CLAIMS

1. A multipole assembly, comprising:
   (a) a plurality of conductive rods;
   (b) a plurality of shoes, each shoe adhesively attached on one of its edges to a corresponding rod; and
   (c) a plurality of isolation rings, each isolation ring attached on at least one of its sides to a subset of the plurality of shoes.

2. The assembly of claim 1, wherein the shoes are directly adhesively attached to the isolation rings.

3. The assembly of claims 1 or 2, wherein the shoes are adhesively attached to the conductive rods by means of epoxy resin.

4. The assembly of any one of claims 1 to 3, wherein the edges of the shoes comprise a slot for taking up excess adhesive.

5. The assembly of any one of claims 1 to 4, wherein each of the rods comprises a plurality of roughened areas corresponding to locations where the shoes are attached to the rod.

6. The assembly of claim 5, wherein the roughened areas comprise laser scribed areas.

7. The assembly of any one of claims 1 to 6, wherein the shoes are essentially disk-shaped and comprise an arcuate cut of a diameter similar to a diameter of the rods.

8. The assembly of claim 7, wherein the arcuate cut has a textured surface.

9. The assembly of claim 8, wherein the textured surface comprises one of sand blasted surface, laser scribed surface, serrated surface, ribbed surface, and ridged surface.

10. The assembly of any one of claims 1 to 9, wherein the shoes comprise an alignment notch.

11. The assembly of any one of claims 1 to 10, wherein the isolation rings comprise an arcuate cut of a radius larger than a radius of the rods.

12. The assembly of any one of claims 1 to 11, wherein the isolation rings comprise a plurality of alignment notches.

13. The assembly of any one of claims 1 to 12, wherein the plurality of rods comprises n rods, the plurality of isolation rings comprises m isolation rings, and the plurality of shoes comprises n times m, n * m, shoes.

14. The assembly of claim 13, wherein n=4 and m=3.

15. The assembly of any one of claims 1 to 14, wherein shoes are attached to the isolation rings on both faces thereof at essentially a same circumferential position.

16. The assembly of any one of claims 1 to 15, wherein the conductive rods define an ion transfer axis and an inner radius, R_0, and materials for the conductive rods, the shoes and the isolation rings are chosen such that the inner radius is essentially invariant with change in temperature.

17. The assembly of any one of claims 1 to 15, wherein the conductive rods define an ion transfer axis and an inner radius, R_0, and a radial distance of a point of attachment between shoes and isolation rings from the ion transfer axis is selected such that, in view of thermal expansion properties of materials for the conductive rods, shoes and isolation rings, the inner radius is essentially invariant with change in temperature.

18. A method for fabricating a multipole assembly, comprising:

(a) inserting a plurality of conductive rods into a fixture;

(b) inserting at least one precision-made spacer in between the plurality of rods;

(c) urging the rods against the spacers to obtain precise alignment of the rods;

(d) adhesively attaching a plurality of shoes onto the rods, each shoe having a plurality of edges of which one edge is adhesively attached to a corresponding rod;

(e) attaching a plurality of isolation rings onto the shoes, each isolation ring having a plurality of sides of which at least one side is attached to a subset of the plurality of shoes; and

(f) after the plurality of shoes are adhesively attached to the rods and the plurality of isolation rings are attached to the shoes, removing the spacers and releasing the rods from the fixture.

19. The method of claim 18, wherein step (e) comprises adhesively attaching the isolation rings directly onto the shoes.

20. The method of claims 18 or 19, further comprising roughening a plurality of areas on each of the rods prior to step (d), the plurality of areas corresponding to the location of bonding of the shoes.

21. The method of any one of claims 18 to 20, further comprising surface treating edges of the plurality of shoes prior to step (d).

22. The method of claim 21, wherein surface treating comprises one of sand blasting the surface, laser scribing the surface, and cutting the surface to generate serrated surface, ribbed surface, or ridged surface.

23. A spacer for fabricating a multipole assembly having a plurality of rods, the spacer comprising arms extending from a cross-point with two arms extending along a rotational axis, the spacer also comprising nesting areas between adjacent arms with effective nesting space for receiving and aligning rods, wherein the cross section of the arms in the nesting areas is configured such that by rotating the spacer around the rotational axis the effective nesting space is increased.

24. The spacer of claim 23, wherein the cross section of the arms is essentially rectangular or square with dimples in the nesting areas.

25. The spacer of claim 23, wherein each arm comprises a section having an S-shaped cross-section, and wherein the S-shaped cross section on one side of the rotational axis is oriented opposite that of the S-shape cross section on the other side of the rotational axis.

26. The spacer of any one of claims 23 to 25, wherein the nesting areas have a shape generally adapted to a diameter of the rods.

27. The spacer of any one of claims 23 to 26, wherein the nesting areas comprise a flattened surface in a region of contact between rod and arm.

28. The spacer of any one of claims 23 to 27, comprising tungsten carbide.

29. A method for fabricating a multipole assembly, comprising:

(a) inserting a plurality of conductive rods into a fixture;

(b) inserting at least one precision-made spacer in between the plurality of rods, the spacer having arms a cross section of which determines an effective width which essentially defines a spacing between two adjacent conductive rods;

(c) urging the rods against the spacer to obtain precise alignment of the rods;

(d) attaching a plurality of isolation rings onto the rods;

(e) removing the spacer by means of a rotational motion along a rotational axis running through spacings between the rods, thereby essentially reducing the effective width of the arms and disengaging the spacer from the rods; and

(f) releasing the rods from the fixture.

30. A fixture for fabricating a multipole assembly having a plurality of conductive rods, comprising:

(a) a support; and

(b) a plurality of isolation ring holders attached to the support, the isolation ring holders having recesses for receiving spacers which assist in the alignment of the rods, and each holder having a plurality of plungers for urging the rods against the spacers during assembly of the rods.

31. The fixture of claim 30, wherein the support comprises a base, and a tower that is one of attached to and made integrally with the base.

32. The fixture of claims 30 or 31, wherein the holders are slidably attached to the support via a sliding track.

33. The fixture of any one of claims 30 to 32, wherein the holders have alignment pins for aligning isolation rings and shoes during assembly of the rods.

34. The fixture of any one of claims 30 to 33, wherein the alignment pins are attached to ends of the plungers.

35. The fixture of any one of claims 30 to 34, wherein the recesses for the spacers have a shape of pockets.

36. The fixture of any one of claims 30 to 35, wherein the plungers are spring-loaded.

37. The fixture of any one of claims 30 to 36, wherein a number of plungers on each holder corresponds to a number of rods to be assembled.

38. The fixture of any one of claims 30 to 37, wherein the holders comprise two half rings, the half rings having two machined steps for supporting an isolation ring and being held in place by removable pins.

CLAIMS

1. A multipole assembly, comprising:

(a) a plurality of conductive rods;

(b) a plurality of shoes, each shoe adhesively attached on one of its edges to a corresponding rod; and

(c) a plurality of isolation rings, each isolation ring attached on at least one of its sides to a subset of the plurality of shoes.

2. The assembly of claim 1, wherein the shoes are directly adhesively attached to the isolation rings.

3. The assembly of claim 1, wherein the shoes are adhesively attached to the conductive rods by means of epoxy resin.

4. The assembly of claim 1, wherein the edges of the shoes comprise a slot for taking up excess adhesive.

5. The assembly of claim 1, wherein each of the rods comprises a plurality of roughened areas corresponding to locations where the shoes are attached to the rod.

6. The assembly of claim 5, wherein the roughened areas comprise laser scribed areas.

7. The assembly of claim 1, wherein the shoes are essentially disk-shaped and comprise an arcuate cut of a diameter similar to a diameter of the rods.

8. The assembly of claim 7, wherein the arcuate cut has a textured surface.

9. The assembly of claim 8, wherein the textured surface comprises one of sand blasted surface, laser scribed surface, serrated surface, ribbed surface, and ridged surface.

10. The assembly of claim 1, wherein the shoes comprise an alignment notch.

11. The assembly of claim 1, wherein the isolation rings comprise an arcuate cut of a radius larger than a radius of the rods.

12. The assembly of claim 1, wherein the isolation rings comprise a plurality of alignment notches.

13. The assembly of claim 1, wherein the plurality of rods comprises n rods, the plurality of isolation rings comprises m isolation rings, and the plurality of shoes comprises n times m, n*m, shoes.

14. The assembly of claim 13, wherein n=4 and m=3.

15. The assembly of claim 1, wherein shoes are attached to the isolation rings on both faces thereof at essentially a same circumferential position.

16. The assembly of claim 1, wherein the conductive rods define an ion transfer axis and an inner radius, R0, and materials for the conductive rods, the shoes and the isolation rings are chosen such that the inner radius is essentially invariant with change in temperature.

17. The assembly of claim 1, wherein the conductive rods define an ion transfer axis and an inner radius, R0, and a radial distance of a point of attachment between shoes and isolation rings from the ion transfer axis is selected such that, in view of thermal expansion properties of materials for the conductive rods, shoes and isolation rings, the inner radius is essentially invariant with change in temperature.

18. A method for fabricating a multipole assembly, comprising:

(a) inserting a plurality of conductive rods into a fixture;

(b) inserting at least one precision-made spacer in between the plurality of rods;

(c) urging the rods against the spacers to obtain precise alignment of the rods;

(d) adhesively attaching a plurality of shoes onto the rods, each shoe having a plurality of edges of which one edge is adhesively attached to a corresponding rod;

(e) attaching a plurality of isolation rings onto the shoes, each isolation ring having a plurality of sides of which at least one side is attached to a subset of the plurality of shoes; and

(f) after the plurality of shoes are adhesively attached to the rods and the plurality of isolation rings are attached to the shoes, removing the spacers and releasing the rods from the fixture.

19. The method of claim 18, wherein step (e) comprises adhesively attaching the isolation rings directly onto the shoes.

20. The method of claim 18, further comprising roughening a plurality of areas on each of the rods prior to step (d), the plurality of areas corresponding to the location of bonding of the shoes.

21. The method of claim 18, further comprising surface treating edges of the plurality of shoes prior to step (d).

22. The method of claim 21, wherein surface treating comprises one of sand blasting the surface, laser scribing the surface, and cutting the surface to generate serrated surface, ribbed surface, or ridged surface.

23. A spacer for fabricating a multipole assembly having a plurality of rods, the spacer comprising arms extending from a cross-point with two arms extending along a rotational axis, the spacer also comprising nesting areas between adjacent arms with effective nesting space for receiving and aligning rods, wherein the cross section of the arms in the nesting areas is configured such that by rotating the spacer around the rotational axis the effective nesting space is increased.

24. The spacer of claim 23, wherein the cross section of the arms is essentially rectangular or square with dimples in the nesting areas.

25. The spacer of claim 23, wherein each arm comprises a section having an S-shaped cross-section, and wherein the S-shaped cross section on one side of the rotational axis is oriented opposite that of the S-shape cross section on the other side of the rotational axis.

26. The spacer of claim 23, wherein the nesting areas have a shape generally adapted to a diameter of the rods.

27. The spacer of claim 23, wherein the nesting areas comprise a flattened surface in a region of contact between rod and arm.

28. The spacer of claim 23, comprising tungsten carbide.

29. A method for fabricating a multipole assembly, comprising:

(a) inserting a plurality of conductive rods into a fixture;

(b) inserting at least one precision-made spacer in between the plurality of rods, the spacer having arms a cross section of which determines an effective width which essentially defines a spacing between two adjacent conductive rods;

(c) urging the rods against the spacer to obtain precise alignment of the rods;

(d) attaching a plurality of isolation rings onto the rods;

(e) removing the spacer by means of a rotational motion along a rotational axis running through spacings between the rods, thereby essentially reducing the effective width of the arms and disengaging the spacer from the rods; and

(f) releasing the rods from the fixture.

30. A fixture for fabricating a multipole assembly having a plurality of conductive rods, comprising:

(a) a support; and

(b) a plurality of isolation ring holders attached to the support, the isolation ring holders having recesses for receiving spacers which assist in the alignment of the rods, and each holder having a plurality of plungers for urging the rods against the spacers during assembly of the rods.

31. The fixture of claim 30, wherein the support comprises a base, and a tower that is one of attached to and made integrally with the base.

32. The fixture of claim 30, wherein the holders are slidably attached to the support via a sliding track.

33. The fixture of claim 30, wherein the holders have alignment pins for aligning isolation rings and shoes during assembly of the rods.

34. The fixture of claim 33, wherein the alignment pins are attached to ends of the plungers.

35. The fixture of claim 30, wherein the recesses for the spacers have a shape of pockets.

36. The fixture of claim 30, wherein the plungers are spring-loaded.

37. The fixture of claim 30, wherein a number of plungers on each holder corresponds to a number of rods to be assembled.

38. The fixture of claim 30, wherein the holders comprise two half rings, the half rings having two machined steps for supporting an isolation ring and being held in place by removable pins.