CLAIMS

1. An apparatus for electrical assessment of a biological specimen, comprising:

a plate having a multiple-well array for disposing thereon the biological specimen, each well of the multiple-well array having a plurality of electrodes disposed therein; and

a multiwell integrated circuit having a first surface facing wells of the multiple-well array of the plate and having a second surface facing opposite the wells of the multiple-well array, comprising:

an array of reticle areas, each reticle area having a plurality of complementary metal oxide semiconductor (CMOS) circuitry of a same design, wherein each reticle area comprises:

at least one well circuit containing a plurality of peripheral circuits in electrical communication with the plurality of electrodes in a well of the multiple-well array using a plurality of addressable switches located underneath each electrode in a pixel; and

a reference electrode bias to connect to any set of the plurality of electrodes to act as a reference electrode using an addressable switch located underneath each electrode in a pixel;

wherein the multiple-well array comprises at least 24 wells; and

wherein the multiple-well array includes at least 24 reticle areas to accommodate a standard number of wells in the multiple-well array.

2. The apparatus of claim 1, further comprising a lid coupled to a second side of the plate opposite a first side of the plate.

3. The apparatus of claim 2, wherein the lid comprises a plurality of photodetectors, each photodetector facing a corresponding well of the multiple-well array.

4. The apparatus of claim 1, further comprising a first substrate and a second substrate, wherein the second substrate has a plurality of conductive structures disposed at a first surface of the second substrate facing a mounting surface of the first substrate, each

conductive structure electrically connected to a corresponding pad of a plurality of pads on the mounting surface of the first substrate.

5. The apparatus of claim 4, wherein the second substrate and the first substrate are coupled via a magnetic force.

6. The apparatus of claim 1, further comprising an enclosure that surrounds the multiwell integrated circuit and the plate on at least five sides.

7. The apparatus of claim 6, wherein the plurality of electrodes within a well are configured to be in electrical communication with an interior of a single cell disposed in the well.

8. The apparatus of claim 1, wherein the multiwell integrated circuit is configured to route a signal of a first type from a first side of the reticle area towards a second side of the reticle area along a first direction, and to route a signal of a second type from a third side of the reticle area towards a fourth side of the reticle area along a second direction different from the first direction; and wherein the signal of a first type is a digital signal and the signal of a second type is an analog signal.

9. The apparatus of claim 8, wherein the reticle area is a first reticle area, and wherein a routing circuit in the first reticle area is configured to receive ~~a~~ the signal of the first type from a second reticle area that is adjacent the first reticle area along the first direction, and the routing circuit in the first reticle area is further configured to receive ~~a~~ the signal of the second type from a third reticle area that is adjacent the first reticle area along the second direction.

10. The apparatus of claim 1, wherein each peripheral circuit comprising a stimulation circuit and a recording circuit, and wherein the plurality of addressable switches is configured to selectively couple a subset of peripheral circuits to a subset of the plurality of electrodes.

11. The apparatus of claim 1, wherein each well has an opening that is open towards the multiwell integrated circuit, and wherein the plurality of electrodes comprise an array of conductors disposed on an insulative surface of the multiwell integrated circuit.

12. The apparatus of claim 1, further comprising an interposer, wherein the second surface facing opposite the wells of the multiple-well array faces the interposer.

13. The apparatus of claim 12, wherein the multiple-well array has a well-to-well distance between 4.5 mm and 9 mm.

14. The apparatus of claim 13, wherein the reticles are centered at a pitch of 18 mm or 9 mm.

15. The apparatus of claim 12, wherein the interposer is a printed circuit board (PCB).

16. The apparatus of claim 1, wherein at least two reticle areas of the array of reticle areas are in electrical communication with each other.

17. The apparatus of claim 16, further comprising a plurality of cross-reticle connections configured to place the at least two reticle areas in electrical communication.

18. The apparatus of claim 17, wherein the at least two reticle areas are disposed on a first surface of the multiwell integrated circuit, the apparatus further comprising a redistribution layer (RDL) on the first surface, wherein at least a portion of the plurality of cross-reticle connections comprise conductors disposed in the RDL layer.

19. The apparatus of claim 9, wherein the routing circuit comprises one or more shift registers configured to route the signal of the first type.

20. The apparatus of claim 9, wherein the routing circuit comprises at least one digital bus, and at least one analog bus.

21. The apparatus of claim 1, wherein the plurality of electrodes comprises at least 1000 electrodes.

22. The apparatus of claim 21, wherein the plurality of electrodes comprises at least 4000 electrodes.

23. The apparatus of claim 1, wherein the at least one well circuit comprises a stimulation circuit which in turn includes a current injector.

24. The apparatus of claim 1, wherein each peripheral circuit of the plurality of peripheral circuits comprises a stimulation circuit and a recording circuit; and wherein the apparatus further comprises one or more switches configured to selectively couple a subset of the plurality of peripheral circuits within the well circuit with one or more optoelectronic components.

25. The apparatus of claim 24, wherein the one or more optoelectronic components comprise a light-emitting diode, a photodetector, or a combination thereof.

26. The apparatus of claim 1, wherein the array of reticle areas is arranged in rows along the first direction and in columns along the second direction, wherein adjacent reticle areas in each row are connected by an array of cross-reticle connections arranged along the second direction, and wherein adjacent reticle areas in each column are connected by an array of cross-reticle connections arranged along the first direction.

27. A method of operating an apparatus to assess a biochemical sensor, the method comprising:

electrically communicating, using the at least one well circuit, with a well of the multiple-well array; and

routing, with the routing circuit, a digital signal of a first type from a first side of the reticle area towards a second side of the reticle area along a first direction, and an analog signal of a second type from a third side of the reticle area towards a fourth side of the reticle area along a second direction different from the first direction;

wherein the apparatus comprises:

a plate having a multiple-well array for disposing thereon the biological specimen, each well of the multiple-well array having a plurality of electrodes disposed therein;

a multiwell integrated circuit having a first surface facing wells of the multiple-well array of the plate and having a second surface facing opposite the wells of the multiple-well array;

a semiconductor device comprising a multiwell integrated circuit; and

at least two reticle areas disposed within the multiwell integrated circuit, each reticle area having a plurality of complementary metal oxide semiconductor (CMOS) circuitry of a same design, wherein each reticle area comprises at least one well circuit and a routing circuit, the semiconductor device further comprising an interposer;

wherein the multiple-well array comprises at least 24 wells; and

wherein the multiple-well array includes at least 24 reticle areas to accommodate a standard number of wells in the multiple-well array.