end surfaces 15 and 21. A problem with such a ring seal 1 is that the ridge or extension 23 can be damaged during handling or installation. For example, the extension may be nicked or dented. Such damage can result is an inadequate seal.

[0008] Still another type of ring seal known in the industry is the "W" seal. Such a sealing system is disclosed, for example, in U.S. Patent No. 7,140,647 ("the '647 patent"), also herein expressly incorporated by reference, in its entirety. The "W" seal in the `647 patent uses a snap ring situated on the inside of a retaining ring, identified in the patent as a guide, to retain the W-seal in the retainer and to keep the sealing surfaces on the W-seal or gasket protected from scratches. The '647 patent retainer or guide also has a snap ring situated on its outside diameter to keep the retainer engaged in the counterbore, which defines the opposing parallel surfaces to be sealed.

[0009] An additional known seal is a "V seal," which is also circular but instead of having a "C" cross-section, the V seal has a "V" cross-section with the low point of the V constructed to point either inwardly or outwardly towards the center of the seal. Though this construction typically provides for sufficient deformation, the V seal does not typically provide particularly good elastic recovery or repeatability because the point of the V seal forms a stress raiser that concentrates the compression loads and makes the seal prone to failure upon repeated compressions and decompressions of the seal.

[0010] Additional seals in the art include "Z seals" and simple "O rings." Each of these seals also suffer various disadvantages.

SUMMARY

[0011] Pursuant to these various approaches, an example ring seal for sealing opposing flow component sealing surfaces defining a fluid flow path and suitable for applications such as a semiconductor manufacturing modular gas delivery system is described. The example ring seal includes an annular extension in the form of a modified "delta" extending from one or both sealing surfaces of the ring seal. The modified "delta" extends to an apex or point above the ring seal's sealing surface from which the modified "delta" extends. First and second extension surfaces extend in opposite directions from the apex back toward the ring seal's sealing surface. In one embodiment, the first extension surface defines a ridge where the slope of the first extension surface changes to decline faster to the ring seal's sealing surface.

[0011a] According to a first aspect of the present invention, there is provided a ring seal for sealing opposing flow component sealing surfaces defining a fluid flow path, the ring seal comprising: an annular seal body defining an axial hole for fluid passage in an axial direction; opposing sealing surfaces on opposing axial ends of the annular seal body; an annular extension extending from at least one of the opposing sealing surfaces in an axial direction, the extension having an apex; wherein the annular extension comprises a first extension surface and a second extension surface respectively extending in opposite directions from the apex back toward the sealing surface from which the annular extension extends; wherein the first extension surface has a first general angle relative to the axial direction and defines a ridge by transitioning to a second general angle relative to the axial direction extending back toward the sealing surface at a steeper general angle than the first extension surface.

[0011b] According to a second aspect of the present invention, there is provided a method of sealing a fluid flow path that extends between two fluid flow components, each having a flow component sealing surface surrounding the fluid flow path, using an annular seal body having opposing sealing surfaces on opposing axial ends of the annular seal body and an annular extension extending from at least one of the opposing sealing surfaces in an axial direction, the extension having an apex, the method comprising: contacting with an annular seal body a flow component sealing surface for a first fluid flow component of the two fluid flow components, wherein the annular seal body defines an axial hole for fluid passage in an axial direction; securing the two fluid flow components to each other to align the flow component sealing surfaces of the two fluid flow components along the fluid flow path and to compress opposing sealing surfaces on opposing axial ends of the annular seal body with the flow component sealing surfaces; wherein the compressing the opposing sealing surfaces comprises: a first compression of the annular extension at a first compression force during compression of a first portion of the annular extension, wherein the first portion of the annular extension is defined by a first extension surface between the apex and a ridge where the first extension surface has a first general angle relative to the axial direction and defines the ridge by transitioning to a second general angle relative to the axial direction extending back toward the sealing surface at a steeper general angle than the first extension surface; a second compression of the annular extension at a second compression force higher than the first compression force during compression of a second portion of the annular extension, wherein the second portion of the annular extension is

defined by the first extension surface portion having the second general angle relative to the axial direction extending back toward the sealing surface.

[0011c] According to a third aspect of the present invention, there is provided a ring seal for sealing opposing flow component sealing surfaces defining a fluid flow path, the ring seal comprising: an annular seal body defining an axial hole for fluid passage in an axial direction; opposing sealing surfaces on opposing axial ends of the annular seal body; an annular extension extending from at least one of the opposing sealing surfaces in an axial direction, the extension having an apex; wherein the apex is located within the annular extension closer to the axial hole than to an outer radial diameter of the annular seal body defined by an outer surface radially opposite that of an inner surface that defines the axial hole.

[0012] So configured, during compression of the ring seal between the flow component sealing surfaces, a first load or compression force plastically deforms the annular extension or modified "delta" at the apex and continuing down to the annular extension's ridge. This deformation work hardens the ring seal material that is thus deformed. A second load or compression force greater than the first load is needed to continue the deformation of the ring seal past the ridge. The shift in force discourages a user from over loading the ring seal, which can damage the flow component sealing surfaces.

[0013] In another embodiment, the apex is located within the annular extension closer to the axial hole than to an outer radial diameter of the annular seal body defined by an outer surface radially opposite that of an inner surface that defines the axial hole. With this configuration, the deformation between the apex and the ridge provides a greater sealing area to provide a seal even where a portion of the annular extension may be damaged during handling, usually at the extension's apex.

[0014] These and other benefits may become clearer upon making a thorough review and study of the drawings and the following detailed description. In these accompanying drawings, like reference numerals designate like parts throughout the figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. 1 is a top view of a prior art seal;

[0016] FIG. 2 is a cross-sectional view along line 2 of the prior art seal shown in FIG. 1;

[0017] FIG. 3 is a top view of an example ring seal configured in accordance with various principles of the invention;

[0018] FIG. 4 is a cross-sectional view along line A-A of the ring seal shown in FIG. 3;

[0019] FIG. 5 is an isometric view of portion of the ring seal of FIG. 3 indicated by line B;

[0020] FIG. 6 is a flow diagram illustrating an example method of sealing a flow path in accordance with various principles of the invention;

[0021] FIG. 7 is a cross-sectional view illustrating an example ring seal in accord with FIGS. 3-5 set between fluid flow components prior to compression in accordance with various principles of the invention;