

We claim:

1. A prosthetic heart valve, comprising:
a frame including a first end with a plurality of apices spaced apart from one another around a circumference of the first end; and
a plurality of discrete cushioning elements covering the plurality of apices, wherein each cushioning element of the plurality of cushioning elements is coupled to and covers a different apex of the plurality of apices.
2. The prosthetic heart valve of claim 1, wherein each cushioning element comprises a flexible material folded over a corresponding apex of the plurality of apices.
3. The prosthetic heart valve of claim 2, wherein the flexible material comprises a fabric.
4. The prosthetic heart valve of any of the preceding claims, wherein each cushioning element comprises a plurality of folds arranged over and across a distal edge of a corresponding apex of the plurality of apices.
5. The prosthetic heart valve of claim 4, wherein, for each cushioning element, the plurality of folds extends between an inner layer and an outer layer of the cushioning element, the inner layer covering an inner surface of the corresponding apex and the outer layer covering an outer surface of the corresponding apex, the inner and outer surfaces relative to a central longitudinal axis of the prosthetic heart valve.
6. The prosthetic heart valve of claim 5, wherein the inner layer and the outer layer are secured together around both sides of the corresponding apex.
7. The prosthetic heart valve of any of claims 5 and 6, wherein each of the inner layer and the outer layer extend from a distal surface of the cushioning element, the distal surface formed by the plurality of folds, to a base of the corresponding apex.

8. The prosthetic heart valve of any of claims 1-3, wherein each cushioning element comprises an inner layer covering an inner surface of a corresponding apex of the plurality of apices, an outer layer covering an outer surface of the corresponding apex, and a distal layer defining a distal surface of the cushioning element and extending radially between the inner layer and the outer layer and across a distal edge of the corresponding apex.

9. The prosthetic heart valve of claim 8, wherein each cushioning element further comprises a plurality of folds arranged between the inner layer and the outer layer, and wherein each fold of the plurality of folds extends from the distal layer to a base of the corresponding apex.

10. The prosthetic heart valve of claim 1, wherein each cushioning element comprises one or more sutures repeatedly looped over a corresponding apex of the plurality of apices.

11. The prosthetic heart valve of claim 1, wherein each cushioning element comprises a pocket surrounding a corresponding apex of the plurality of apices and including a padding element disposed within the pocket, the padding element arranged distally to a distal edge of the corresponding apex.

12. The prosthetic heart valve of claim 11, wherein the pocket comprises a flexible material including one of a fabric and flexible polymer.

13. The prosthetic heart valve of any of claims 11 and 12, wherein overlapping folds of the pocket are secured to one another, along at least a portion of a periphery of the pocket.

14. The prosthetic heart valve of any of claims 11-13, wherein the pocket is fastened directly to the corresponding apex.

15. The prosthetic heart valve of any of claims 11-14, wherein the padding element is fixed to the pocket.

16. The prosthetic heart valve of any of the preceding claims, further comprising an outer skirt arranged around a circumference of the frame, at the first end, and wherein the cushioning element is attached to the outer skirt.

17. The prosthetic heart valve of any of the preceding claims, wherein the prosthetic heart valve is adapted to be crimped on a delivery device with the first end arranged at a distal end of the delivery device, proximate to a nosecone of the delivery device.

18. An assembly, comprising:
a delivery device including a proximal shoulder, a distal shoulder, and a nosecone arranged at distal end of the distal shoulder; and
a prosthetic valve arranged in a radially compressed configuration on the delivery device, between the distal shoulder and the proximal shoulder, the prosthetic valve having a frame including a distal end arranged adjacent to the distal shoulder, the distal end of the frame having a first plurality of apices spaced apart from one another around a circumference of the distal end, wherein each apex of the first plurality of apices is curved inward toward a central longitudinal axis of the frame.

19. The assembly of claim 18, wherein the frame includes a central portion arranged between the distal end and a proximal end of the frame, the central portion being a longest portion of the frame, and wherein the central portion is arranged parallel to the central longitudinal axis.

20. The assembly of any of claims 18, wherein the frame further includes a proximal end having a second plurality of apices spaced apart from one another around a circumference of the proximal end, wherein each apex of the second plurality of apices is oriented in a direction parallel to the central longitudinal axis.

21. The assembly of any of claims 18 and 19, wherein the frame further includes a proximal end having a second plurality of apices spaced apart from one another around a circumference of the proximal end, wherein each apex of the second plurality of apices is curved inward toward the central longitudinal axis, at an angle of curvature that is less than an angle of curvature of the first plurality of apices.

22. The assembly of any of claims 18-21, wherein the frame includes a plurality of struts, wherein the first plurality of apices is formed by meeting ends of adjacent struts of the plurality of struts, and wherein at least a portion of the adjacent struts forming the first plurality of apices are curved inward toward the central longitudinal axis.

23. The assembly of any of claims 18-22, further comprising an outer skirt arranged around a circumference of the frame, at the distal end of the frame, on an outside of the frame.

24. The assembly of any of claims 18-23, wherein a diameter of the frame, at the distal end of the frame, is smaller than a diameter of the frame at a proximal end of the frame and the same or smaller than a proximal end of the nosecone.

25. The assembly of any of claims 18-24, wherein each apex of the first plurality of apices is curved inward at an angle, relative to a line parallel with the central longitudinal axis and wherein the angle is less than 45 degrees.

26. The assembly of any of claims 18-25, wherein a first end of a jacket is attached to a proximal end of the nosecone and wherein a free, second end of the jacket is adapted to translate between positions that are proximal and distal to the first end.

27. The assembly of claim 26, wherein the jacket comprises one or more of a fabric, tissue, and a polymeric sheet.

28. The assembly of any of claims 18-25, further comprising a bio-resorbable element covering the first plurality of apices at the distal end of the frame of the prosthetic valve.

29. The assembly of any of claims 18-25, wherein the distal shoulder and the proximal shoulder are mounted to a shaft of the delivery device and wherein the proximal shoulder is radially crimpable and mounted to the shaft at a location proximal to the distal shoulder, the proximal shoulder including an outer surface adapted to interface with a valve crimper and a distal edge adapted to move axially toward the distal shoulder, relative to a central longitudinal axis of the shaft, when a crimping force is applied to the outer surface to move the proximal shoulder from an uncrimped state to a crimped state, wherein the proximal shoulder is plastically deformable such that the proximal shoulder remains in the crimped state after crimping.

30. A nosecone for a delivery device, comprising:
a nosecone body; and
a jacket including a first end attached to the nosecone body and a free, second end adapted to translate between positions that are proximal and distal to the first end.

31. The nosecone of claim 30, wherein the first end of the jacket is attached to a proximal end of the nosecone body, the proximal end adapted to be coupled to a distal shoulder of the delivery device.

32. The nosecone of any of claims 30 and 31, wherein the second end is unattached to the nosecone body along an entire edge of the second end.

33. The nosecone of any of claims 30-32, wherein the jacket comprises one or more of a fabric, tissue, and a polymeric sheet.

34. The nosecone of any of claims 30-33, wherein the jacket is translatable between a proximal, first position wherein the second end is arranged over a distal end of a

frame of a prosthetic valve crimped onto a balloon of the delivery device and a distal, second position wherein the second end is arranged distally away from the distal end of the frame.

35. The nosecone of claim 34, wherein the jacket is in the first position during delivery of a prosthetic valve crimped onto the balloon, where the delivery device is advanced through a delivery sheath to a target implantation site for the prosthetic valve and wherein the jacket is in the second position after inflation of the balloon and deployment of the prosthetic valve.

36. A method for a transcatheter delivery system, comprising:
inserting a distal end portion of a delivery device and a prosthetic valve into vasculature of a patient, wherein the prosthetic valve is in a crimped state around a balloon of the delivery device at a location proximal to a nosecone of the delivery device with a nosecone jacket covering a distal end of a frame of the prosthetic valve; and
inflating the balloon to radially expand the prosthetic valve, which causes the nosecone jacket to slide off of the distal end of the frame, in a distal direction.

37. The method of claim 36, wherein the distal end of the prosthetic valve includes a plurality of apices arranged around a circumference of the distal end and wherein the distal end of the prosthetic valve is oriented proximate to the nosecone.

38. The method of claim 37, wherein inserting the distal end portion of the delivery device into the vasculature of the patient includes inserting the distal end portion of the delivery device, including the prosthetic valve, into and through an introducer sheath inserted into the vasculature of the patient and further comprising, maintaining the nosecone jacket covering the distal end of the frame of the prosthetic valve during advancing the distal end portion of the delivery device through the introducer sheath and the vasculature of the patient to a target implantation site for the prosthetic valve.

39. The method of claim 38, wherein when the nosecone jacket covers the distal end of the frame, the nosecone jacket coverts the plurality of apices of the distal end and provides a barrier between the plurality of apices and the introducer sheath.

40. The method of any of claims 36-39, wherein the nosecone jacket is attached at a first, fixed end to the nosecone and includes a second, free end and further comprising, prior to arranging the prosthetic valve is the crimped state around the balloon of the delivery device, orienting the free end of the nosecone jacket distally away from the frame of the prosthetic valve, relative to a central longitudinal axis of the delivery device.

41. The method of any of claims 36-40, wherein the nosecone jacket comprises a material including one or more of fabric, tissue, and a polymeric sheet that is adapted to translate freely between positions where a free end of the nosecone jacket covers the distal end of the frame and slides off the distal end of the frame.

42. A prosthetic heart valve, comprising:
a frame including a proximal end and a distal end including a plurality of apices; and
a bio-resorbable element covering the plurality of apices at the distal end.

43. The prosthetic heart valve of claim 42, wherein the bio-resorbable element is a dissolving biofilm.

44. The prosthetic heart valve of claim 42, wherein the bio-resorbable element is a bio-resorbable polymer.

45. The prosthetic heart valve of any of claims 42-44, wherein the bio-resorbable element is wrapped around an entire circumference of the distal end of the frame.

46. The prosthetic heart valve of any of claims 42-45, wherein the bio-resorbable element is wrapped around a circumference of the distal end of the frame in a single layer.

47. The prosthetic heart valve of any of claims 42-45, wherein the bio-resorbable element is wrapped around a circumference of the distal end of the frame in multiple layers.

48. The prosthetic heart valve of any of claims 42-47, wherein the bio-resorbable element is adapted to degrade in a pre-determined time frame that is based on a time to advance the prosthetic heart valve, crimped on a delivery device, through a sheath to a desired implantation site in a patient.

49. The prosthetic heart valve of any of claims 42-48, wherein each apex of the plurality of apices is curved inward toward a central longitudinal axis of the frame.

50. A delivery device for a transcatheter delivery system, comprising:
a shaft;
a distal shoulder mounted to the shaft; and
a radially crimpable proximal shoulder spaced apart from the distal shoulder and mounted to the shaft at a location proximal to the distal shoulder, the proximal shoulder including an outer surface adapted to interface with a valve crimper and a distal edge adapted to move axially toward the distal shoulder, relative to a central longitudinal axis of the shaft, when a crimping force is applied to the outer surface to move the proximal shoulder from an uncrimped state to a crimped state;

wherein the proximal shoulder is plastically deformable such that the proximal shoulder remains in the crimped state after crimping.

51. The delivery device of claim 50, further comprising a balloon arranged around the shaft, distal shoulder, and proximal shoulder.

52. The delivery device of any of claims 50 and 51, wherein a prosthetic valve is adapted to be crimped around the balloon, in a space arranged between the distal shoulder and the proximal shoulder.

53. The delivery device of any of claims 50-52, wherein the distal edge is a circumferential edge arranged perpendicular to an outer surface of the shaft and the outer surface is a circumferential surface arranged concentric with and parallel to the outer surface of the shaft.

54. The delivery device of any of claims 50-53, wherein the proximal shoulder includes an inclined edge arranged between a proximal edge of the proximal shoulder and the distal edge that is angled relative to the central longitudinal axis and wherein the inclined edge is adapted to pivot towards the shaft and about the proximal edge.

55. A method for crimping a prosthetic valve to a delivery device, comprising:
arranging a prosthetic valve on a valve-mounting portion of a balloon, between a distal shoulder and proximal shoulder mounted on a shaft of the delivery device, the proximal shoulder and distal shoulder arranged within the balloon; and

crimping the prosthetic valve onto the balloon via exerting an inward, radial force, relative to a central longitudinal axis of the valve shaft, against the prosthetic valve and an outer surface of the proximal shoulder, wherein the inward, radial force causes a distal edge of the proximal shoulder to move axially toward the prosthetic valve and the distal shoulder and exert an axial push force on a proximal end of the frame of the prosthetic valve, moving the prosthetic valve distally toward the distal shoulder while the prosthetic valve is radially compressed.

56. The method of claim 55, wherein the outer surface is spaced farther away from the shaft prior to crimping than after crimping.

57. The method of any of claims 55 and 56, wherein the distal edge is a circumferential edge extending around a circumference of the shaft and arranged perpendicular to an outer surface of the shaft and wherein the distal edge is spaced farther away from the proximal end of the frame prior to crimping than after crimping.

58. The method of any of claims 55-57, wherein the proximal shoulder includes an inclined edge arranged between a proximal edge of the proximal shoulder and the distal edge of the proximal shoulder and angled relative to the central longitudinal axis of the shaft and wherein the inclined edge pivots about the proximal edge as the inward, radial force is exerted on the outer surface of the proximal shoulder, moving the inclined edge closer to the valve shaft and decreasing an angle between the inclined edge and the proximal edge.

59. The method of claim 58, wherein the proximal shoulder is plastically deformable about the proximal edge and wherein, after crimping, the proximal shoulder maintains its position, including the decreased angle between the inclined edge and the proximal edge and the distal edge abutting the proximal end of the frame.