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Dynamic vacuum seal system for physical vapor deposition sputter applications

Abstract

Provided is a vacuum seal and seal system including a corresponding isolation ring and a corresponding sputtering target. The seal and seal system may be used in PVD sputter applications. The seal may include a compressible portion and a rigid portion. The compressible portion may include two or more higher profile protrusions and two or more lower profile recesses that facilitate formation of a vacuum seal through compression by and between the isolation ring and the sputtering target. The seal may further include a removable and replaceable plasma shield that is attachable to a first end of the seal. The seal may further include a rim on a second end that selectively couples with a corresponding step-out portion of the isolation ring. The sputtering target may have a continuous peripheral flange surface. In an embodiment, the seal and seal system is self-centering.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS (1) The application is a continuation of U.S. patent application Ser. No. 18/992,549 filed on Jan. 8, 2025, which is the U.S. National Phase Entry of International Application No. PCT/US2023/027301 filed on Jul. 10, 2023, which claims priority to U.S. Patent Application No. 63/367,914, filed on Jul. 8, 2022, entitled “Dynamic

Vacuum Seal System for Physical Vapor Deposition Sputter Applications,” each of which are incorporated herein by reference in their entireties.

FIELD OF THE INVENTION

(1) The present disclosure relates generally to a dynamic vacuum seal system for physical vapor deposition sputter applications and, more particularly, to a vacuum seal and seal system including a corresponding isolation ring and a corresponding sputtering target that does not incorporate an O-ring and corresponding groove or any vent slots or scallops.

BACKGROUND

(2) Physical Vapor Deposition (PVD) is a thin film deposition technique used in manufacturing processes to create coatings and coating patterns on a desired surface substrate. The technique can employ sputtering methods to transfer material from a solid source, e.g., a sputtering target, onto a substrate surface in a vacuum environment. PVD may be used in a variety of applications, such as semiconductor manufacturing, glass coatings, optical coatings, solar cell coatings, nanotechnology, and the like, to deposit thin film layers. Sputtering in vacuum environments may also be used to provide sputter cleaning, such as in ion plating.

(3) In an example, PVD may involve bombarding a sputtering target with high-energy particles, such as ions or plasma, to eject atoms or molecules from the target surface, which thereby can become vapor in the vacuum chamber. The vaporized particles may then travel through the vacuum chamber and deposit onto the substrate surface, forming a thin film layer on the substrate surface. The sputtering target is consumed and has a finite life based on erosion characteristics and usable material. The composition of the deposited film is determined by the material composition of the sputtering target and can be chosen to provide desired properties, such as conductivity, optical characteristics, adhesion, and the like.

(4) PVD processes typically require a high vacuum environment to minimize gas interference and unwanted reactions, but achieving and maintaining a high vacuum environment can be technically demanding and expensive. Moreover, the presence of residual gases or contaminants can affect the quality and properties of the deposited films. Adequate seals are needed to maintain the vacuum integrity and prevent air or other gases from entering or escaping the vacuum chamber and disrupting the controlled environment, to minimize contamination of the system, to provide system stability in the accuracy and reliability of the processes performed in the high vacuum environment as well as to satisfy other considerations such as safety assurances and energy efficiency.

SUMMARY

(5) The following presents a summary of this disclosure to provide a basic understanding of some aspects. This summary is intended to neither identify key or critical elements nor define any limitations of embodiments or claims. Furthermore, this summary may provide a simplified overview of some aspects that may be described in greater detail in other portions of this disclosure. Any of the described aspects may be isolated or combined with other described aspects without limitation to the same effect as if they had been described separately and in every possible combination explicitly.

(6) Disclosed is a vacuum seal and seal system including a corresponding isolation ring and a corresponding sputtering target. The seal and seal system may be used in PVD sputter applications. In an embodiment, the seal and seal system does not incorporate an O-ring and corresponding groove or any vent slots or scallops, or other shapes or features having similar function. The seal may include a compressible portion and a rigid portion. The compressible portion may include two or more higher profile protrusions and two or more lower profile recesses that facilitate formation of a vacuum seal through compression by and between the isolation ring and the sputtering target. The rigid portion may be encapsulated by the same material as the compressible portion. The seal may further include a removable and replaceable plasma shield that is attachable to a first end of the seal. The seal may further include a rim on a second end that selectively interfaces with a

corresponding step-out portion of the isolation ring. The sputtering target may have a continuous peripheral flange surface. In an embodiment, the seal and seal system is self-centering. In an embodiment, the seal and seal system provides an increased sealing surface or interface. In an embodiment, the seal and seal system provides a buffer between the sputtering target and the isolation ring.

(7) In an exemplary embodiment of the invention, a sealing ring for a physical vapor deposition (PVD) vacuum chamber is disclosed having a compressible portion, wherein the compressible portion comprises at least one protrusion and at least one recess; a rigid portion adjacent the compressible portion, wherein the rigid portion has a rib that is substantially encapsulated by a secondary material; a rim that extends from a first surface of the sealing ring and is configured to selectively couple to an isolation ring; and a removable shield that is configured to selectively couple to a first end of the compressible portion and that is configured to isolate the compressible portion from an interior of a vacuum chamber.

(8) In a further aspect, the compressible portion is made of a fluorocarbon, fluoroelastomer, and/or fluorine kautschuk material. In another aspect, the secondary material is a same material as the compressible portion and the rim. In an additional aspect, the at least one protrusion extends past the first surface and a second, opposite surface of the sealing ring. In a further aspect, the at least one recess terminates prior to the first surface and a second, opposite surface of the sealing ring. In an additional aspect, each of the at least one protrusion and each of the at least one recess alternate. In a further aspect, the compressible material and at least one recess are configured to entrap particulates.

(9) In an additional aspect, the rib of the rigid portion is comprised of aluminum. In a further aspect, the compressible portion and the rigid portion are approximately the same length. In an additional aspect, the shield is configured to snap fit with the first end of the compressible portion. In a further aspect, the shield is configured to inhibit plasma arcing and thermal degradation of the compressible portion. In an additional aspect, the shield comprises polytetrafluoroethylene. In a further aspect, the rim further includes a plurality of retention tabs. In a further aspect, the sealing ring is configured to selectively interface with the isolation ring by an interference fit, thereby forming a seal between the sealing ring and isolation ring when installed in the PVD vacuum chamber.

(10) In an additional aspect, the sealing ring is configured to self-center with the isolation ring using the plurality of retention tabs on the rim and a step-out portion of the isolation ring cut out of approximately 90 degrees. In a further aspect, a second surface of the sealing ring is configured to selectively interface with a sputtering target, thereby forming a seal between the sealing ring and sputtering target when installed in the PVD vacuum chamber. In an additional aspect, the sputtering target is devoid of any grooves, vent slots, and scallops and is configured to contact the sealing ring with a flat surface. In a further aspect, the sealing ring is configured to provide a buffer between the sputtering target and the isolation ring.

(11) In yet another embodiment, a sputtering target is disclosed having a first surface configured to selectively interface to a sealing ring on a PVD vacuum chamber, wherein the first surface is devoid of any grooves, vent slots, and scallops and is configured to contact the sealing ring with a flat surface. In another aspect, the first surface is configured to be isolated from an isolation ring and wherein the isolation ring is configured to selectively interface with an opposite side of the sealing ring on the vacuum chamber, when installed in the PVD vacuum chamber. In a further aspect,

(12) In a further embodiment, an isolation ring is provided, which includes a first surface configured to selectively interface with a compressible portion and rigid portion of a sealing ring when installed in a PVD vacuum chamber, wherein the first surface is generally flat; and a step-out portion configured to selectively interface with a rim of the sealing ring when installed in a PVD vacuum chamber. In yet another aspect, the step-out portion has a cut out of approximately 90

degrees.

(13) In an additional embodiment, a sealing kit for a vacuum chamber is provided, which includes, a sealing ring, wherein the sealing ring includes a compressible portion, a rigid portion adjacent the compressible portion, and a rim extending perpendicularly from the rigid portion. An isolation ring configured to selectively interface with a first mating surface of the isolation ring including the rim, wherein the isolation ring includes a cut out configured to selectively accommodate and contact the rim of the sealing ring, thereby forming a seal between the isolation ring and the sealing ring when installed in a PVD vacuum chamber. A sputtering target including a substantially planar first mating surface configured to selectively interface to a second mating surface of the sealing ring, thereby forming a seal between the sputtering target and the sealing ring when installed in a PVD vacuum chamber.

(14) In another aspect, the first mating surface of the sputtering target is devoid of any O-ring grooves, vent slots, and scallops. In yet another aspect, the compressible portion comprises at least one protrusion and at least one recess, wherein each of the at least one protrusion and each of the at least one recess alternate. In a further aspect, a rib of the rigid portion is suspended in a same material that comprises the compressible material and the rim. In yet another aspect, the sealing ring further includes a plasma shield configured to attach to an inner perimeter side of the compressible portion.

(15) In a further aspect, the sputtering target and the isolation ring each form a seal with the sealing ring. In another aspect, the sputtering target and the isolation ring are isolated from each other by the sealing ring.

(16) In another embodiment, a method for assembling the sealing kit is provided, which includes, placing an isolation ring on a PVD vacuum chamber, wherein the isolation ring includes a step out on a mating surface; placing a sealing ring on the mating surface of the isolation ring, the sealing ring having a first mating surface and a second mating surface on an opposite side of the first mating surface, wherein the first mating surface of the sealing ring includes a rim configured to selectively couple to the step out of the isolation ring and wherein the first mating surface of the sealing ring contacts the mating surface of the isolation ring; placing a sputtering target on the second mating surface of the sealing ring, wherein the sealing ring includes a compressible portion and a shield, and wherein the sputtering target is configured to compress the compressible portion and the shield of the sealing ring; wherein the isolation ring and the sealing ring form a seal when installed in the PVD vacuum chamber, and the sealing ring and the sputtering target form a seal when installed in the PVD vacuum chamber. In a further aspect, the sputtering target and the isolation ring are isolated from each other by the sealing ring.

(17) Also disclosed is a sealing kit for a physical vapor deposition (PVD) vacuum chamber, having a sealing ring for the PVD vacuum chamber having a compressible portion, wherein the compressible portion comprises at least one protrusion and at least one recess; a rigid portion adjacent the compressible portion, wherein the rigid portion has a rib that is substantially encapsulated by a secondary material; a rim that extends from a first surface of the sealing ring and is configured to selectively couple to an isolation ring; a removable shield that is configured to selectively couple to a first end of the compressible portion and that is configured to isolate the compressible portion from an interior of the vacuum chamber.

(18) The isolation ring, having a first surface configured to selectively interface with the compressible portion and the rigid portion of the sealing ring when installed in the PVD vacuum chamber, wherein the first surface is generally flat; a step-out portion configured to selectively interface with the rim of the sealing ring when installed in the PVD vacuum chamber. The sputtering target having a first surface with a peripheral flange surface configured to interface with the sealing ring, when installed in the PVD vacuum chamber, wherein the peripheral flange surface of the first surface is devoid of any O-ring grooves, vent slots, and scallops and is configured to contact the sealing ring with a flat surface.

(19) The following description and the drawings disclose various illustrative aspects. Some improvements and novel aspects may be expressly identified, while others may be apparent from the description and drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

- (1) The present teachings may be better understood by reference to the following detailed description taken in connection with the following illustrations, in which like reference characters refer to like parts throughout, wherein:
- (2) FIG. 1A shows an embodiment of a conventional vacuum chamber and seal comprising an O-ring inserted into a dovetail groove machined into a sputtering target;
- (3) FIG. 1B shows an enlarged view of the conventional vacuum chamber and seal in FIG. 1A comprising an O-ring inserted into a dovetail groove machined into a sputtering target;
- (4) FIGS. 1C-F shows embodiments of a conventional vacuum chamber and seal comprising an O-ring inserted into a dovetail groove machined into a sputtering target and further including an inner vent slot (i), scallop slot (ii), cross gland vent slot (iii), and outer vent slot (iv);
- (5) FIGS. 2A-F shows examples of arcing events, oxidation, nodule formation, abrasion, and redeposition that can occur with the conventional vacuum chambers and seals of FIGS. 1A-C;
- (6) FIG. 3A shows an embodiment of a seal and seal system including an isolation ring and sputtering target assembled on a vacuum chamber in accordance with aspects disclosed herein;
- (7) FIG. 3B shows an embodiment of a seal and seal system including an isolation ring and sputtering target assembled on a vacuum chamber in accordance with aspects disclosed herein;
- (8) FIG. 4A shows a top view of an embodiment of a seal in accordance with aspects disclosed herein and FIG. 4B shows a bottom view of an embodiment of a seal in accordance with aspects disclosed herein;
- (9) FIG. 5A shows an enlarged top view of an embodiment of a seal in accordance with aspects disclosed herein and FIG. 5B shows an enlarged bottom view of an embodiment of a seal in accordance with aspects disclosed herein;
- (10) FIG. 6A shows a cross-sectional top view of an embodiment of a seal in accordance with aspects disclosed herein, FIG. 6B shows a cross-sectional bottom view of an embodiment of a seal in accordance with aspects disclosed herein, and FIG. 6C shows a cross-sectional side view of an embodiment of a seal in accordance with aspects disclosed herein;
- (11) FIG. 7 shows a perspective view of an embodiment of a sputtering target in accordance with aspects disclosed herein;
- (12) FIG. 8A shows a top view of an embodiment of an isolation ring in accordance with aspects disclosed herein, FIG. 8B shows a cross-sectional side view of an embodiment of an isolation ring in accordance with aspects disclosed herein, and FIG. 8C shows an enlarged cross-sectional side view of an embodiment of an isolation ring in accordance with aspects disclosed herein;
- (13) FIGS. 9A-B show embodiments of an isolation ring as assembled on a vacuum chamber in accordance with aspects disclosed herein;
- (14) FIGS. 10A-B show embodiments of a seal as assembled on an isolation ring and vacuum chamber in accordance with aspects disclosed herein;
- (15) FIG. 11 shows an embodiment of a sputtering target to be assembled on a seal, isolation ring, and vacuum chamber in accordance with aspects disclosed herein;
- (16) FIG. 12A shows an embodiment of a vacuum chamber in accordance with aspects disclosed herein and FIG. 12B shows an embodiment of a sputtering target in accordance with aspects disclosed herein;
- (17) FIGS. 13A-B shows examples of an after-life sputtering target using the described seal and

sealing systems in accordance with aspects disclosed herein;

(18) FIGS. 14A-D shows examples of an after-life sputtering target using the described seal and sealing systems in accordance with aspects disclosed herein;

(19) FIGS. 15A-E show experimental data using the described seal and sealing systems in accordance with aspects disclosed herein.

(20) The invention may be embodied in several forms without departing from its spirit or essential characteristics. The scope of the invention is defined in the appended claims, rather than in the specific description preceding them. All embodiments that fall within the meaning and range of equivalency of the claims are therefore intended to be embraced by the claims.

DETAILED DESCRIPTION

(21) Reference will now be made in detail to exemplary embodiments of the present teachings, examples of which are illustrated in the accompanying drawings, wherein like numbered aspects refer to a common feature throughout. It is to be understood that other embodiments may be utilized and structural and functional changes may be made without departing from the respective scope of the present teachings. Moreover, features of the various embodiments may be combined or altered without departing from the scope of the present teachings. As such, the following description is presented by way of illustration only and should not limit in any way the various alternatives and modifications that may be made to the illustrated embodiments and still be within the spirit and scope of the present teachings.

(22) In this disclosure, numerous specific details provide a thorough understanding of the subject disclosure. It should be understood that aspects of this disclosure may be practiced with other embodiments not necessarily including all aspects described herein, etc.

(23) As used herein, the words “example” and “exemplary” means an instance, or illustration. The words “example” or “exemplary” do not indicate a key or preferred aspect or embodiment. The word “or” is intended to be inclusive rather than exclusive, unless context suggests otherwise. As an example, the phrase “A employs B or C,” includes any inclusive permutation (e.g., A employs B; A employs C; or A employs both B and C). As another matter, the articles “a” and “an” are generally intended to mean “one or more” unless context suggest otherwise.

(24) Further, unless context suggest otherwise, descriptions of shapes (e.g., circular, rectangular, triangular, etc.) refer to shapes meeting the definition of such shapes and general representation of such shapes. For instance, a triangular shape or generally triangular shape may include a shape that has three sides and three vertices or a shape that generally represents a triangle, such as a shape having three major sides that may or may not have straight edges, triangular like shapes with rounded vertices, etc.

(25) Disclosed is a vacuum seal and seal system including a corresponding isolation ring and a corresponding sputtering target. The seal and seal system may be used in PVD sputter applications. PVD sputter applications utilize a sputtering target to provide a material transfer under vacuum conditions. The material from the sputtering target may be vaporized by bombarding the sputtering target with high-energy particles and the vaporized material may be deposited onto a substrate surface as a thin film layer. The sputtering target may be consumed during this process.

(26) For semiconductor applications, in an example, the sputtering target may be a suitable material for vaporization and deposition on a substrate, such as, but not limited to, copper. The vacuum chamber may be used to vaporize the material from the sputtering target and deposit the material onto the substrate, such as a forming copper traces on a wafer. The material transferring from the sputtering target to the substrate can be used to create conductive paths, insulating layers, or provide barrier properties, and may otherwise be used to fabricate a circuit board or other electrical component. The vacuum conditions and seal between the sputtering target and the vacuum chamber are useful to carry out PVD and to provide a viable end product.

(27) As shown in FIGS. 1A-F, conventional sealing in PVD sputtering processes may generally comprise an O-ring 13 inserted into a O-ring groove, such as, but not limited to, a dovetail groove,

that is machined into a flange of the sputtering target 255. Such O-rings can twist and turn within the groove during assembly and PVD processes, resulting in an inadequate and unreliable seal of the vacuum chamber 5 over the life and use of the sputtering target 255 and before the sputtering target 255 is consumed. Additionally, the flange of the sputtering target 255 may generally include vent slots and/or scallops that cross the seal surface, or other shapes with similar function, see FIG. 1C-1F showing examples of an inner vent slot 21, scallop slot 22, cross gland vent slot 23, and outer vent slot 24.

(28) These conventional features, however, can weaken the flange of the sputtering target 255 and provide sources of leakage between atmosphere and the sputter environment within the vacuum chamber 5, especially under elevated and sustained pressures. As sputtering targets are consumed and mass is reduced, the physical properties of the assembly may also be compromised. Arcing events, oxidation, nodule formation, degradation, abrasion, redeposition, and particle generation often occur near or adjacent the O-ring seal, vent slots, and/or scallops, see FIGS. 2A-F for example, and can lead to inefficiency and failure in the system seal. Additionally, the single O-ring 13, relying on a single and discrete point of contact, can result in a single point fulcrum effect with the bottom contact surface 15a of isolation ring 15 during dynamic cycling of the sputtering target (A), which, in turn, causes in a single point of stress providing a seal that may be susceptible wear and malfunction.

(29) There is a need for improved vacuum sealing mechanisms for vacuum chambers and sputter applications. There is a need for an improved vacuum seal that provides one or more (or all) of the following: prevents leakage and maintains a vacuum seal over the life and use of a sputtering target; minimizes or prevents arcing events, oxidation, nodule formation, degradation, abrasion, redeposition, and/or particle generation (and associated failure of PVD due to these events) over the life and use of a sputtering target; is not susceptible to variations or fluctuations in use (e.g., twisting); provides consistent application and stabilization of the components; achieves self-leveling and self-centering during assembly; minimizes or eliminates vent slots and/or scallops; minimizes or eliminates grooves in the sputtering target surface; eliminates the single point fulcrum effect of conventional systems; provides an increased sealing surface or interface; incorporates an intrinsic occlusion mechanism to trap and eliminate potential particles from entering the vacuum chamber that can occur during dynamic cycling; includes an integral plasma shield to protect the seal from high energy ionized gas (plasma) attack and thermal degradation; provides a buffer between the sputtering target and the isolation ring; and the like.

(30) In an embodiment, the seal and seal system eliminates the requirement for an O-ring and corresponding groove or any vent slots or scallops in the sputtering target, such as a backing plate in a non-monolithic sputtering target or flange of a monolithic sputtering target. The sputtering target may have a continuous peripheral flange surface. In an embodiment, the seal and seal system is self-centering. In an embodiment, the seal and seal system provides an increased sealing surface or interface. In an embodiment, the seal and seal system provides a buffer between the sputtering target and the isolation ring.

(31) The disclosed seal and seal system may provide one or more (or all) of the following: prevents leakage and maintains a vacuum seal over the life and use of a sputtering target; minimizes or prevents arcing events, oxidation, nodule formation, degradation, abrasion, redeposition, and/or particle generation (and associated failure of PVD due to these events) over the life and use of a sputtering target; is not susceptible to variations or fluctuations in use (e.g., twisting); provides consistent application and stabilization of the components; achieves self-leveling and self-centering during assembly; minimizes or eliminates vent slots and/or scallops; minimizes or eliminates grooves in the sputtering target surface; eliminates the single point fulcrum effect of conventional systems; provides an increased sealing surface or interface; incorporates an intrinsic occlusion mechanism to trap and eliminate potential particles from entering the vacuum chamber that can occur during dynamic cycling; includes an integral plasma shield to protect the seal from high

energy ionized gas (plasma) attack and thermal degradation; provides a buffer between the sputtering target and the isolation ring; and the like.

(32) Turning to FIG. 3-6, shown is a sealing ring **100** that may be used as part of a sealing system **400**, including a corresponding isolation ring **210** and/or a corresponding sputtering target **255**. Isolation ring **210** may selectively interface with a vacuum chamber **5**. Sealing ring **100** may selectively interface with isolation ring **210**. Sputtering target **255** may selectively interface with sealing ring **100**. The assembly of isolation ring **210**, sealing ring **100**, and sputtering target **255** (comprising sealing system **400**) onto vacuum chamber **5** may provide a vacuum seal between sputtering target **255** and vacuum chamber **5**, enabling PVD processes to be performed while containing plasma within the vacuum chamber **5**.

(33) FIGS. 9-11, for example, show assembly of the isolation ring **210** onto vacuum chamber **5**, followed by assembly of sealing ring **100** onto isolation ring **210**, followed by assembly of sputtering target **255** onto sealing ring **100**. In an embodiment, each of the sealing ring **100**, isolation ring **210**, and sputtering target **255** may be generally concentric and sized and shaped to fit onto the vacuum chamber, such as vacuum chamber **5**. In an embodiment, each of the sealing ring **100**, isolation ring **210**, and sputtering target **255** may be attached with an interference or friction fit. It is noted that other attachment mechanisms may also be used. Assembly of the sealing ring **100**, isolation ring **210**, and sputtering target **255** may be fast, e.g., achieved in under 5 minutes, in under 1 minute, in under 30 seconds, etc. Components of the sealing ring **100**, isolation ring **210**, and sputtering target **255**, such as rim portion **140** with retention tabs **144**, and the like, may facilitate fast assembly and features such as self-centering and self-leveling.

(34) Sealing ring **100** may generally include a planar portion **148** and a rim portion **140**. The planar portion **148** having a first side (or surface) **102** and a second side (or surface) **104**. In an embodiment, first side **102** of sealing ring **100** may be understood as an isolation ring facing side that may be selectively coupled with a corresponding side of isolation ring **210**. In an embodiment, second side **104** of sealing ring **100** may be understood as a sputtering target facing side that may be selectively interfaced with a corresponding side of sputtering target **255**. It is noted that first side **102** may also be referred to as an underside of sealing ring **100** and second side **104** may also be referred to as a top side of sealing ring **100**. When assembled, the first side (or surface) **102** may contact (interface with) isolation ring **210** and second side (or surface) **104** may contact (interface with) sputtering target **255**. In an embodiment, sealing ring **100** may serve as a buffer and separation between isolation ring **210** and sputtering target **255** so that isolation ring **210** and sputtering target **255** do not make contact with one another when assembled in vacuum chamber **5**.

(35) Planar portion **148** of sealing ring **100** may include a compressible portion **110** that extends towards a center of the sealing ring **100**. In an embodiment, compressible portion **110** may include one or more higher profile protrusions that extend away from a horizontal axis **150** of the sealing ring **100**, e.g., protrusions **113**. The planar portion **148** includes a horizontal axis **150**. In an embodiment, the horizontal axis **150** that is located midway between the peak of the protrusions **113** on the first side **102** and the peak of the protrusions **113** on the second side **104**, and one or more lower profile recesses that narrow toward a horizontal axis **150** of the sealing ring **100**, e.g., recess **116**. In an embodiment, compressible portion **110** may include two or more higher profile protrusions **113**. For example, compressible portion **110** may include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, etc., higher profile protrusions **113**. In an embodiment, compressible portion **110** may include two or more lower profile recesses **116**. For example, compressible portion **110** may include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, etc., lower profile recesses **116**. Protrusions **113** and recesses **116** may alternate. In an embodiment, compressible portion **110** may include n protrusions **113** and n-1 recesses **116**. For example, compressible portion **110** may include two protrusions **113** and one recess **116**. The one recess **116** may be positioned in between the two protrusions **113**. In an embodiment, compressible portion **110** may include n protrusions **113** and n+1 recesses **116**. For example, compressible portion **110** may include two protrusions **113** and three recess **116**. One

recess **116** may be positioned in between the two protrusions **113** and each of the other two recesses **116** may be positioned on the other side of each protrusions **113**, so that the resulting pattern resembles recess, protrusion, recess, protrusion, recess. It is noted that other quantities, positions, and patterns of protrusions **113** and recesses **116** may also be used in compressible portion **110**.

(36) In an embodiment, protrusions **113** may extend beyond the rest of the profile of the sealing ring **100** on the second side **104**. Stated alternatively, protrusions **113** may extend further away from the horizontal axis **150** than any other feature on first side **102** of the sealing ring **100**. Further, protrusions **113** may extend beyond the rest of the profile of the sealing ring **100** on the first side **102**, except for the rim portion **140**. Stated alternatively, protrusions **113** may extend further away from the horizontal axis **150** than any other feature on second side **104** of the sealing ring **100**, except for the rim portion **140**. In an exemplary embodiment, protrusions **113** may have a greater height or diameter than the rest of the profile of the sealing ring **100** (not including rim portion **140**). In an embodiment, recess **116** may terminate before the rest of the profile of the sealing ring **100**. In an embodiment, recess **116** may have a smaller height or diameter than the rest of the profile of the sealing ring **100**. In an exemplary embodiment, protrusions **113** may extend past first surface **102**. In an exemplary embodiment, protrusions **113** may extend past second surface **104**. In an exemplary embodiment, protrusions **113** may extend past both first surface **102** and second surface **104**. In an exemplary embodiment, protrusions **113** may be generally rounded or circular. It is noted that other shapes may also be used unless context or this disclosure suggest otherwise. In an exemplary embodiment, recesses **116** may terminate before first surface **102**. In an example, recesses **116** may terminate before second surface **104**. In an exemplary embodiment, recesses **116** may terminate before both first surface **102** and second surface **104**. Further, in an exemplary embodiment, recesses **116** may extend below first surface **102** toward the horizontal axis **150** of sealing ring **100**. In an exemplary embodiment, recesses **116** may terminate below the second surface **104** toward the horizontal axis **150** of sealing ring **100**. In an exemplary embodiment, recesses **116** may terminate below both first surface **102** and second surface **104** toward the horizontal axis **150** of sealing ring **100**. In an exemplary embodiment, recesses **116** may be generally rounded or concaved. It is noted that other shapes may also be used unless context or this disclosure suggest otherwise.

(37) Compressible portion **110** may comprise any compressible material or combination of materials as may be desired or suitable for a particular purpose or intended application. In an embodiment, compressible portion **110** may comprise a fluorocarbon, fluoroelastomer, or fluorine kautschuk material (FKM) composition. Materials may be selected based on their durometer, in an example. Materials may be selected based on their compressibility and/or resilience, in an example. Materials may be selected based on their heat resistance, in an example. Other materials may include, but are not limited to, polymers such as polyurethane, ethylene propylene diene monomer, styrene-butadiene rubber, thermoplastic elastomers, and the like, other natural rubbers or silicone rubbers, neoprene, expanded polytetrafluoroethylene, foam materials such as polyurethane foam, combinations of two or more thereof, and the like.

(38) Protrusions **113** may serve as contact or compression points that selectively contact a corresponding surface of the isolation ring **210** and/or a corresponding surface of the sputtering target **255** wherein the corresponding surface of the isolation ring **210** and/or the corresponding surface of the sputtering target **255** selectively compress the protrusions **113** until the corresponding surface of the isolation ring **210** and/or the corresponding surface of the sputtering target **255** contact the remaining body portion of sealing ring **100** (e.g., rigid portion **130**, shield **190**, etc.). Recesses **116** may generally provide clearance for the compressed protrusions **113** and enable the protrusions **113** to be compressed into recesses **116** to achieve a vacuum seal. The compressible portion **110** may generally facilitate formation of a vacuum seal through compression of the protrusions **113** by and between the isolation ring **210** and/or the sputtering target **255**.

(39) Sealing ring **100** may provide a radially concentric seal that enables separation of high vacuum

(sputter) environment, e.g., within vacuum chamber **5** where sputtering occurs, from atmosphere during dynamic cycling that occurs throughout PVD processes.

(40) In an embodiment, the greater or longer the compressible portion **110** extends toward the center of the sealing ring **100** and the more protrusions **113** or contact points, the greater contact area. Protrusions **113** may be semi-circle in shape. The greater contact area may provide a greater longevity of the vacuum seal and may provide additional rigidity and structure to the sealing ring **100**. Multiple contact points, e.g., multiple protrusions **113**, may provide duplicity in the vacuum seal so that the vacuum seal may be sustained and may not be as susceptible to weaknesses such as leakage during the use and life of the sputtering target **255**. In an exemplary embodiment, protrusions **113** may be spaced apart by about 0.150". Stated alternatively, a vertical axis **113a** of each of the consecutive protrusions **113** may be spaced apart by about 0.150", when measured along horizontal axis **150**, such as when travelling along the horizontal axis **150** from outside wall **147** to the center of the sealing ring **100**. Each of the protrusions **113a** having a vertical axis **113a**. Further, in an exemplary embodiment, the inner most protrusion **113** (protrusion closest to the center of the sealing ring **100**) may be located about 0.255" from the tip **190a** of the shield **190**. Further, in an exemplary embodiment, the inner most protrusion **113** (protrusion closest to the center of the sealing ring **100**) may be located about 0.255" from the inner diameter of the shield **190**. In an exemplary embodiment, protrusion **113** may have a height of about 0.114"-0.124", when measured from a top **113b** to a bottom **113c** of a protrusion **113** in a vertical direction along vertical axis **113a**.

(41) Additionally, multiple contact points, e.g., multiple protrusions **113**, may provide occlusion mechanisms that entrap gases and particulate within the annulus of sealing ring **100** and compressible portion **110** while allowing sufficiently high contact forces to form the vacuum seal. Sealing ring **100** may increase contact areas on a flange portion of the sputtering target **255** while allowing sufficient contact forces on the sealing ring **100** that can help reduce sputtering target flange movement through life of the sputtering target **255**. In an embodiment, flat gasket type seals can require impractical contact forces to seal that vacuum forces alone will not provide.

(42) Sealing ring **100** may further comprise a rigid portion **130**. In an embodiment, rigid portion **130** may be positioned adjacent compressible portion **110**. In an embodiment, rigid portion **130** may be positioned further away from the center of sealing ring **100** (e.g., toward an ambient environment), when compared to the position of the compressible portion **110**, which is positioned closer to the center of the sealing ring **100**, when compared to the position of the rigid portion **130** (e.g., toward an interior of vacuum chamber **5**).

(43) Rigid portion **130** may be more rigid than compressible portion **110**. A rib **131** may be present in rigid portion to provide rigidity. Rib **131** may comprise any rigid material or combination of materials as may be desired or suitable for a particular purpose or intended application. In an embodiment, rib **131** may comprise aluminum. It is noted that any other non-magnetic materials with appropriate mechanical properties may also be used. Materials may be selected based on their durometer, in an example. Materials may be selected based on their rigidity, non-magnetic properties, conductive properties, and the like, in an example. Other materials may include, but are not limited to, certain grades of stainless steel, titanium, brass, carbon fiber reinforced polymers, ceramics such as alumina and zirconia, fiberglass, and the like.

(44) Rib **131** of rigid portion **130** may be encapsulated by or suspended within the same material as the compressible portion **110**. Rib **131** may be encapsulated by or suspended within a similar material as the compressible portion **110**. Rib **131** may be fully encapsulated by a compressible material. Rib **131** may be substantially encapsulated by a compressible material. Rib **131** may be partially encapsulated by a compressible material. A horizontal axis of the rigid portion **130** may be located along a horizontal axis **150** of the sealing ring **100**. Further, a horizontal axis of rib **131** may be located along a horizontal axis **150** of the sealing ring **100**. For example, rib **131** may be fully encapsulated by a compressible material except for several cutouts or apertures **120** that are used to

suspend rib **131** in a mold to apply the compressible material thereon. In an embodiment, rib **131** may be exposed through the cutouts or apertures **120** in the compressible material in the rigid portion **130**. The coating or encapsulation may prevent or minimize arcing between rigid portion **130** and sputtering target **255**. In an embodiment, the thickness of the coating or encapsulation at rigid portion **130** (on each side above and below rib **131**) may be about 0.084"-0.096". In other embodiments, the thickness of the coating or encapsulation at the rigid portion may be about 0.080"-0.010". In further exemplary embodiments, the thickness of the coating or encapsulation at the rigid portion may be about 0.076"-0.014".

(45) In other embodiments, the thickness of the coating or encapsulation at rigid portion **130** (on each side above and below the rib **131**) may be about 0.014". In other embodiments, the thickness of the coating or encapsulation at rigid portion **130** between a top surface **131a** of the rib **131** and second side **104** may be about 0.014" and the thickness of the coating or encapsulation at rigid portion **130** between a bottom surface **131b** of the rib **131** and first side **102** may be about 0.013". In another exemplary embodiment, the thickness of the coating or encapsulation at rigid portion **130** between the bottom surface **131b** of the rib **131** and first side **102** may be about 0.008"-0.018". In other embodiments, the thickness of the coating or encapsulation between a rear surface **131d** of the rib **131** and the second end **108** of the sealing ring **100** may be about 0.07". The coating or encapsulation may prevent or minimize abrasion from the isolation ring **210** and/or sputtering target **255**. In an embodiment, rigid portion **130** may be approximately the same size in width relative compressible portion **110**. In an embodiment, rigid portion **130** may be smaller in length than compressible portion **110**. In an embodiment, rigid portion **130** may be larger in length than compressible portion **110**. The rib **131** may have a thickness of 0.063" (distance between the top surface **131a** and bottom surface **131b** of the rib portion **131**). The rib **131** may also have a width of about 0.45" (distance between the inner surface **131c** and the outer surface **131d** along the horizontal cross-section of rigid portion **130** (or rib **131**), stated alternatively, along the horizontal axis **150**).

(46) Rigid portion **130** may provide support, rigidity, and/or stability to sealing ring **100**. Rigid portion **130** may provide strength to sealing ring **100** during dynamic sputter cycling and may help to eliminate excessive flange sputtering target **255** to isolation ring **210** movement. Rigid portion **130** may eliminate or minimize mechanical abrasion and particle generation resulting from proximity movements from the flange of sputtering target **255** (flange of backing plate **260** of sputtering target **255** of non-monolithic target or peripheral flange of monolithic sputtering target **255**) and isolation ring **210**. In an exemplary embodiment, the inner diameter of the rib **131** measured from the inner surface **131c** of the rib **131** may be about 19.57"-19.63" and the outer diameter of the rib **131** measured from the outer surface **131d** of the rib **131** may be about 20.47"-20.53".

(47) Sealing ring **100** may generally include a first end **106** and a second end **108**. In an embodiment, first end **106** may be an inner perimeter end of sealing ring **100** located toward a center of the sealing ring **100**. In an embodiment, second end **108** may be an outer perimeter end of sealing ring **100** located opposite of the first end **106** and away from a center of the sealing ring **100**. First end **106** may extend from the compressible portion **110** toward the center of the sealing ring **100**. First end **106** may be attached to and positioned adjacent the compressible portion **110** of sealing ring **100**. First end **106** may comprise the same or similar material as compressible portion **110**. In an embodiment, compressible portion **110** may be positioned between rigid portion **130** and first end **106**. First end **106** may be configured to selectively receive a shield **190**. Shield **190** may be configured to cover all or at least a portion of first end **106**. Shield **190** may be configured to isolate and protect compressible portion **110** and the rest of sealing ring **100** from the vacuum environment in vacuum chamber **5**, such as providing protection from the plasma in vacuum chamber **5**. Shield **190** may be selectively removable from compressible portion **110** sealing ring **100** and may be replaceable. First end **106** may be configured to selectively receive a shield **190**

with a snap-fit engagement. It is noted that other connection mechanisms may also be utilized as may be desired or suitable for a particular purpose or intended application. In an embodiment, first end **106** of sealing ring **100** may be tapered. In an embodiment, first end **106** of sealing ring **100** may be referred to as a c-shape. In an embodiment, first end **106** of sealing ring **100** may be referred to as a snake-head shape. In an example, first end **106** of sealing ring **100** may include a ramp up portion having a gradual increase in slope and a slot. In an example, shield **190** may include a hollow portion generally sized and shaped to correspond to the tapered or snake-head shape of the first end **106** of sealing ring **100** and a snap finger that is configured to insert into slot. Snap finger may be inserted over the ramp up portion having a gradual increase in slope of the first end **106** of sealing ring **100** until the snap finger inserts and locks into slot. The shape of shield **190** may be configured so that shield **190** is pinched onto first end **106** of sealing ring **100** during assembly of the seal system **400** and upon pressure from sputtering target **255** and isolation ring **210**. In an exemplary embodiment, shield **190** may have an inner diameter of about 18.585"-18.645", when measured from a tip **190a** of the shield **190**. In an exemplary embodiment, shield **190** may have an inner diameter of about 19.095"-19.155", when measured from a base **190b** of the shield **190**.

(48) As shown in FIG. 3A, shield **190** may have a curved or rounded shape c-shape that has a relatively slim profile and that is sized and shaped to reflect the first end **106** of sealing ring **100**. As shown in FIG. 3B, shield **190** may have an elongated tear-drop shape that extends into the interior of vacuum chamber **5** towards a center of the sealing ring **100**. In an embodiment, elongated tear-drop shape of shield **190** may extend onto and over an interior edge of isolation ring **210**. It is noted that other shapes, thicknesses, and sizes of shield **190** may also be incorporated. In an exemplary embodiment, shield **190** may have a width of 0.130" along the horizontal axis **150**, when measured from tip **190a** to base **190b**. In another exemplary embodiment, shield **190** may have a height of about 0.114"-0.124" when measured in a vertical direction (parallel to vertical axis **113a**) perpendicular to the horizontal axis **150**.

(49) Shield **190** may comprise any plasma suppression material or combination of materials as may be desired or suitable for a particular purpose or intended application. In an embodiment, shield **190** may comprise plasma inhibiting polytetrafluoroethylene (PTFE) material which is a synthetic fluoropolymer of tetrafluoroethylene. It is noted that any other materials that inhibit plasma and thermal damage may also be used. Materials may be selected based on their low coefficient of friction, in an example. Other materials may include, but are not limited to, polyimide, ceramics such as alumina and boron nitride, molybdenum disulfide, fluorinated ethylene propylene, and the like.

(50) In an embodiment, shield **190** may be referred to as a plasma shield. In an embodiment, shield **190** may provide plasma arc suppression and protect the vacuum seal by inhibiting plasma arcing and thermal degradation of the vacuum seal material.

(51) Therefore, the planar portion **148** of sealing ring **100** has a shield **190**, compressible portion **110** and rigid portion **130**, when traveling outward from the center of the sealing ring **100** along the horizontal axis **150**.

(52) Sealing ring **100** may further comprise a rim portion **140** situated on the first surface **102** and forming an "L" with the planar portion **148**. The rim portion **140** has an inside wall **142** oriented toward the center of the sealing ring **100** perpendicular to the first surface **102**, an outside wall **147** located on the exterior perimeter of sealing ring **100** perpendicular to the first surface, and a bottom wall **146** connecting a bottom **142a** of inside wall **142** and a bottom **147a** of outside wall **147**. Inside wall **142** may be oriented toward the center of sealing ring **100**. Bottom wall **146** may be oriented perpendicular to inside wall **142** and outside wall **147** to form a "U". The outside wall **147** and second end **108** may form a continuous surface linearly equidistant from first end **106** when measured along the horizontal axis **150** of planar portion **148**. In an exemplary embodiment, rim portion **140** may be positioned adjacent rigid portion **130** of planar portion **148**. In an exemplary

embodiment, rim portion **140** may be positioned at the second end **108** of sealing ring **100**. In an exemplary embodiment, rim portion **140** may extend perpendicular from rigid portion **130** and compressible portion **110** on the isolation ring facing first surface **102** of sealing ring **100**. In an exemplary embodiment, sealing ring **100** may have an L-shape. Rim portion **140**, rigid portion **130**, and compressible portion **110** may be provided as a single, attached unit. Rim portion **140** may comprise the same material as the compressible portion **110**. Rim portion **140** may comprise a similar material as the compressible portion **110**. Rim portion **140** may be configured to selectively couple with a corresponding step-out portion **213** of isolation ring **210**. Both inside wall **142** and bottom wall **146** (or inside wall **142**, retention tabs **144**, and/or bottom wall **146**) may selectively engage with corresponding walls of the step-out portion **213** of isolation ring **210**.

(53) In an exemplary embodiment, the sealing ring **100** may have a thickness of about 0.270" when measured at the rim portion **140**. Stated alternatively, in an exemplary embodiment, the distance between the bottom wall **146** and second side **104** of the sealing ring **100** may be about 0.270". Further, in another exemplary embodiment, the sealing ring **100** may have a thickness of about 0.085"-0.095" at the rigid portion **130**. Stated alternatively, in an exemplary embodiment, the distance between the first side **102** and second side **104** of the sealing ring **100** at the rigid portion **130** may be about 0.085"-0.095". In further exemplary embodiments, the diameter of the second end **108** of the sealing ring **100** may be about 20.585"-20.645". In another exemplary embodiment, the diameter of the inside wall **142** of the sealing ring **100**, at locations where a retention tab **144** is not present, may be about 20.325"-20.385".

(54) Rim portion **140** may further include one or more (or a plurality of) retention tabs **144** positioned on and extending from inside wall **142** along the inner perimeter of the rim portion **140** toward the center of sealing ring **100**. In an exemplary embodiment, the plurality of retention tabs **144** may be positioned equidistant along a circumference of inside wall **142**. In an exemplary embodiment, the plurality of retention tabs **144** may be positioned at varying distances along the circumference of inside wall **142**. In an exemplary embodiment, rim portion **140** may include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 30, etc. retention tabs **144**. Retention tabs **144** may be semi-circular in shape and extend from the bottom wall **146** (or bottom of inside wall **142a**) to first side **102**. Retention tabs **144** may have a chamfer near the bottom wall **146** (or bottom of inside wall **142a**) to aid in placement of the sealing ring **100** onto the isolation ring **210**. In an exemplary embodiment, an inner surface **144a** of the retention tabs **144** may be about 10.10" from a center of the sealing ring **100**. The inner surface **144a** is the surface of tab **144** that is closest to the center of the sealing ring **100** while travelling along the horizontal axis **150**.

(55) In an exemplary embodiment, rim portion **140** may provide ease of alignment of sealing ring **100** onto isolation ring **210** during assembly of the seal system **400**. In an exemplary embodiment, retention tabs **144** may provide self-centering of sealing ring **100** onto isolation ring **210**. In an exemplary embodiment, retention tabs **144** may grip onto isolation ring **210** and may secure sealing ring **100** to isolation ring **210**. In an exemplary embodiment, sealing ring **100** may be applied upside down, e.g., to an isolation ring **210** that is above sealing ring **100** and the retention tabs **144** may hold and secure sealing ring **100** to the upside down isolation ring **210** (e.g. retention tabs may hold and secure sealing ring **100** onto the isolation ring **210**, when isolation ring **210** and sealing ring **100** are inverted such that isolation ring **210** is oriented above sealing ring **100** and sealing ring **100** is being pulled away from isolation ring **210** by gravity).

(56) Turning to FIG. 7, shown is sputtering target **255** comprising seal mating surface **259**. As described, seal mating surface **259** may be a generally continuous and/or smooth flange surface, i.e., a surface devoid of any grooves, vent slots, scallops, and other shapes or features having similar function see also FIGS. 3A-B. In an exemplary embodiment, the flange (seal mating surface **259**) of the backing plate **260** of sputtering target **255** is featureless. In an embodiment, sputtering target **255** eliminates the conventional O-ring seal, groove, vent slots, scallops, and other shapes or features having similar function shown in FIGS. 1A-F which may be susceptible to the failures

shown in FIGS. 2A-F, including arcing events, oxidation, nodule formation, degradation, abrasion, redeposition, and particle generation often occur near or adjacent the O-ring seal, vent slots, and/or scallops. In an exemplary embodiment, sputtering target **255** also eliminates the radial single point fulcrum in conventional sputtering target vacuum chamber assemblies that can contribute to the mechanical movement of components during dynamic sputter cycling of the sputtering target **255**.

(57) Seal mating surface **259** of sputtering target **255** (e.g the flange of the backing plate **260** of the sputtering target **255** of non-monolithic target or peripheral flange of monolithic sputtering target **255**) may be configured to selectively interface with sealing ring **100**. Seal mating surface **259** of sputtering target **255** may be configured to selectively interface with second side **104** of sealing ring **100**, including compressible portion **110**, rigid portion **130** (encapsulated by a compressible material), and shield **190**. Sputtering target **255** may provides a vacuum seal with sealing ring **100**.

(58) Sputtering target **255** may comprise any material or combination of materials as may be desired or suitable for a particular purpose or intended application. In an embodiment, sputtering target **255** may comprise copper, titanium, gold, and the like. It is noted that any other metals, alloys, oxides, and nitrides thereof materials may also be used. Materials may be selected based on their sputtering capabilities, in an example. Other materials may include, but are not limited to, aluminum, tungsten, nickel, silicon, germanium, and the like.

(59) Turning to FIGS. 8A-C, shown is isolation ring **210** comprising seal mating surface **216** and rim mating step out **213**. As described, seal mating surface **216** (top surface) may be a generally continuous and/or smooth surface and rim mating step out **213** may provide a step out **213** on an outer circumference of the isolation ring **210**. Rim mating step out **213** may be configured to selectively engage both inside wall **142** and bottom wall **146** of the rim portion **140** (or inside wall **142** and retention tabs **144**). Rim mating step out **213** may generally have a cut out of approximately 90 degrees. In an exemplary embodiment, step out **213** may be formed by cutting vertically and horizontally into the top of the outer diameter of the isolation ring **210**. Stated alternatively, in an exemplary embodiment, step out **213** may be formed in the mating surface **216** and outer surface **217** of the isolation ring **210**, thereby creating a vertical face **218** and horizontal face **219** of the step out **213**. In an exemplary embodiment, once the step out **213** is formed in the isolation ring, the vertical face **218** may be offset by about 0.200" from the outer surface **217** and the horizontal face **219** may be offset by about 0.200" from the mating surface **216**. In an exemplary embodiment, the inner diameter of the isolation ring **210** may be about 18.505", when measured at the inner surface **220** of the isolation ring **210**. In a further exemplary embodiment, the outer diameter of the isolation ring **210** may be about 20.625", when measured at the outer surface **217** of the isolation ring **210**. In an additional exemplary embodiment, the diameter of the isolation ring **210** may be about 20.225", when measured at the vertical face **218** of the step out **213** of the isolation ring **210**. In a further exemplary embodiment, the thickness of the isolation ring **210** may be about 0.538", when measured from mating surface **216** to a bottom surface **221** of isolation ring **210**. In an additional exemplary embodiment, the thickness of the isolation ring **210** may be about 0.338", when measured from horizontal face **219** to a bottom surface **221** of the isolation ring **210**. In another exemplary embodiment, the width of the isolation ring **210** may be about 1.06", when measured from the outer surface **217** to inner surface **220**. The outer surface **217** is located opposite of the inner surface **220**.

(60) Seal mating surface **216** of isolation ring **210** may be configured to selectively couple with sealing ring **100**. Seal mating surface **216** of isolation ring **210** may be configured to selectively couple with first side **102** of sealing ring **100**, including compressible portion **110**, rigid portion **130** (encapsulated by a compressible material), shield **190**, and rim portion **140**. Isolation ring **210** may provide a vacuum seal with sealing ring **100**. Together the sealing ring **100**, sputtering target **255**, and isolation ring **210** may also provide an increased sealing surface or interface and a buffer between sputtering target **255** and isolation ring **210**.

(61) Isolation ring **210** may comprise any material or combination of materials as may be desired or

suitable for a particular purpose or intended application. In an embodiment, isolation ring **210** may comprise a highly polished ceramic dielectric material. It is noted that any other materials that can electrically isolate the sputtering target **255** from the vacuum chamber **5** may also be used. Materials may be selected based on their electrical insulation, in an example. Other materials may include, but are not limited to, glass, plastics and polymers such as polyethylene (PE), polypropylene (PP), polycarbonate (PC), polyimide (PI), and polytetrafluoroethylene (PTFE), mica, epoxy resin, polyethylene terephthalate (PET), and the like.

(62) FIGS. **13A-B** and **14A-D** show end of life sputtering targets **255** using sealing ring **100** and sealing system **400**. The resulting sputtering target **255** shows no indication of arcing, particles, or flange abrasion. Additionally, sidewall oxide formation is consistently controlled.

(63) FIGS. **15A-E** show various experiential data taken during the life of sputtering target **255** using sealing ring **100** and sealing system **400**. For example, FIG. **15A** indicates the observed bake-out. FIG. **15B** indicates that no helium leakage was observed at the seal. FIG. **15C** indicates that the gas load was stable during processing of the sputtering target **255**. FIG. **15D** indicates that no arc discharge events were captured during the sputtering target **255** life. FIG. **15E** indicates the idle mode chamber pressure was stable throughout the sputtering target **255** life.

(64) Although the embodiments of the present teachings have been illustrated in the accompanying drawings and described in the foregoing detailed description, it is to be understood that the present teachings are not to be limited to just the embodiments disclosed, but that the present teachings described herein are capable of numerous rearrangements, modifications and substitutions without departing from the scope of the claims hereafter. The claims as follows are intended to include all modifications and alterations insofar as they come within the scope of the claims or the equivalent thereof.

Claims

1. A sealing kit for a physical vapor deposition (PVD) vacuum chamber, comprising: a sealing ring for the PVD vacuum chamber comprising: a compressible portion, wherein the compressible portion comprises at least one protrusion and at least one recess; a rigid portion adjacent the compressible portion, wherein the rigid portion has a rib that is substantially encapsulated by a secondary material; a rim that extends from a first surface of the sealing ring and is configured to selectively couple to an isolation ring; a removable shield that is configured to selectively couple to a first end of the compressible portion and that is configured to isolate the compressible portion from an interior of the vacuum chamber; the isolation ring, comprising: a first surface configured to selectively interface with the compressible portion and the rigid portion of the sealing ring when installed in the PVD vacuum chamber, wherein the first surface is generally flat; a step-out portion configured to selectively interface with the rim of the sealing ring when installed in the PVD vacuum chamber; and a sputtering target, comprising: a peripheral flange surface of a first surface configured to interface with the sealing ring, when installed in the PVD vacuum chamber, wherein the peripheral flange surface is devoid of any O-ring grooves, vent slots, and scallops and is configured to contact the sealing ring with a flat surface.

2. A sealing ring for a physical vapor deposition (PVD) vacuum chamber comprising: a compressible portion, wherein the compressible portion comprises at least one protrusion and at least one recess; a rigid portion adjacent the compressible portion, wherein the rigid portion has a rib that is substantially encapsulated by a secondary material; a rim that extends from a first surface of the sealing ring and is configured to selectively couple to an isolation ring; a removable shield that is configured to selectively couple to a first end of the compressible portion and that is configured to isolate the compressible portion from an interior of a vacuum chamber.

3. The sealing ring of claim 2, wherein the compressible portion comprises a fluorocarbon, fluoroelastomer, and/or fluorine kautschuk material.

4. The sealing ring of claim 2, wherein the secondary material is a same material as the compressible portion and the rim.
5. The sealing ring of claim 2, wherein the at least one protrusion extends past the first surface and a second, opposite surface of the sealing ring.
6. The sealing ring of claim 2, wherein the at least one recess terminates prior to the first surface and a second, opposite surface of the sealing ring.
7. The sealing ring of claim 2, wherein each of the at least one protrusion and each of the at least one recess alternate.
8. The sealing ring of claim 2, wherein the compressible material and at least one recess are configured to entrap particulates.
9. The sealing ring of claim 2, wherein the rib of the rigid portion is comprised of aluminum.
10. The sealing ring of claim 2, wherein the compressible portion and the rigid portion are approximately the same length.
11. The sealing ring of claim 2, wherein the shield is configured to snap fit with the first end of the compressible portion.
12. The sealing ring of claim 2, wherein the shield is configured to inhibit plasma arcing and thermal degradation of the compressible portion.
13. The sealing ring of claim 2, wherein the shield comprises polytetrafluoroethylene.
14. The sealing ring of claim 2, wherein the rim further includes a plurality of retention tabs.
15. The sealing ring of claim 2, wherein the sealing ring is configured to selectively interface with the isolation ring by an interference fit, thereby forming a seal between the sealing ring and isolation ring when installed in the PVD vacuum chamber.
16. The sealing ring of claim 2, wherein the sealing ring is configured to self-center with the isolation ring using the plurality of retention tabs on the rim and a step-out portion of the isolation ring cut out of approximately 90 degrees.
17. The sealing ring of claim 2, wherein a second surface of the sealing ring is configured to selectively interface with a sputtering target, thereby forming a seal between the sealing ring and sputtering target when installed in the PVD vacuum chamber.
18. The sealing ring of claim 17, wherein the sputtering target is devoid of any grooves, vent slots, and scallops and is configured to contact the sealing ring with a flat surface.
19. The sealing ring of claim 17, wherein the sealing ring is configured to provide a buffer between the sputtering target and the isolation ring.
20. A sealing kit for a vacuum chamber, comprising: a sealing ring, wherein the sealing ring includes a compressible portion, a rigid portion adjacent the compressible portion, and a rim extending perpendicularly from the rigid portion, an isolation ring configured to selectively interface with a first mating surface of the isolation ring including the rim, wherein the isolation ring includes a cut out configured to selectively accommodate and contact the rim of the sealing ring, thereby forming a seal between the isolation ring and the sealing ring when installed in a PVD vacuum chamber; a sputtering target comprising a substantially planar first mating surface configured to selectively interface to a second mating surface of the sealing ring, thereby forming a seal between the sputtering target and the sealing ring when installed in a PVD vacuum chamber.
21. The sealing kit of claim 20, wherein the first mating surface of the sputtering target is devoid of any grooves, vent slots, and scallops.
22. The sealing kit of claim 20, wherein the compressible portion comprises at least one protrusion and at least one recess, wherein each of the at least one protrusion and each of the at least one recess alternate.
23. The sealing kit of claim 20, wherein a rib of the rigid portion is suspended in a same material that comprises the compressible material and the rim.
24. The sealing kit of claim 20, wherein the sealing ring further includes a plasma shield configured to attach to an inner perimeter side of the compressible portion.

25. The sealing kit of claim 20, wherein the sputtering target and the isolation ring each form a seal with the sealing ring.
26. The sealing kit of claim 20, wherein the sputtering target and the isolation ring are isolated from each other by the sealing ring.
27. A method for assembling the sealing kit of claim 20, comprising: placing an isolation ring on a PVD vacuum chamber, wherein the isolation ring includes a step out on a mating surface; placing a sealing ring on the mating surface of the isolation ring, the sealing ring having a first mating surface and a second mating surface on an opposite side of the first mating surface, wherein the first mating surface of the sealing ring includes a rim configured to selectively couple to the step out of the isolation ring and wherein the first mating surface of the sealing ring contacts the mating surface of the isolation ring; placing a sputtering target on the second mating surface of the sealing ring, wherein the sealing ring includes a compressible portion and a shield, and wherein the sputtering target is configured to compress the compressible portion and the shield of the sealing ring; wherein the isolation ring and the sealing ring form a seal when installed in the PVD vacuum chamber, and the sealing ring and the sputtering target form a seal when installed in the PVD vacuum chamber.
28. The method of claim 27, wherein the sputtering target and the isolation ring are isolated from each other by the sealing ring.
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