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 conductor,

wherein each said transistor structure in the array comprises 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,

wherein each said transistor structure in the array is physically separated from adjacent transistor structures in the array by trenches, and

wherein an electrically insulative material is disposed in the trenches.

2. The microfluidic device of claim 1, wherein lateral width of the base region is between about 200 nm and about 300 nm.

3. The microfluidic device of claim 1, wherein the base region has a vertical thickness equal to or greater than the lateral width of the base region and the collector region has a vertical thickness equal to or greater than a lateral width of the collector region.

4. The microfluidic device of claim 3, wherein the vertical thickness of the base region is about two to four times greater than the lateral width of the base region and the vertical thickness of the collector region is about two to ten times greater than the lateral width of the collector region.

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

6. The microfluidic device of claim 3, wherein the vertical thickness of the base region is about 3.5 times greater than the lateral width of the base region and the vertical thickness of the collector region is about six times greater than the lateral width of the collector region.

7. The microfluidic device of claim 1, wherein the base region comprises a p-type dopant and the collector and emitter regions each comprise an n-type dopant.

8. The microfluidic device of claim 1, wherein the common conductor comprises an N+ semiconductor substrate upon which the array of transistor structures rests.

9. The microfluidic device of claim **8**, wherein the N+ semiconductor substrate has a resistivity of about 0.025 ohm-cm to about 0.050 ohm-cm.

10. The microfluidic device of claim **1**, wherein the collector region has a lateral width that is between about 100 nm and about 1000 nm.

11. The microfluidic device of claim **1**, wherein the collector region has a lateral width that is between about 600 nm and about 750 nm.

12. The microfluidic device of claim **1**, wherein the collector region has a resistivity of about 5 ohm-cm to about 10 ohm-cm.

13. The microfluidic device of claim **1**, wherein a vertical thickness of the emitter region is about 10 nm to about 500 nm, wherein a vertical thickness of the base region is about 6 to 12 times greater than the vertical thickness of the emitter region, and wherein a vertical thickness of the collector region is about 3 to 6 times greater than the vertical thickness of the base region.

14. The microfluidic device of claim **13**, wherein the vertical thickness of the emitter region is about 50 nm to about 150 nm.

15. The microfluidic device of claim **1**, wherein a pitch of the transistor structures of the array is about 1000 nm to about 20,000 nm.

16. The microfluidic device of claim **1**, wherein a vertical depth of the trench is at least 10% greater than a combined vertical depth of the collector, base, and emitter regions.

17. The microfluidic device of claim **1**, wherein a vertical depth of the trench is about 2,000 nm to about 11,000 nm and a lateral width of the trench is about 100 nm to about 1000 nm.

18. The microfluidic device of claim **1**, 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.

19. The microfluidic device of claim **18**, wherein a vertical thickness of the border is about 750 nm to about 2,000 nm.

20. The microfluidic device of claim **18**, wherein the dielectric border overlays the perimeter portion of the emitter region by about 10 nm to about 200 nm.

21. The microfluidic device of claim **1**, wherein the microfluidic structure and the base together further define a holding pen, and wherein the holding pen is connected to the flow path.

22. The microfluidic device of claim **21**, wherein the flow path comprises a fluidic channel, and wherein the holding pen is connected to the fluidic channel.

23. The microfluidic device of claim **1**, wherein:

the transistor structures of the array connect different regions of the outer surface of the base to the common conductor, and

the regions of the outer surface of the base are disposed to contact directly fluidic medium in the flow path.

24. The microfluidic device of claim **23**, further comprising a biasing electrode, wherein the flow path is disposed between the biasing electrode and the common electrical conductor of the base.

25. The microfluidic device of claim **1**, wherein the common conductor comprises an N+ semiconductor substrate upon which the array of transistor structures rests.

26. The microfluidic device of claim **25**, wherein the N+ semiconductor substrate has a resistivity of about 0.025 ohm-cm to about 0.050 ohm-cm.

27. The microfluidic device of claim **1**, wherein a pitch of the transistor structures of the array is about 1000 nm to about 20,000 nm.

28. The microfluidic device of claim **1**, wherein the microfluidic structure and the base together further define a holding pen, and wherein the holding pen is connected to the flow path.

29. The microfluidic device of claim **28**, wherein the flow path comprises a fluidic channel, and wherein the holding pen is connected to the fluidic channel.

30. The microfluidic device of claim **1**, wherein:

the transistor structures of the array connect different regions of the outer surface of the base to the common conductor, and

the regions of the outer surface of the base are disposed to contact directly fluidic medium in the flow path.

31. The microfluidic device of claim **30**, further comprising a biasing electrode, wherein the flow path is disposed between the biasing electrode and the common electrical conductor of the base.