Claims

1. A microfluidic device comprising: an enclosure having a microfluidic structure and a base, wherein the base comprises a common electrical conductor, wherein the microfluidic structure and an outer surface of the base together define a flow path within the enclosure, and wherein the base comprises an array of transistor structures, each said transistor structure in the array comprising a lateral bipolar transistor connecting a corresponding region of the outer surface of the base to the common electrical conductor.

2. The microfluidic device of claim 1, wherein each said transistor structure in the array further comprises a vertical bipolar transistor connecting the corresponding region of the outer surface of the base.

3. The microfluidic device of claim 1 or 2, wherein each said transistor structure in the array comprising a collector region, a base region, and an emitter region, wherein the base region surrounds the emitter region, wherein the collector region surrounds the base region, wherein the base region has a lateral width that is between about 10 nm and about 400 nm, and wherein each said transistor structure in the array is physically separated from other transistor structures in the array.

4. The microfluidic device of claim 1, wherein each said transistor structure in the array is physically separated from the other transistor structures in the array by a trench, wherein a vertical depth of the trench is at least 10% greater than a combined vertical depth of the collector, base, and emitter regions.

5. The microfluidic device of claim 3, wherein the base region has a vertical thickness that is about two to four times greater than the lateral width of the base region.

6. The microfluidic device of claim 3, wherein the base region comprises a p-type dopant selected from the group consisting of Boron, Aluminum, Beryllium, Zinc, and Cadmium, wherein the common electrical conductor comprises an N+ semiconductor substrate upon which the array of transistor structures rests, wherein the N+ semiconductor substrate comprises a dopant selected from the group consisting of Antimony, Arsenic, and Phosphorus, wherein the collector region comprises an n-type dopant selected from the group

consisting of Antimony, Arsenic, and Phosphorus, and wherein the emitter region comprises an n-type dopant selected from the group consisting of Antimony, Arsenic, and Phosphorus.

7. The microfluidic device of claim 3, wherein the collector region has a lateral width that is between about 600 nm and about 750 nm.

8. The microfluidic device of claim 3, wherein the collector region has a vertical thickness and a lateral width, wherein the vertical thickness of the collector region is about four to eight times greater than the lateral width of the collector region.

9. The microfluidic device of claim 3, wherein a vertical thickness of the emitter region is about 50 nm to about 150 nm.

10. The microfluidic device of claim 1, wherein a pitch of the transistor structures of the array is about 5000 nm to about 10,000 nm.

11. The microfluidic device of claim 3, further comprising a dielectric border disposed on the outer surface of the base between adjacent pairs of the transistor structures of the array, wherein the border overlays a perimeter portion of the emitter region of each said transistor structure of the array but comprises windows exposing an interior portion of the emitter region, wherein the windows of the dielectric border expose the interior portions of the emitter regions of the transistor structures of the array to direct contact with fluidic medium in the flow path.

12. The microfluidic device of claim 11, wherein a vertical thickness of the border is about 750 nm to about 2,000 nm, and wherein the dielectric border overlays the perimeter portion of the emitter region by about 10 nm to about 200 nm.

13. The microfluidic device of claim 1, further comprising a biasing electrode, wherein the flow path is disposed between the biasing electrode and the common electrical conductor of the base; wherein: the transistor structures of the array connect different regions of the outer surface of the base to the common electrical conductor, and the regions of the outer surface of the base are disposed to contact directly fluidic medium in the flow path.

14. The microfluidic device of claim 1, wherein: the base comprises a first section and a second section electrically insulated from the first section; the array of transistor structures is

a first array of said transistor structures in the first section, the base comprising a second array of said transistor structures in the second section; the common electrical conductor is a first common conductor that is common to the transistor structures of the first section but not the transistor structures of the second section; and the base further comprises a second common conductor that is common to the transistor structures of the second section but not the transistor structures of the first section.

15. A microfluidic apparatus, comprising: a first microfluidic device; and a second microfluidic device, wherein each of the first and second microfluidic devices is configured according to the microfluidic device of claim 1, wherein the enclosure of the first microfluidic device is separate and distinct from the enclosure of the second microfluidic device, and wherein the common electrical conductor of the first microfluidic device and the common electrical conductor of the second microfluidic device are electrically connected and compose an electrical conductor common to the first microfluidic device and the second microfluidic device.

16. A system comprising a microfluidic device according to claim 1, further comprising control equipment for controlling operation of the microfluidic device.

17. The system of claim 16, wherein the control equipment comprises a light source, a spatial light modulator, and a light path for directing selected patterns of light into the enclosure.

18. A method of moving a micro-object in a fluidic medium in the microfluidic device of claim 13, the method comprising: providing biasing power to the biasing electrode and the common electrical conductor of the base; and activating a first of the transistor structures at a first of the regions of the outer surface of the base, wherein said activating creates an electrokinetic force in the vicinity of the activated first transistor structure sufficient to move a nearby micro-object in the flow path.

19. The method of claim 18, wherein the activating induces a first current flow in the lateral bipolar transistor of the first transistor structure, and wherein the electrokinetic force moves the nearby micro-object away from the first region of the outer surface of the base that corresponds to the activated first transistor structure.

20. The method of claim 18, wherein the micro-object is a biological cell selected from the group consisting of SP2, HeLa, embryo, sperm, oocytes, and jurkat.