CLAIMS

1. A downhole tool for use in a well comprising: a mandrel; an expandable sealing element disposed about the mandrel for engaging the well in a set position of the tool; a first slip ring disposed about the mandrel and radially expandable outwardly from an unset to a set position in which the slip ring grippingly engages the well, the first slip ring comprising a plurality of slip segments having first and second side surfaces, each of the plurality of slip segments being bonded with a bonding material to an adjacent slip segment at the first and second side surfaces thereof; and a second slip ring disposed about the mandrel and expandable radially outwardly from an unset to a set position in which the second slip ring grippingly engages the well, the second slip ring comprising a plurality of slip segments having first and second side surfaces, each of the plurality of slip segments being bonded with the bonding material to adjacent slip segments at the first and second side surfaces thereof.

2. A downhole tool according to claim 1, further comprising: a groove defined in an end surface of each of the slip segments, wherein the grooves in the slip segments in the first slip ring collectively define a retaining groove therein, the groove in the slip segments in the second slip ring defining a retaining groove therein; and a first retaining band disposed in the retaining groove in the first slip ring; and a second retaining band disposed in the retaining groove in the second slip ring.

3. A downhole tool according to claim 2, wherein the first and second retaining bands are not exposed to fluid in the well.

4. A downhole tool according to claim 2 or 3, wherein: the retaining bands in the first and second slip rings are encapsulated.

5. A downhole tool according to claim 2, 3 or 4, the first and second slip rings each comprising an end layer covering the retaining bands, the end layer comprising the bonding material used to bond the slip segments together.

6. A downhole tool according to claim 5, wherein the bonding material is nitrile rubber.

7. A downhole tool according to any preceding claim, further comprising: a sealing element having first and second ends disposed about the mandrel and positioned between the first and second slip rings; and first and second extrusion limiters contacting the first and second ends of the sealing element, the first and second extrusion limiters comprising a plurality of alternating layers of rubber and a fiberglass composite, wherein the first and second extrusion limiters have an arcuately shaped cross section in the unset position of the tool.

8. A downhole tool according to claim 7, further comprising first and second slip wedges disposed about the mandrel, each having an abutment end, wherein the abutment end of the first and second slip wedges abuts the first and second extrusion limiters.

9. A downhole tool according to claim 8, wherein the abutment end of each slip wedge comprises a flat portion extending radially outwardly from a mandrel outer surface and a rounded transition from the flat portion to a radially outer surface on the slip wedge.

10. A apparatus according to claim 8 or 9, wherein the abutment ends of the first and second slip wedges compress the sealing element seal and move the sealing element to the set position.

11. A downhole tool for use in a well comprising: a composite mandrel comprising a plurality of layers of fiberglass filaments bonded to one another with an epoxy resin; a packer element disposed about the mandrel; first and second slip rings disposed about the mandrel and positioned above and below the packer element, respectively; a head portion threadedly and removably connected to the mandrel; and a spacer ring disposed about the mandrel for axially retaining the first slip ring, wherein a lower end of the head portion provides an abutment for the spacer ring.

12. A downhole tool according to claim 11, an inner surface of the head portion defining a downward facing shoulder and the mandrel having an upper end, wherein the downward facing shoulder on the head portion and the upper end of the mandrel define an annular space therebetween.

13. A downhole tool according to claim 12, further comprising a spacer sleeve positioned in the annular space and captured by the downward facing shoulder on the head portion and the upper end of the mandrel.

14. A downhole tool according to claim 11, 12 or 13, further comprising: a ball movably disposed in the head portion; and a barrier to entrap the ball in the head portion, the head portion defining a ball seat, wherein the ball will engage the ball seat to prevent fluid flow through the downhole tool in a first direction, and is movable by fluid pressure off the ball seat to allow fluid flow in a second direction through the downhole tool.

15. A downhole tool according to any one of claims 11 to 14, further comprising a solid plug disposed in the head portion and trapped between the upper end of the mandrel and the downward facing shoulder to prevent flow through the tool.

16. A downhole tool according to any one of claims 11 to 15, wherein the head portion is comprised of a composite material.

17. A downhole tool for use in a well comprising: a mandrel comprised of a composite material; a single packer element disposed about the mandrel, the packer element being expandable from an unset position to a set position in which the packer element engages the well; a first extrusion limiter adjacent a first end of the packer element; and a second extrusion limiter adjacent a second end of the packer element, the first and second extrusion limiters comprising a plurality of layers of fiberglass and a plurality of rubber layers, wherein each fiberglass layer has a rubber layer adjacent thereto.

18. A downhole tool according to claim 17, wherein the rubber layer is comprised of nitrile rubber.

19. A downhole tool according to claim 17 or 18, wherein the fiberglass layer is comprised of fiberglass filaments bonded together with an epoxy resin.

20. A downhole tool according to claim 17, 18 or 19, wherein each of the first and second extrusion limiters are arcuate in cross section in the unset position of the sealing element.

21. A downhole tool according to any one of claims 17 to 20, further comprising: a first slip wedge disposed about the mandrel, the first slip wedge having an abutment end abutting the first extrusion limiter; and a second slip wedge disposed about the mandrel, the second slip wedge having an abutment end abutting the second extrusion limiter, wherein the first and second slip wedges have a radially outer surface and an arcuate transition from the abutment end thereof to the radially outer surface.

22. A downhole tool according to any one of claims 17 to 21, further comprising: a first slip ring disposed about the mandrel and movable from an unset to a set position in which the first slip ring grippingly engages the well; and a second slip ring disposed about the mandrel and movable from an unset to a set position in which the second slip ring grippingly engages the well, the first and second slip rings comprising a plurality of individual slip ring segments, each slip ring segment being adhesively bonded to an adjacent slip ring segment.

23. A downhole tool according to claim 22, further comprising a retaining band disposed in a groove in the first and second retaining rings wherein the retaining bands are covered by an end layer bonded to an end surface of each of the slip segments.

24. A downhole tool for use in a well comprising: a composite mandrel; a packer element disposed about the mandrel and expandable from an unset to a set position to sealingly engage the well; a first slip ring comprised of individual segments bonded together at side surfaces thereof; a second slip ring comprised of individual segments bonded together at side surfaces thereof, the first and second slip rings disposed about the mandrel and radially expandable from an unset to a set position to grippingly engage the well; and a head portion threadedly connected to the mandrel, the mandrel having an upper end; wherein the head portion and the upper end of the mandrel define an annular space therebetween.

25. A tool according to claim 24, further comprising: a sleeve having a central bore to permit fluid flow therethrough received in the annular space and captured by the head portion and the upper end of the mandrel.

26. A tool according to claim 24 or 25, further comprising a ball movably trapped in the head portion for engaging a seat defined by the head portion, to prevent flow in one direction through the tool and to allow flow in the opposite direction.

27. A tool according to claim 24, 25 or 26, further comprising: a solid plug received in the annular space and trapped therein for preventing flow through the tool.

What is claimed is:

1. A downhole tool for use in a well comprising: a mandrel; a expandable sealing element disposed about the mandrel for engaging the well in a set position of the tool; a first slip ring disposed about the mandrel and radially expandable outwardly from an unset to a set position in which the slip ring grippingly engages the well, the first slip ring comprising a plurality of slip segments having first and second side surfaces, each of the plurality of slip segments being bonded with a bonding material to an adjacent slip segment at the first and second side surfaces thereof; a second slip ring disposed about the mandrel and expandable radially outwardly from an unset to a set position in which the second slip ring grippingly engages the well, the second slip ring comprising a plurality of slip segments having first and second side surfaces, each of the plurality of slip segments being bonded with the bonding material to adjacent slip segments at the first and second side surfaces thereof; a groove defined in an end surface of each of the slip segments, wherein the grooves in the slip segments in the first slip ring collectively define a retaining groove therein, the groove in the slip segments in the second slip ring defining a retaining groove therein; a first retaining band disposed in the retaining groove in the first slip ring; and a second retaining band disposed in the retaining groove in the second slip ring wherein, when the downhole tool is in the well, the first and second retaining bands are not exposed to the well.

2. The downhole tool of claim 1 wherein the first and second retaining band are not exposed to a fluid in the well when the downhole tool is in the well.

3. The downhole tool of claim 1 wherein: the first retaining band and the second retaining band in the first and second slip rings are encapsulated.

4. The downhole tool of claim 1, the first and second slip rings each comprising an end layer covering the retaining bands, the end layer comprising the bonding material used to bond the slip segments together.

5. The downhole tool of claim 4, wherein the bonding material is nitrile rubber.

6. The downhole tool of claim 1, further comprising: a sealing element having first and second end disposed about the mandrel and positioned between the first and second slip rings; and first and second extrusion limiters contacting the first and second ends of the sealing element, wherein the first and second extrusion limiters have an accurately shaped cross section in the unset position of the tool.

7. The downhole tool of claim 6, further comprising first and second slip wedges disposed about the mandrel, each having an abutment end, wherein the abutment end of the first and second slip wedges abuts the first and second extrusion limiters.

8. The downhole tool of claim 7 wherein the abutment end of each slip wedge comprises a flat portion extending radially outwardly from a mandrel outer surface and a rounded transition from the flat portion to a radially outer surface on the slip wedge such that the abutment end of the first slip wedge can provide axial force and radially outward force on the first extrusion limiter and the abutment end of the second slip wedge can provide axial force and radially outwards force of the second extrusion limiter.

9. The apparatus of claim 7, wherein the abutment ends of the first and second slip wedges compress the sealing element seal and move the sealing element to the set position.

10. A downhole tool for use in a well comprising: a composite mandrel having a central flow passage therethrough: a packer element disposed about the mandrel: first and second slip rings disposed about the mandrel and positioned above and below the packer element, respectively; a head portion threadedly and removably connected to the mandrel, the head portion configured to be convertible between a frac plug configuration and a bridge plug configuration and having an inner surface defining a downward facing shoulder and the mandrel having an upper end, wherein the downward facing shoulder on the head portion and the upper end of the mandrel define an annular space therebetween such that a spacer sleeve can be positioned in the annular space so as to allow fluid to pass unobstructed through the annular space and into the central flow passage or a plug can be positioned in the annular space so as to prevent fluid to pass through the annular space and into the central flow passage; and a spacer ring disposed about the mandrel for axially retaining the first slip ring, wherein a lower end of the head portion provides an abutment for the spacer ring.

11. The downhole tool of claim 10 further comprising a spacer sleeve positioned in the annular space and captured by the downward facing shoulder on the head portion and the upper end of the mandrel.

12. The downhole tool of claim 11, further comprising: a ball movably disposed in the head portion; and a barrier to entrap the ball in the head portion, the head portion defining a ball seat, wherein the ball will engage the ball seat to prevent fluid flow through the downhole tool in a first direction, and is movable by fluid pressure off the ball seat to allow fluid flow in a second direction through the downhole tool.

13. The downhole tool of claim 10 further comprising a solid plug disposed in the head position and trapped between the upper end of the mandrel and the downward facing shoulder to provide flow through the tool.

14. The downhole tool of claim 10, wherein the head portion is comprised of a composite material.

15. A downhole tool for use in a well comprising: a mandrel comprised of a composite material; a single packer element disposed about the mandrel, the packer element being expandable from an unset position to a set position in which the packer element engages the well; a first extrusion limiter adjacent a first end of the packer element; and a second extrusion limiter adjacent a second end of the packer element wherein each of the first and second extrusion limiters are arcuate in cross section in the unset position of the sealing element; a first slip wedge disposed about the mandrel, the first slip wedge having an abutment end abutting the first extrusion limiter; and a second slip wedge disposed about the mandrel, the second slip wedge having an abutment end abutting the second extrusion limiter, wherein the first and second slip wedges have a radially outer surface and an arcuate transition from the abutment end thereof to the radially outer surface such that the arcuate transition and abutment end form an abutment surface such that the abutment surface of the first slip wedge can provide axial force and radially outward force on the first extrusion limiter and the abutment surface of the second slip wedge can provide axial force and radially outward force on the second extrusion limiter.

16. The downhole tool of claim 15 further comprising: a first slip ring disposed about the mandrel and moveable from an unset to a set position in which the first slip ring grippingly engages the well; and a second slip ring disposed about the mandrel and movable from an unset to a set position in which the second slip ring grippingly engages the well, the first and second slip rings comprising a plurality of individual slip ring segments, each slip ring segment being adhesively bonded to an adjaced slip ring segment.

17. The downhole tool of claim 16, further comprising a retaining band disposed in a groove in the first and second retaining slip rings wherein the retaining bands are covered by an end layer bonded to an end surface of each of the slip segments.