CLAIMS

1. A multi-layered flexible sparger, comprising:

a bottom film layer, a middle film layer, and a top film layer;

a first inner mesh disposed between the bottom film layer and the middle film layer;

a second inner mesh disposed between the middle film layer and the top film layer; and

a port capable of delivering a gas to the multi-layered flexible sparger disposed between the top film layer and the bottom film layer,

wherein the middle film layer comprises drill holes and the top film layer comprises drill holes.

2. The multi-layered flexible sparger of claim 1, further comprising bonds between the bottom film layer and the middle film layer, and bonds between the top film layer and the middle film layer.

3. The multi-layered flexible sparger of claim 1, further comprising a flange for housing the port.

4. The multi-layered flexible sparger of claim 1, wherein the total area of drill holes in the middle film layer is lower than the total area of drill holes in the top film layer, wherein back pressure is created.

5. The multi-layered flexible sparger of claim 1, wherein the drill holes in the middle film layer are from 10-800 microns in diameter, and the drill holes in the top film layer are from 10-800 microns in diameter.

6. The multi-layered flexible sparger of claim 1, wherein the drill holes in the middle film layer are larger than the drill holes in the top film layer.

7. The multi-layered flexible sparger of claim 1, wherein the drill holes in the middle film layer are smaller than the drill holes in the top film layer.

8. The multi-layered flexible sparger of claim 1, wherein the drill holes in the middle film layer are lower quantity than the drill holes in the top film layer.

9. The multi-layered flexible sparger of claim 1, wherein the middle film layer comprises between 20-200 drilled holes and the top film layer comprises between 1000-36,000 drilled holes.

10. The multi-layered flexible sparger of claim 1, further comprising:

a bond around a perimeter of the multi-layered flexible sparger that bonds the top film layer, the middle film layer, and the bottom film layer;

a central bond in a center of the multi-layered flexible sparger, wherein the central bond is formed from the top film layer through the middle film layer and includes the bottom film layer; and

at least two radial bonds extending from a central bond to a perimeter bond and from the top film layer and the middle film layer, wherein two flow pockets are created.

11. The multi-layered flexible sparger of claim 1, wherein the drill holes comprise profiles of crosses, slots, and/or crooks.

12. The multi-layered flexible sparger of claim 1, further comprising a spot bond in at least one flow pocket.

13. A bioreactor system, comprising:

a bioreactor; and

the multi-layered flexible sparger of claim 1 disposed therein.

14. A multi-zone, multi-layered, flexible sparger, comprising:

a bottom film layer, a middle film layer, and a top film layer;

a first inner mesh disposed between and bonded to the bottom film layer and the middle film layer;

a second inner mesh disposed between and bonded to the middle film layer and the top film layer; and

a port capable of delivering a gas to at least two sparging zones within the multi-zone, multi-layered flexible sparger disposed between the top film layer and the bottom film layer, wherein the middle film layer comprises drill holes and the top film layer comprises drill holes.

15. The multi-zone, multi-layered, flexible sparger of claim 14, comprising four sparging zones, wherein the port is in the center of the four sparging zones.

16. The multi-zone, multi-layered flexible sparger of claim 14, wherein the drill holes in the middle film layer are from 10-800 microns in diameter, and the drill holes in the top film layer are from 10-800 microns in diameter.

17. The multi-zone, multi-layered flexible sparger of claim 14, wherein the drill holes in the middle film layer are larger than the drill holes in the top film layer.

18. The multi-zone, multi-layered flexible sparger of claim 14, wherein the middle film layer comprises between 80-800 drilled holes and the top film layer comprises between 4000-144,000 drilled holes.

19. The multi-zone, multi-layered flexible sparger of claim 14, further comprising a bond around a perimeter of the multi-layered flexible sparger.

20. The multi-zone, multi-layered flexible sparger of claim 14, wherein a total area of drill holes in the middle film layer is lower than the total area of drill holes in the top film layer, wherein back pressure is created.