hayes, U.S. Patent 5,688,391, November 18, 1997.
15. "Method for Producing Micro-optical Components," D.J. Hayes and W.R. Cox, U.S. Patent 5,707,684, January 13, 1998.

16. "Methods and Apparatus for Direct Heating of Biological Material," D.J. Hayes, D.B. Wallace, and C.J. Frederickson, U.S. Patent 5,721,123, February 24, 1998.
17. "In-line Thermo-cycler", D.J. Hayes, D.B. Wallace, and C.J. Frederickson, U.S. Patent 5,736,314, April 7, 1998.
18. "Manufacture of Coated Spheres," D.J. Hayes and M.W. Hartnett, U.S. Patent 5,736,074, April 7, 1998.
19. "Printhead for Liquid Metals and Method of Use," S.D. Ayers, D.J. Hayes, M.T. Boldman, and D.B. Wallace, U.S. Patent 5,772,106, June 30, 1998.
20. "Method and Apparatus for Making Apparatus for Conducting Biochemical Analyses," D.J. Hayes, D.B. Wallace, and C.J. Frederickson, U.S. Patent 5,849,208, December 15, 1998.
21. "Method for Electro-deposition Passivation of Ink Channels in Ink Jet Printhead," D.J. Hayes, U.S. Patent 5,858,190, January 12, 1999.
22. "Process for Manufacturing Metal Ball Electrodes for a Semiconductor Device," D.J. Hayes, U.S. Patent 5,861,323, January 19, 1999.
23. "Direct Solder Bumping of Hard to Solder Substrate," D.J. Hayes, M.T. Boldman, and Virang G. Shah, U.S. Patent 6,015,083, January 18, 2000.
24. "Method of Drop Size Modulation with Extended Transition Time Waveform," R.G. Self and D.B. Wallace, U.S. Patent 6,029,896, February 29, 2000.
25. "Method of Forming an Adhesive Connection," D.J. Hayes, U.S. Patent 6,077,380, June 20, 2000.
26. "Method for Preparing a Chip Scale Package and Product Produced by the Method," D.J. Hayes and M.W. Hartnett, U.S. Patent 6,114,187, September 05, 2000.
27. "Orifice Array for High Density Ink Jet Printhead", D.J. Hayes, U.S. Patent 6,188,416, February 13, 2001.
28. "Implantable Diagnostic Sensor," D.W. Taylor, U.S. Patent 6,267,724, July 31, 2001.
29. "Devices for Presenting Airborne Materials to the Nose," D.J. Hayes, C.J. Frederickson, and D.B. Wallace, U.S. Patent 6,325,475, December 4, 2001.
30. "Method for Collecting Interstitial Fluid from the Skin," D.J. Hayes, D.W. Taylor, and D.B. Wallace, U.S. Patent 6,334,851, January 1, 2002.
31. "Flexible Apparatus with Ablation Formed Chamber(s) for Conducting Bio-chemical Analyses," D.J. Hayes, D.B. Wallace, and C.J. Frederickson, U.S. Patent 6,334,980, January 1, 2002.
32. "Digital Olfactometer and Method for Testing Olfactory Thresholds," D.J. Hayes, I. Achiriloaie, D.W. Taylor, N. Comparini, and D.B. Wallace, U.S. Patent 6,338,715, January 15, 2002.
33. "Method and Apparatus for Dispensing Airborne Materials for Controlling Pests," D.J. Hayes, C.J. Frederickson, and M. Sinks, U.S. Patent 6,339,897, January 22, 2002.

34. "Flat-sided Fluid Dispensing Device," T. Chen and D.J. Hayes, U.S. Patent 6,367,925, April 9, 2002.
35. "Cartridge Element for Micro Jet Dispensing," D.W. Taylor, I. Achiriloaie, U.S. Patent 6,378,988 , April 30, 2002.
36. "Method and Apparatus for Delivery of Fragrances and Vapors to the Nose," C.J. Frederickson, D.B. Wallace, D.J. Hayes, D.W. Taylor, M.D. Hayes, U.S. Patent 6,390,453, May 21, 2002.
37. "Low Cost Method for Making Thermoelectric Coolers," D.J. Hayes, U.S. Patent 6,440,212, August 27, 2002.
38. "Method for Fabricating Laminated Carrier for Collecting Interstitial Fluid from the Skin," D.J. Hayes, D.W. Taylor, and D.B. Wallace, U.S. Patent 6,620,283, September 16, 2003.
39. "Ink-jet Printing of Collimating Microlenses onto Optical Fibers," W.R. Cox and C. Guan, U.S. Patent 6,625,351, September 23, 2003.
40. "Method for Producing a Fiber Optic Switch," D.J. Hayes, T. Chen, and W.R. Cox, U.S. Patent 6,642,068, November 4, 2003.
41. "Method of Calibrating a Sensor for Measuring Concentration of Odors," C. J Frederickson, D.J. Hayes, D.B. Wallace, D.W. Taylor, and M.D. Hayes, U.S. Patent 6,672,129, January 6, 2004.
42. "Precision Micro-Optical Elements and the Method of Making Precision Micro-Optical Elements," D.J. Hayes, U.S. Patent 6,805,902 B1, October 19, 2004.
43. "Method for forming polymer microspheres," D. Radulescu, U.S. patent 6,998,074, February 14, 2006.
44. "Cat's Eye Retro-reflector Array Coding Device and Method of Fabrication," U.S. patent 7,152,984, December 26, 2006.

### ***Patents Assigned to MicroFab's Customers***

1. "Apparatus and Process for Reagent Fluid Dispensing and Printing," D.J. Hayes, D.B. Wallace, D. VerLee, and K. Houseman, U.S. Patent 4,877,745, October 31, 1989.
2. "Method of Forming Tapered Orifice Arrays in Fully Assembled Ink Jet Printheads," D.J. Hayes, U.S. Patent 5,208,980, May 11, 1993.
3. "Sidewall Actuator for a High Density Ink Jet Printhead," J.R. Pies, D.B. Wallace and D.J. Hayes, U.S. Patent 5,227,813, July 13, 1993.
4. "High Density Ink Jet Printhead," J.R. Pies, D.B. Wallace, and D.J. Hayes, U.S. Patent 5,235,352, August 10, 1993.
5. "Method and Apparatus for Film Coated Passivation of Ink Channels in Ink Jet Printhead," D.J. Hayes, J.R. Pies, U.S. Patent 5,334,415, August 2, 1994.
6. "Ink-Jet Print Head," M.H. Everett, D.B. Wallace and D.J. Hayes, U.S. Patent 5,373,314, December 13, 1994.
7. "High Density Ink Jet Printhead," D.B. Wallace, U.S. Patent 5,400,064, March 21, 1995.
8. "Integrated Multicolor Ink Jet Printhead," D. Fusting, J.R. Pies, D.B. Wallace, D.J. Hayes, U.S. Patent 5,402,162, March 28, 1995.
9. "Enhanced U-Type Ink Jet Printheads," D.J. Hayes and D.B. Wallace, U.S. Patent 5,406,319, April 11, 1995.
10. "Ink Jet Printhead Assembly Having Aligned Dual Internal Channel Arrays," D.H. Hayes, U.S. Patent 5,414,916, May 16, 1995.
11. "Method of Manufacturing a High Density Ink Jet Printhead," J.R. Pies, D.B. Wallace and D.J. Hayes, U.S. Patent 5,433,809, July 18, 1995.
12. "Method of Manufacturing a Single Sid Drive System Interconnectable Ink Jet Printhead," D.J. Hayes and J.L. Stortz, U.S. Patent 5,435,060, July 25, 1995.
13. "Switched Digital Drive System for an Ink Jet Printhead," J.L. Stortz and D.B. Wallace, U.S. Patent 5,436,648, July 25, 1995.
14. "Droplet Volume Modulation Techniques for Ink Jet Printheads," D.B. Wallace and J.L. Stortz, U.S. Patent 5,461,403, October, 1995.
15. "Apparatus for Film Coated Passivation of Ink Channels in Ink Jet Printhead," J.R. Pies, U.S. Patent 5,462,600, October 31, 1995.
16. "Ink Jet Printhead Manufactured by a Film Coated Passivation Process," J.R. Pies and D.J. Hayes, U.S. Patent 5,481,285, January 2, 1996.
17. "Workpieces Manufactured by a Film Coated Passivation Process," J.R. Pies and D.J. Hayes, U.S. Patent 5,506,034, April 9, 1996.
18. "Dual Element Switched Digital Drive System," J.L. Stortz and D.B. Wallace, U.S. Patent 5,521,618, May 28, 1996.
19. "Method of Manufacturing PZT Printhead," D.J. Hayes, U.S. Patent 5,543,009, August 6, 1996.

20. "Method of Manufacturing a High Density Ink Jet Printhead," J.R. Pies, D.B. Wallace and D.J. Hayes, U.S. Patent 5,554,247, September 10, 1996.
21. "Ink Jet Printhead Assembly Having Aligned Dual Internal Channel," D.J. Hayes, U.S. Patent 5,557, 309, September 17, 1996.
22. "Multi-channel Array Actuation System for an Ink Jet Printhead," D.J. Hayes, D.B. Wallace, U.S. Patent 5,581, 286, December 3, 1996.
23. "Enhanced UU Type Ink Jet Printheads," D.J. Hayes, J.R. Pies, and D.B. Wallace, U.S. Patent 5,621,442, April 15, 1997.
24. "Process of Manufacturing a Drop-on-demand Ink Jet Printhead Having Thermoelectric Temperature Control Means," D.J. Hayes, U.S. Patent 5,622,897, April 22, 1997.
25. "Single Side Drive System Interconnectable Ink Jet Printhead," D.J. Hayes and J.L. Stortz, U.S. Patent, September 9, 1997
26. "Method of Forming an Orifice Array for a High Density Ink Jet Printhead," D.J. Hayes and W.R. Cox, U.S. Patent 5,703,631, December 30, 1997.
27. "Ink Jet Printhead with Built in Filter Structure," D.J. Hayes, U.S. Patent 5,742,314, April 21, 1998.
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29. "High Density Interconnect Apparatus for an Ink Jet Printhead," J.L. Stortz, U.S. Patent 5,345,256, September 6, 1994.
30. "Method of Manufacturing of a Page Wide Piezoelectric Ink Jet Printhead Assembly," K.R. Walker, C.C. Scalf, D.B. Granzow, U.S. Patent 5,365,645, November 22, 1994.
31. "Three Element Switched Digital Drive System for an Ink Jet Printhead," R.K. Williamson, J.L. Stortz, U.S. Patent 5,426,455, June 20, 1995.
32. "Ink Jet Printhead Having a Modulatable Cover Plate," J.L. Stortz, U.S. Patent 5,430,470, July 4, 1995.
33. "Method of Making an Elongated Ink Jet Printhead," D.B. Granzow, U.S. Patent, 5,438,739, August 8, 1995.
34. "Method and Apparatus for Pagewide Inkjet Printheads," L. Good, U.S. Patent 5,440,332 August 8, 1995.
35. "Differential Drive System for an Ink Jet Printhead," J.L. Stortz, U.S. Patent 5,444,467, August 22, 1995.
36. "Method of Manufacturing Piezoelectric Printheads by Induction Heating of Low Melting Point Metal Alloys," R.D. Murphy, U.S. Patent 5,479,684, January 2, 1996.

37. "Method of Manufacturing Inkjet Printheads," B. Plesinger, U.S. Patent 5,505,364, April 9, 1996.
38. "Piezoelectric Inkjet Printhead Assembly and Method of Manufacture," B. Plesinger, B. D. Suma, U.S. Patent 5,535,494, July 16, 1996.
39. Spot Size Modulatable Ink Jet Printhead," J.L. Stortz, U.S. Patent 5,557,304, Sept. 17, 1996.
40. "Removable Orifice Plate For Ink Jet Printing and Servicing Apparatus," B. Plesinger, U.S. Patent 5,563,641, Oct. 8, 1996.
41. "Self-Aligning Orifice Plate For Ink Jet Printheads," H.S. Merkel, D.E. Gough, U.S. Patent 5,604,521, February 18, 1997.
42. "Multiple Printhead Ink Jet Printer Using Ink Transfer Medium," D.B. Granzow, U.S. Patent 5,677,719, October 14, 1997.
43. "Method of Manufacturing a Page Wide Ink Jet Printhead," L.M. Good, U.S. Patent 5,678,290, October 21, 1997.
44. "Elongated Ink Jet Printhead Using Joined Piezoelectric Actuator," D.B. Granzow, U.S. Patent 5,751,318, May 12, 1998.
45. "Ink Jet Printhead Having An Ultrasonic Maintenance System," D.M. Bruner, U.S. Patent 5,757,396, May 26, 1998.
46. "Page-wide Piezoelectric Ink Jet Print Engine With Circumferentially Poled Piezoelectric Material," R. D. Murphy, U.S. Patent 5,767,878, June 16, 1998.
47. "Method of Manufacturing a Page-Wide Piezoelectric Ink Jet Print Engine," R.D. Murphy, U.S. Patent 5,787,558, August 4, 1998.
48. "Process of Making an Orifice Plate for a Page-Wide Ink Jet Printhead," K.R. Walker, D.B. Granzow, U.S. Patent 5,955,022, September 21, 1999.
49. "Methods and Apparatus for Adhesively Bonding an Orifice Plate to the Internally Chambered Body Portion of an Ink Jet Print Head Assembly," J.V. Davis, U.S. Patent 6,079,810, June 27, 2000.
50. "Method of Applying Small Drop-shaped Quantities of Melted Solder from a Nozzle to Surfaces to Be Wetted and Device for Carrying out the Method," H. Hieber, U.S. Patent 4,828,886, May 9, 1989.