CLAIMS

1. A brachytherapy device, comprising:

a base adapted for being at least partially introduced into a body of a subject; and

a plurality of radionuclide atoms of a first alpha-emitting isotope, coupled to the base in a manner that not more than 25% of the radionuclide atoms leave the base in 24 hours, in methods other than radioactive decay,

wherein when installed in a human subject, the brachytherapy device emits radionuclide atoms of the first alpha-emitting isotope at a rate of at least 0.1% of the number of radionuclide atoms of the first alpha-emitting isotope coupled to the base, per 24 hours.

2. The brachytherapy device of claim 1, wherein the first alpha-emitting isotope comprises Radium-224.

3. The brachytherapy device of claim 1, wherein the first alpha-emitting isotope comprises Radium-223.

4. The brachytherapy device of any of claims 1-3, further comprising a semi-porous polymer coating layer on the radionuclide atoms, configured to allow diffusion of a percentage of the radionuclide atoms, so as to provide the emission of the at least 0.1% of the number of radionuclide atoms of the first alpha-emitting isotope coupled to the base, per 24 hours.

5. The brachytherapy device of claim 4, wherein the semi-porous polymer coating layer comprises PDMS (polydimethylsiloxane).

6. The brachytherapy device of claim 4, wherein the semi-porous polymer coating layer has a thickness of no more than 0.5 microns.

7. The brachytherapy device of claim 4, wherein the semi-porous polymer coating layer allows diffusion of the radionuclide atoms out of the brachytherapy device at a rate of at least 0.5% in 24 hours.

8. The brachytherapy device of claim 4, further comprising a base polymer coating layer on the base, and wherein the plurality of radionuclide atoms are attached to the base polymer coating layer and thus coupled to the base in a manner allowing the radionuclide atoms to detach and diffuse, without nuclear decay.

9. The brachytherapy device of claim 8, wherein the base polymer coating layer is configured to prevent diffusion of the radionuclide atoms therethrough.

10. The brachytherapy device of claim 8, wherein the base polymer coating layer comprises polycarbonate.

11. The brachytherapy device of claim 8, wherein the base polymer coating layer has a thickness of at least 0.25 microns.

12. The brachytherapy device of any of claims 1-3, wherein the brachytherapy device emits radionuclide atoms of the first alpha-emitting isotope at a rate of at least 3% of the number of radionuclide atoms of the first alpha-emitting isotope coupled to the base, per 24 hours.

13. The brachytherapy device of any of claims 1-3, wherein not more than 15% of the radionuclide atoms leave the base in 24 hours, in methods other than radioactive decay.

14. The brachytherapy device of any of claims 1-3, wherein the plurality of radionuclide atoms are coupled to the base in a manner that not more than 8% of the radionuclide atoms leave the base in 24 hours, in methods other than radioactive decay.

15. The brachytherapy device of any of claims 1-3, further comprising a bio-absorbable polymer coating layer on the base, wherein the radionuclide atoms are embedded in the bio-absorbable polymer coating layer, and wherein when installed in a subject, the bio-absorbable polymer coating layer dissolves in a manner causing emission from the device of the at least 0.1% of the number of radionuclide atoms of the first alpha-emitting isotope coupled to the base, per 24 hours.

16. The brachytherapy device of claim 15, wherein the radionuclide atoms are distributed substantially evenly in a thickness of the bio-absorbable polymer coating layer.

17. The brachytherapy device of any of claims 1-3, further comprising a plurality of radionuclide atoms of a second alpha-emitting isotope, which decays into the first alpha-emitting isotope, which are coupled to the base in a manner that the radionuclide atoms do not leave the brachytherapy device, but upon nuclear decay, a daughter nuclei of the decaying radionuclide atom is emitted from the device.

18. The brachytherapy device of claim 17, wherein the plurality of radionuclide atoms of the second alpha-emitting isotope have an activity level of less than 20% of the activity level of the radionuclide atoms of the first alpha-emitting isotope included in the device.

19. The brachytherapy device of claim 18, wherein the plurality of radionuclide atoms of the second alpha-emitting isotope have an activity level of less than 10% of the activity level of the radionuclide atoms of the first alpha-emitting isotope included in the device.

20. The brachytherapy device of claim 18, wherein the plurality of radionuclide atoms of the second alpha-emitting isotope have an activity level of less than 5% of the activity level of the radionuclide atoms of the first alpha-emitting isotope included in the device.

21. The brachytherapy device of claim 17, wherein the plurality of radionuclide atoms of the second alpha-emitting isotope have an activity level greater than 1% of the activity level of the radionuclide atoms of the first alpha-emitting isotope included in the device.

22. The brachytherapy device of any of claims 1-3, wherein the plurality of radionuclide atoms of the first alpha-emitting isotope provide at least 50% of the activity of the radionuclide atoms in the brachytherapy device.

23. The brachytherapy device of any of claims 1-3, wherein the plurality of radionuclide atoms of the first alpha-emitting isotope have a density of at least $5*10^{10}$ atoms per square centimeter of the base.

24. A brachytherapy device, comprising:

a seed base adapted for being at least partially introduced into a body of a subject;

a first coating layer on the seed base, configured to prevent passage of Radium-224 or Radium-223 therethrough;

particles of a Radium-224 or Radium-223 radionuclide placed on the first coating layer; and

a second coating layer on the particles, configured to allow diffusion of at least 0.1% of the particles of Radium.

25. The brachytherapy device of claim 24, wherein the seed base comprises a tube defining an internal channel.

26. The brachytherapy device of claim 24, wherein the first coating layer comprises polycarbonate.

27. The brachytherapy device of claim 24, wherein the first coating layer has a thickness of at least 0.05 microns.

28. The brachytherapy device of claim 24, wherein the first coating layer has a thickness of at least 0.1 microns.

29. The brachytherapy device of claim 24, wherein the first coating layer has a thickness of at least 0.3 microns.

30. The brachytherapy device of claim 24, wherein the first coating layer has a thickness of no more than 1 micron.

31. The brachytherapy device of claim 24, wherein the first coating layer has a thickness of no more than 0.5 microns.

32. The brachytherapy device of any of claims 24-31, wherein the second coating layer comprises PDMS (polydimethylsiloxane).

33. The brachytherapy device of any of claims 24-31, wherein the second coating layer has a thickness of no more than 0.5 microns.

34. The brachytherapy device of any of claims 24-31, wherein the second coating layer has a thickness of no more than 0.3 microns.

35. The brachytherapy device of any of claims 24-31, wherein the second coating layer has a thickness of at least 0.1 microns.

36. The brachytherapy device of any of claims 24-31, wherein the device allows diffusion of the particles of Radium through the second coating layer at a rate of at least 0.5% in 24 hours.

37. The brachytherapy device of any of claims 24-31, wherein the device allows diffusion of the particles of Radium through the second coating layer at a rate of at least 5% in 24 hours.

38. The brachytherapy device of any of claims 24-31, wherein the device allows diffusion of the particles of Radium through the second coating layer at a rate of no more than 10% in 24 hours.

39. The brachytherapy device of any of claims 24-31, wherein the device allows diffusion of the particles of Radium through the second coating layer at a rate of no more than 2% in 24 hours.

40. A brachytherapy device, comprising:

a probe adapted for being at least partially introduced into a body of a subject;

particles of Radium-224 retainably embedded on or beneath a surface of the probe, in a manner ensuring that the particles remain in the probe while a therapeutic dose of decay chain nuclei and alpha particles of said particles is emitted outside the surface; and

particles of Thorium-228 retainably embedded on or beneath a surface of the probe, in a manner ensuring that the particles remain in the probe while a therapeutic dose of decay chain nuclei and alpha particles of said particles is emitted outside the surface,

wherein an activity level of the Thorium-228 particles is lower than 50% of an activity level of the particles of Radium-224 in the device.

41. The brachytherapy device of claim 40, wherein the probe comprises a removable probe.

42. The brachytherapy device of claim 41, wherein the removable probe comprises a needle, a tip of an endoscope, a tip of a laparoscope or a tip of an imaging device.

43. The brachytherapy device of claim 40, wherein the probe comprises a tube defining an internal channel.

44. The brachytherapy device of any of claims 40-43, further comprising a protective coat, coating the probe and the Thorium-228 radionuclide, wherein a thickness and a material of said protective coat is selected so as not to prevent said emission of said decay chain nuclei and said alpha particles.

45. The brachytherapy device of any of claims 40-43, wherein the probe comprises an inner elongated member and an outer tubular member having a mouth section configured for receiving said inner elongated member, said inner elongated member being movable within said outer tubular member and having a distal end and a proximal end, whereby said radionuclide is on or beneath a surface of said distal end.

46. The brachytherapy device of any of claims 40-43, wherein the probe and particles of a Thorium-228 are not coated.

47. The brachytherapy device of any of claims 40-43, wherein the probe comprises a brachytherapy seed.

48. A method of brachytherapy treatment, comprising:

determining at least one property of a malignant tumor in a patient;

selecting a layout of one or more seeds loaded with radionuclide atoms of a first isotope which emits alpha radiation, to be implanted in the malignant tumor, responsively to the determined at least one property;

selecting for each of the one or more seeds, a rate of release of the first isotope from the seed, not including the release of alpha particles and daughter nuclei; and

installing seeds having the selected rates of release in the malignant tumor according to the selected layout.

49. The method of claim 48, wherein the first isotope comprises Radium-224.

~~50. The method of claim 48, wherein determining the at least one property of the malignant tumor comprises determining a size of the malignant tumor.~~

~~51. The method of claim 48, wherein determining the at least one property of the malignant tumor comprises determining a shape of the malignant tumor.~~

~~52. The method of any of claims 48-51, wherein installing the seeds comprises installing seeds having at least two substantially different rates of release of the first isotope.~~

CLAIMS

1. A brachytherapy device, comprising:

a base adapted for being at least partially introduced into a body of a subject; and

a plurality of radionuclide atoms of a first alpha-emitting isotope, coupled to the base in a manner that not more than 25% of the radionuclide atoms leave the base in 24 hours, in methods other than radioactive decay,

wherein when installed in a human subject, the brachytherapy device emits radionuclide atoms of the first alpha-emitting isotope at a rate of at least 0.1% of the number of radionuclide atoms of the first alpha-emitting isotope coupled to the base, per 24 hours.

2. The brachytherapy device of claim 1, wherein the first alpha-emitting isotope comprises Radium-224.

3. The brachytherapy device of claim 1 or claim 2, further comprising a semi-porous polymer coating layer on the radionuclide atoms, configured to allow diffusion of a percentage of the radionuclide atoms, so as to provide the emission of the at least 0.1% of the number of radionuclide atoms of the first alpha-emitting isotope coupled to the base, per 24 hours.

4. The brachytherapy device of claim 3, wherein the semi-porous polymer coating layer comprises PDMS (polydimethylsiloxane).

5. The brachytherapy device of claim 3 or claim 4, wherein the semi-porous polymer coating layer has a thickness of no more than 0.5 microns.

6. The brachytherapy device of any one of claims 3-5, wherein the semi-porous polymer coating layer allows diffusion of the radionuclide atoms out of the brachytherapy device at a rate of at least 0.5% in 24 hours.

7. The brachytherapy device of any one of claims 3-6, further comprising a base polymer coating layer on the base, and wherein the plurality of radionuclide atoms are attached to the base polymer coating layer and thus coupled to the base in a manner allowing the radionuclide atoms to detach and diffuse, without nuclear decay.

8. The brachytherapy device of claim 7, wherein the base polymer coating layer comprises polycarbonate.

9. The brachytherapy device of claim 7 or claim 8, wherein the base polymer coating layer has a thickness of at least 0.25 microns.

10. The brachytherapy device of any one of claims 1-9, wherein the brachytherapy device emits radionuclide atoms of the first alpha-emitting isotope at a rate of at least 3% of the number of radionuclide atoms of the first alpha-emitting isotope coupled to the base, per 24 hours.

11. The brachytherapy device of any one of claims 1-10, wherein not more than 15% of the radionuclide atoms leave the base in 24 hours, in methods other than radioactive decay.

12. The brachytherapy device of claim 11, wherein the plurality of radionuclide atoms are coupled to the base in a manner that not more than 8% of the radionuclide atoms leave the base in 24 hours, in methods other than radioactive decay.

13. The brachytherapy device of any one of claims 1-12, further comprising a bio-absorbable polymer coating layer on the base, wherein the radionuclide atoms are embedded in the bio-absorbable polymer coating layer, and wherein when installed in a subject, the bio-absorbable polymer coating layer dissolves in a manner causing emission from the device of the at least 0.1% of the number of radionuclide atoms of the first alpha-emitting isotope coupled to the base, per 24 hours.

14. The brachytherapy device of any one of claims 1-13, further comprising a plurality of radionuclide atoms of a second alpha-emitting isotope, which decays into the first alpha-emitting isotope, which are coupled to the base in a manner that the radionuclide atoms do not leave the brachytherapy device, but upon nuclear decay, a daughter nuclei of the decaying radionuclide atom is emitted from the device.

15. The brachytherapy device of claim 14, wherein the plurality of radionuclide atoms of the second alpha-emitting isotope have an activity level of less than 20% of the activity level of the radionuclide atoms of the first alpha-emitting isotope included in the device.

16. The brachytherapy device of claim 15, wherein the plurality of radionuclide atoms of the second alpha-emitting isotope have an activity level of less than 5% of the activity level of the radionuclide atoms of the first alpha-emitting isotope included in the device.

17. The brachytherapy device of any one of claims 1-16, wherein the plurality of radionuclide atoms of the first alpha-emitting isotope provide at least 50% of the activity of the radionuclide atoms in the brachytherapy device.

18. The brachytherapy device of any one of claims 1-17, wherein the plurality of radionuclide atoms of the first alpha-emitting isotope have a density of at least $5*10^{10}$ atoms per square centimeter of the base.

19. A brachytherapy device, comprising:

a seed base adapted for being at least partially introduced into a body of a subject;

a first coating layer on the seed base, configured to prevent passage of Radium-224 or Radium-223 therethrough;

particles of a Radium-224 or Radium-223 radionuclide placed on the first coating layer; and

a second coating layer on the particles, configured to allow diffusion of at least 0.1% of the particles of Radium.

20. The brachytherapy device of claim 19, wherein the seed base comprises a tube defining an internal channel.

21. The brachytherapy device of claim 19 or claim 20, wherein the first coating layer comprises polycarbonate.

22. The brachytherapy device of any one of claims 19-21, wherein the first coating layer has a thickness of at least 0.05 microns.

23. The brachytherapy device of claim 22, wherein the first coating layer has a thickness of at least 0.1 microns.

24. The brachytherapy device of any one of claims 19-23, wherein the first coating layer has a thickness of no more than 1 micron.

25. The brachytherapy device of any one of claims 19-24, wherein the second coating layer comprises PDMS (polydimethylsiloxane).

26. The brachytherapy device of any one of claims 19-25, wherein the second coating layer has a thickness of no more than 0.5 microns.

27. The brachytherapy device of any one of claims 19-26, wherein the second coating layer has a thickness of at least 0.1 microns.

28. The brachytherapy device of any one of claims 19-27, wherein the device allows diffusion of the particles of Radium through the second coating layer at a rate of at least 0.5% in 24 hours.

29. The brachytherapy device of any one of claims 19-28, wherein the device allows diffusion of the particles of Radium through the second coating layer at a rate of at least 5% in 24 hours.

30. The brachytherapy device of any one of claims 19-29, wherein the device allows diffusion of the particles of Radium through the second coating layer at a rate of no more than 10% in 24 hours.