

CLAIMS

1. A device comprising:

a substrate comprising a plurality of channels configured to transport one or more substance, wherein the plurality of channels comprises:

a first channel disposed vertically within the substrate,

a second channel in operable communication with the first channel and disposed horizontally within the substrate,

a third channel in operable communication with the second channel and disposed vertically within the substrate, and

a fourth channel in operable communication with the third channel and disposed horizontally within the substrate;

wherein the first, second, third and fourth channels are disposed in such a manner as to provide a path for movement of the one or more substance through the substrate from the first channel to the second channel to the third channel to the fourth channel.

2. The device of claim 1, wherein the one or more substance is injected into the first channel disposed vertically within the substrate through a bottom horizontal planar surface having an opening to the first channel, in a vertical direction to maintain directional and volumetric continuity with the first channel.

3. The device of claim 1, wherein the one or more substance is injected into the first channel disposed vertically within the substrate through a bottom horizontal planar surface having an opening to the first channel, wherein the bottom horizontal planar surface has at least one shorter length from one edge to another edge compared to at least

one length from one edge to another edge on a vertical planar surface of the chip, in a vertical direction to maintain directional and volumetric continuity with the first channel.

4. The device of claim 1, wherein the one or more substance is injected into the first channel disposed vertically within the substrate through a bottom horizontal planar surface having an opening to the first channel, wherein the bottom horizontal planar surface has a smaller or equal surface area compared to a surface area on a vertical planar surface of the chip, in a vertical direction to maintain directional and volumetric continuity with the first channel.

5. The device of claim 1, wherein the first channel comprises an opening disposed at an exterior surface of the substrate and in such a manner as to provide a path for the one or more substance to enter vertically into the substrate and to move vertically within the first channel.

6. The device of claim 1, wherein the one or more substance is injected into the first channel disposed vertically within the substrate through a bottom horizontal planar surface having an opening to the first channel, in a vertical direction to maintain directional and volumetric continuity with the first channel, and wherein a cross section of the first channel and a cross section of the opening have the same area, a smaller area, or a larger area.

7. The device of claim 1, wherein the one or more substance is injected into the first channel disposed vertically within the substrate through a bottom horizontal planar surface having an opening to the first channel, in a vertical direction to maintain directional and volumetric continuity with the first channel, and wherein the first channel and the opening are shaped, sized and oriented in a manner to maintain directional and volumetric continuity.

8. The device of claim 1 further comprising a collimated or focused light source oriented to interact with particles or cells in the fourth channel.

9. The device of claim 1, wherein a collimated or focused light source is oriented to propagate in the direction of, opposite the direction of, orthogonal to the direction of, or diagonal to the movement of the one or more substance in the fourth channel.
10. The device of claim 1, wherein the fourth channel allows for imaging and analysis of particles or cells in multiple focal planes.
11. The device of claim 1, wherein the fourth channel allows for imaging and analysis of particles or cells in multiple focal planes during movement of the one or more substance.
12. The device of claim 1, wherein the fourth channel allows for imaging and analysis of particles or cells during movement of the one or more substance.
13. The device of claim 1, wherein the fourth channel allows for imaging and analysis of particles or cells during movement of the one or more substance and from multiple angles and/or orientations.
14. The device of claim 1, wherein the fourth channel allows for imaging and analysis of particles or cells during movement of the one or more substance and from multiple focal planes, angles, and/or orientations by one or more imaging devices.
15. The device of claim 1, further comprising one or more electrical force, optical force, and/or fluidic force to move cell(s) or particle(s) in one or more channels.
16. The device of claim 1, further comprising one or more electrokinetic force, electrophoretic force, and/or dielectrophoretic (DEP) force to move cell(s) or particle(s) in one or more channels.

17. The device of claim 1, further comprising one or more imaging device, wherein at least one of the imaging devices is capable of being moved in a manner to change the focal plane being imaged in the fourth channel.
18. The device of claim 1, wherein cell(s) or particle(s) in the fourth channel are capable of being moved by a change in optical and/or fluidic forces, and the region of the cell being imaged in the fourth channel is changed as the particle moves.
19. The device of claim 1, wherein the fourth channel is located at a distance from two or more outer surfaces of the substrate allowing for imaging and analysis of multiple image slices of a cell or a particle as a focal plane moves relative to the cell or particle.
20. The device of claim 1, wherein the fourth channel is located at a distance from two or more outer surfaces of the substrate allowing for imaging and analysis of multiple image slices of a moving cell or a particle as it moves through a focal plane.
21. The device of claim 1, wherein the fourth channel is located at a distance from two or more outer surfaces of the substrate allowing for imaging and analysis of multiple image slices of a suspended or static cell or particle.
22. The device of claim 1, wherein the one or more substance is capable of being moved by pressure, vacuum, peristalsis, electrokinetic force, electrophoretic force, magnetic force, optical force, or any combination thereof.
23. The device of claim 1 further comprising a dichroic mirror to direct light to or away from an imaging device imaging and/or analyzing cells or particles in the fourth channel.
24. The device of claim 1 further comprising a dichroic mirror to direct a collimated or focused light source to interact with cells or particles in the fourth channel.

25. The device of claim 1 further comprising a dichroic mirror to direct a collimated or focused light source away from an imaging device, another light source, or another part of the device.
26. The device of claim 1, wherein the plurality of channels comprises a fifth channel disposed horizontally, vertically, or diagonally within the substrate.
27. The device of claim 1, wherein the plurality of channels comprises a fifth channel, which splits into two or more channels or wells to sort cells or particles.
28. The device of claim 1, wherein the fourth channel is located closer to the top of the substrate than either the first channel, the second channel, or the third channel.
29. The device of claim 1, wherein the fourth channel is located from 100 microns to 100 mm from the top of the substrate.
30. The device of claim 1, wherein the first channel ranges from 0.1 mm to 100.0 mm in length.
31. The device of claim 1, wherein the second channel ranges from 0.1 mm to 100.0 mm in length.
32. The device of claim 1, wherein the third channel ranges from 0.05 mm to 100.0 mm in length.
33. The device of claim 1, wherein the fourth channel ranges from 0.1 mm to 100.0 mm in length.
34. The device of claim 1, wherein the first channel is greater in length than the second channel, the third channel, or the fourth channel.

35. The device of claim 1 further comprising a cell or particle interrogation unit.
36. The device of claim 1 further comprising a cell or particle collection channel.
37. The device of claim 1 further comprising an imaging device selected from at least one of a bright field imager, a light scatter detector, a single wavelength fluorescent detector, a spectroscopic fluorescent detector, a CCD camera, a CMOS camera, a photodiode, a photodiode array (PDA), a spectrometer, a photomultiplier tube or tube array, a photodiode array, a chemiluminescent detector, a bioluminescent detector, a standard Raman spectroscopy detection system, surface enhanced Raman spectroscopy (SERS), coherent antistokes Raman spectroscopy (CARS), and/or coherent stokes Raman spectroscopy (CSRS).
38. The device of claim 1 further comprising a tube end injecting the one or more substance into an opening disposed at an exterior surface of the substrate and in such a manner as to provide a path for the one or more substance to enter into the substrate and to move within the first channel, wherein a cross section of the opening has an equal, larger, or smaller area than a cross section of the tube end.
39. An apparatus for holding a microfluidic chip comprising:
- a cavity to hold the microfluidic chip;
 - an integrated light source holder to allow for focused illumination in constrained space requirements;
 - an integrated prism holder to allow a prism to reflect light to a desired location in or on the chip;
 - threaded screw holes for screws to hold and allow for adjustment of the microfluidic chip; and

threaded or non-threaded pass through holes for tubing and connector(s).

40. The apparatus of claim 44, wherein the integrated light source is selected from at least one of a light emitting diode (LED), organic light emitting diode (OLED), fiber optic, fiber bundle, laser, flash tube, fluorescent lamp, and/or incandescent or halogen lamp.

41. A device for moving cells and/or particles in fluid comprising:

a substrate with multiple interior fluidic channels comprising:

a first channel of the multiple interior channels disposed in the substrate in a manner such that a first plane oriented vertically with respect to the substrate traverses the first channel along its length;

an opening disposed at an outer surface of the substrate and in operable communication with the first channel in a manner such that one or more substance is capable of entering and moving in the first channel vertically;

a second channel of the multiple interior channels disposed in the substrate and in operable communication with the first channel in a manner such that a second plane oriented horizontally with respect to the substrate traverses the second channel along its length.

42. The device of claim 41, wherein the one or more substance is injected into the first channel disposed vertically within the substrate through a bottom horizontal planar surface having an opening to the first channel, in a vertical direction to maintain directional and volumetric continuity with the first channel.

43. The device of claim 41, wherein the one or more substance is injected into the first channel disposed vertically within the substrate through a bottom horizontal planar surface having an opening to the first channel, wherein the bottom horizontal planar surface has at least one shorter length from one edge to another edge compared to at least one length from one edge to another edge on a vertical planar surface of the chip, in a vertical direction to maintain directional and volumetric continuity with the first channel.

44. The device of claim 41, wherein the one or more substance is injected into the first channel disposed vertically within the substrate through a bottom horizontal planar surface having an opening to the first channel, wherein the bottom horizontal planar surface has a smaller surface area compared to a surface area on a vertical planar surface of the chip, in a vertical direction to maintain directional and volumetric continuity with the first channel.

45. The device of claim 41, wherein the first channel comprises an opening disposed at an exterior surface of the substrate and in such a manner as to provide a path for the one or more substance to enter vertically into the substrate and to move vertically within the first channel.

46. The device of claim 41, wherein the one or more substance is injected into the first channel disposed vertically within the substrate through a bottom horizontal planar surface having an opening to the first channel, in a vertical direction to maintain directional and volumetric continuity with the first channel, and wherein a cross section of the first channel and a cross section of the opening have the same, smaller, or larger area.

47. The device of claim 41, wherein the one or more substance is injected into the first channel disposed vertically within the substrate through a bottom horizontal planar surface having an opening to the first channel, in a vertical direction to maintain directional and volumetric continuity with the first channel, and wherein the first channel

and the opening are shaped, sized and oriented in a manner to maintain directional and volumetric continuity.

48. The device of claim 41 further comprising a collimated or focused light source oriented to interact with particles or cells in the second channel.

49. The device of claim 41, wherein a collimated or focused light source is oriented to propagate in the direction of, opposite the direction of, orthogonal to the direction of, or diagonal to the direction of the movement of the one or more substance in the second channel.

50. The device of claim 41, wherein the second channel allows for imaging and analysis of particles or cells in multiple focal planes.

51. The device of claim 41, wherein the second channel allows for imaging and analysis of particles or cells in multiple focal planes during movement of the one or more substance.

52. The device of claim 41, wherein the second channel allows for imaging and analysis of particles or cells during movement of the one or more substance.

53. The device of claim 41, wherein the second channel allows for imaging and analysis of particles or cells during movement of the one or more substance and from multiple angles and/or orientations.

54. The device of claim 41, wherein the second channel allows for imaging and analysis of particles or cells during movement of the one or more substance and from multiple focal planes, angles, and/or orientations by one or more imaging devices.

55. The device of claim 41, further comprising one or more electrical force, optical force, and/or fluidic force to move cell(s) or particle(s) in one or more channels.

56. The device of claim 41, further comprising one or more electrokinetic force, electrophoretic force, and/or dielectrophoretic (DEP) force to move cell(s) or particle(s) in one or more channels.
57. The device of claim 41, further comprising one or more imaging device, wherein at least one of the imaging devices is capable of being moved in a manner to change the focal plane being imaged in the second channel.
58. The device of claim 41, wherein cell(s) or particle(s) in the second channel are capable of being moved by a change in optical and/or fluidic forces, and the region of the cell being imaged in the second channel is changed as the particle moves.
59. The device of claim 41, wherein the second channel is located at a distance from two or more outer surfaces of the substrate allowing for imaging and analysis of multiple image slices of a cell or a particle as a focal plane moves relative to the cell or particle.
60. The device of claim 41, wherein the second channel is located at a distance from two or more outer surfaces of the substrate allowing for imaging and analysis of multiple image slices of a moving cell or a particle as it moves through a focal plane.
61. The device of claim 41, wherein the second channel is located at a distance from two or more outer surfaces of the substrate allowing for imaging and analysis of multiple image slices of a suspended or static cell or particle.
62. The device of claim 41, wherein the one or more substance is capable of being moved by pressure, vacuum, peristalsis, electrokinetic force, electrophoretic force, magnetic force, optical force, or any combination thereof.

63. The device of claim 41 further comprising a dichroic mirror to direct light to or away from an imaging device imaging and/or analyzing cells or particles in the second channel.
64. The device of claim 41 further comprising a dichroic mirror to direct a collimated or focused light source to interact with cells or particles in the second channel.
65. The device of claim 41 further comprising a dichroic mirror to direct a collimated or focused light source away from an imaging device, another light source, or another part of the device.
66. The device of claim 41, wherein the plurality of channels comprises a third channel disposed horizontally, vertically, or diagonally within the substrate.
67. The device of claim 41, wherein the plurality of channels comprises a third channel, which splits into two or more channels or wells to sort cells or particles.
68. The device of claim 41, wherein the second channel is located closer to the top of the substrate than the first channel.
69. The device of claim 41, wherein the second channel is located from 100 microns to 100 mm from the top of the substrate.
70. The device of claim 41, wherein the first channel ranges from 0.1 mm to 100.0 mm in length.
71. The device of claim 41, wherein the second channel ranges from 0.1 mm to 100.0 mm in length.
72. The device of claim 41, wherein the first channel is greater in length than the second channel.

73. The device of claim 41 further comprising a cell or particle interrogation unit.
74. The device of claim 41 further comprising a cell or particle collection channel.
75. The device of claim 41 further comprising an imaging device selected from at least one of a bright field imager, a light scatter detector, a single wavelength fluorescent detector, a spectroscopic fluorescent detector, a CCD camera, a CMOS camera, a photodiode, a photodiode array (PDA), a spectrometer, a photomultiplier tube or tube array, a photodiode array, a chemiluminescent detector, a bioluminescent detector, a standard Raman spectroscopy detection system, surface enhanced Raman spectroscopy (SERS), coherent antistokes Raman spectroscopy (CARS), and/or coherent stokes Raman spectroscopy (CSRS).
76. The device of claim 41 further comprising a tube end injecting the one or more substance into an opening disposed at an exterior surface of the substrate and in such a manner as to provide a path for the one or more substance to enter into the substrate and to move within the first channel, wherein a cross section of the opening has an equal, larger, or smaller area than a cross section of the tube end.
77. The device of claim 1, wherein the one or more substance is capable of being moved by pressure, vacuum, peristalsis, electrokinetic force, electrophoretic force, magnetic force, optical force, or any combination thereof, to sort cell(s) or particle(s) into one or more separate region or well.
78. The device of claim 41, wherein the one or more substance is capable of being moved by pressure, vacuum, peristalsis, electrokinetic force, electrophoretic force, magnetic force, optical force, or any combination thereof, to sort cell(s) or particle(s) into one or more separate region or well.