

**METHOD AND DESIGN FOR SPUTTER TARGET
ATTACHMENT TO A BACKING PLATE**

This application claims priority under 35 U.S.C. §119(e) of prior U.S. Provisional Patent Application No. 60/480,196 filed June 20, 2003, which is incorporated in its entirety by reference herein.

BACKGROUND OF THE INVENTION

[0001] The present invention relates to sputtering components. More particularly, the present invention relates to a mechanical method of joining the components of a sputter cathode assembly.

[0002] In the sputter application field, sputtering is widely used for depositing a film or thin layer of material from a sputter target onto a desired substrate. A sputter cathode assembly including the sputter target and an electrode can be placed together with an anode in a sputtering device or chamber filled with an inert gas. The desired substrate is positioned in the chamber near the anode with a receiving surface of the substrate oriented normally to a path between the sputter cathode assembly and the anode. A high voltage electric field is applied across the sputter cathode assembly and the anode, creating an electrical field that ionizes the inert gas and propels it toward the sputter target surface. Bombardment of the sputter target surface by the ions of inert gas dislodges material from the sputter target, which material is then deposited on the receiving surface of the substrate to form a thin layer or film.

[0003] Typically, a sputter cathode assembly includes a sputter target and an electrode in thermal and electrical contact. For instance, a metal target or metal target blank (e.g., tantalum, titanium, aluminum, copper, cobalt, tungsten, etc.) is bonded onto an electrode or a backing plate, such as a backing plate flange assembly such as copper, aluminum, or alloys thereof. To achieve the necessary thermal and electrical contact between the assembly components, the target and the backing plate can be permanently attached to each

other by a metallurgical bond such as by diffusion bonding, explosion bonding, friction welding, press fitting, epoxy cement, and the like.

[0004] The differential thermal expansion between the target material and the backing plate material which occurs when bonding is accomplished at elevated temperatures by diffusion bonding, friction welding, explosion bonding and the like, can generate very high levels of mechanical stress in the metal bodies. The mechanical stress often causes deflection of the sputter target and can cause the bond to fail so that the sputter target separates from the backing plate during the elevated temperatures attained during the sputtering process. The strain on the interface between the sputter target and the backing plate when relatively high temperatures are used to form the bond is proportional to the difference in linear thermal expansion coefficients between the target and backing plate multiplied by the bonding temperature and multiplied by the radial dimension of the target, or:

$$\varepsilon = R(\alpha_1 - \alpha_2)\Delta T \quad (\text{Eq. 1})$$

where ε is the strain at a point a distance R from the target center, α_1 and α_2 are the linear thermal expansion coefficients of the target and backing plate, respectively, and ΔT is the difference between the bonding temperature and room temperature. Generally, all units are metric and temperatures are °C. From Eq. 1, it can be seen that as the target size increases the strain on the bond will increase. In addition, the higher the bonding temperature, the higher the strain. Finally, strain increases as the difference between the thermal expansion coefficients of the target and backing plate increases. Thus, controlling strain, ε , presents a particular challenge for large area sputter cathode assemblies that are needed to coat a relatively large-area substrate, such as for a flat glass panel to be used in a flat panel display of a computer monitor or a television screen.

[0005] Another disadvantage to permanently attaching the sputter cathode assembly members by a metallurgical bond is that separating the assembly members is typically achieved in a destructive manner, such as machining or chemical etching. The backing plate flange assembly typically contains features, e.g., bolt holes, alignment marks, and/or an o-ring groove, that are difficult and expensive to machine. When the sputter target of the sputter cathode assembly is spent or otherwise deemed unusable, the entire assembly is typically returned to the processor for recycling. In assemblies in which the flange is made from the same material as the sputter target, the flange and the target are typically converted to powder or other form suitable for remelting. Otherwise, the flange is typically removed from the target and reprocessed separately. In either case, the flange is destroyed even though it and its machined features are often in a near-perfect, or at least usable condition.

[0006] A conventional method used to control the strain produced from bonding sputter targets to the electrode for large flat panel display targets is to use a low melting point solder or braze material. Although solder or low temperature brazing techniques reduce net strain via a comparatively low bonding temperature, T , the bond strength achieved can be insufficient for large sputter targets. Thus, to reduce R , multi-piece target construction in the form of several target tiles bonded to the electrode is used to maintain the strain from differential thermal expansion during cool-down from solder bonding below the failure point for the solder. By using a multi-piece construction, the differential thermal expansion stress, ϵ , is reduced. However, the solder can intrude the joints between the multi-piece target segments of the assembly and thus becomes a source of arcing and particle emission (i.e., contamination) during sputtering. Also, the sputtering behavior of the edges of the individual target tiles may differ from that of the bulk of the target array, resulting in a deposited film having diminished thickness uniformity. A schematic diagram of a typical large rectangular sputter cathode assembly with multi-piece sputter target

construction is provided in Fig. 1.

[0007] While the use of solder and brazing techniques avoids the recovery and recycle issues described above for metallurgically bonded components, change-out of a spent target of a soldered sputter cathode assembly nevertheless requires the entire assembly to be removed from the sputtering chamber so that the assembly can be heated to the soldering temperature. Likewise, use of sputter targets of different sputter materials require change-out of the entire sputter cathode assembly. This makes change-out of a sputter target a costly and time-consuming process.

[0008] Accordingly, a need exists for a sputter cathode assembly in which the bonding-induced strain at the interface between the sputter target and the electrode is less than that of conventional permanently bonded sputter cathode assemblies. A need also exists for a sputter cathode assembly whose components can be easily recovered for recycling or re-use. A further need exists for a sputter cathode assembly that avoids the undesirable arcing and contamination issues associated with soldered and multi-target sputter cathode assemblies. Yet a further need exists for a sputter cathode assembly in which the spent sputter target can be readily removed and replaced without having to remove the electrode from the sputtering chamber.

SUMMARY OF THE PRESENT INVENTION

[0009] It is therefore a feature of the present invention to provide a sputter cathode assembly for which the debonding issue is avoided by providing a fail-safe bond between the assembly components.

[0010] Another feature of the present invention is to provide a sputter cathode assembly in which the assembly components can be separated from each other by nondestructive means and the recovered usable components can be reused and/or recycled.

[0011] A further feature of the present invention is to provide a sputter cathode assembly, especially a large-area sputter cathode assembly, that avoids the undesirable arcing and contamination issues that are present in conventional soldered sputter cathode assemblies of multi-target construction.

[0012] Yet another feature of the present invention is to provide a sputter cathode assembly in which the sputter target component can be readily removed and replaced without the need to also remove the electrode from the sputtering chamber.

[0013] Additional features and advantages of the present invention will be set forth in part in the description that follows, and in part will be apparent from the description, or may be learned by practice of the present invention. The objectives and other advantages of the present invention will be realized and attained by means of the elements and combinations particularly pointed out in the description and appended claims.

[0014] To achieve these and other advantages, and in accordance with the purposes of the present invention, as embodied and broadly described herein, the present invention relates to a sputter cathode assembly that includes a first assembly member having a mating surface with a plurality of projections having side walls; and a second assembly member having a mating surface with a plurality of corresponding grooves having sidewalls, wherein the projections are received in said grooves, and wherein thermal expansion causes contacting of the side walls of the projections and the side walls of the grooves at a contact temperature to form a temporary mechanical attachment between the first and second assembly members. The sputter cathode assembly optionally includes a mechanical interlock for interlocking the first and second assembly members together.

[0015] The present invention further relates to a method of forming a sputter cathode assembly that includes bonding an interlayer or backing plate to a sputter target which is then temporarily attached to an electrode by thermal expansion at the backing

plate/electrode interface so that non-metallic sputter target materials can be used in the sputter cathode assembly.

[0016] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are intended to provide a further explanation of the present invention, as claimed.

[0017] The accompanying drawings, which are incorporated in and constitute a part of this application, illustrate various aspects of the present invention and together with the description, serve to explain the principles of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] Figure 1 is a schematic diagram of a multi-piece large area rectangular sputter cathode assembly.

[0019] Figure 2 is a schematic diagram of one version of the sputter cathode assembly of the present invention with exploded cross-sectional views of a version of the mechanical interlock and a version of the projection/groove attachment.

[0020] Figure 3 is a schematic diagram of a method of forming a sputter cathode assembly according to one embodiment of the present invention.

[0021] Figure 4 is graph showing theoretical sputter target temperature changes with sputtering power density for sputter cathode assemblies designed to make contact at 50° C and at 80° C.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

[0022] A method of forming a sputter cathode assembly according to the present invention includes positioning a first assembly member having a mating surface with a plurality of projections having side walls, and a second assembly member having a mating surface with a plurality of corresponding grooves having side walls, whereby the projections are received in the grooves, wherein gaps are present between the side walls of

the projections and the side walls of the grooves; and heating the first assembly member or the second assembly member or both, whereby thermal expansion causes contacting of the side walls of the projections and the side walls of the grooves at a contact temperature to form a temporary mechanical attachment between the first assembly member and the second assembly member. The method optionally includes mechanically interlocking the first assembly member and the second assembly member together.

[0023] In more detail, the sputter cathode assembly as described above, includes two components or assembly members, i.e., a sputter target and an electrode. The sputter target member and the electrode can be any suitable target grade and electrode grade materials. With respect to the target materials to be attached by the method of the present invention, examples include, but are not limited to, tantalum, niobium, cobalt, titanium, copper, aluminum, and alloys thereof. Examples of electrode materials include, but are not limited to, copper, or a copper alloy, tantalum, niobium, cobalt, titanium, aluminum, molybdenum, and alloys thereof, such as TaW, NbW, TaZr, NbZr, TaNb, NbTa, TaTi, NbTi, TaMo, NbMo, and the like, or steel. No limitation exists as to the type of materials used in the sputter target and the electrode. In the present invention, the target material to be attached to the electrode can be conventional target grade material, for instance as described in U.S. Patent No. 6,348,113, incorporated in its entirety herein by reference. The purity, texture, and/or grain size and other properties, including size and the like are not critical to the present invention. The powder used to make the target grade plate as well as the target itself can have any purity with respect to the metal. For instance, the purity can be 99% or greater such as from about 99.5% or greater and more preferably 99.95% or greater and even more preferably 99.99% or greater, or 99.995% or greater or 99.999% or greater. The target grade plate can have any suitable grain size (e.g., average grain sizes of less than 300 microns, less than 100 microns, less than 50 microns, less than 20 microns) and/or texture.

For instance, the texture can be random, a primary (111) texture, or a primary (100) texture that can be on the surface or throughout the entire thickness of the target. Preferably, the texture is uniform. Also, the target can have a mixed (111):(110) texture throughout the surface or throughout the entire thickness of the target. In addition, the target can be substantially void of textural banding, such as substantially void of (100) textural banding. The present invention provides a method of making a sputter cathode assembly with any type of sputter target and electrode.

[0024] The sputter target and the electrode can have any shape and/or dimensions, as described, for example, in U.S. Patent Application No. 60/450,196 filed February 25, 2003, which is incorporated in its entirety herein by reference. For instance, the sputter target can be circular, rectangular, or can be any other geometric shape suitable for sputtering. The size or surface area of the sputter target can be any suitable size, including conventional sizes or the sizes described below. Preferably, the sputter target and the electrode are substantially of the same shape and the same dimensions. Optionally, the electrode can have dimensions in excess of the dimensions of the target, or, alternatively the target grade plate can have dimensions in excess of the dimensions of the electrode. In a preferred embodiment, both the target and the electrode are substantially rectangular or circular in shape, having a length of from about 1 ft or less to about 5 ft or more, and a width of from about 1 ft or less to about 5 ft or more, or diameters of from 6 inches or less to 5 feet or more. Any dimensions or ranges therein can be used. Other shapes of the target grade plate and the electrode can have similar surface areas. Other dimensions for the sputter cathode assembly include sputter surface areas of greater than 1.5 m². Preferred sputter surface areas are from about 1.5 to about 10 m² and more preferably from about 2 to about 6 m². Another way to describe one aspect of the invention is a sputter cathode assembly in which the attached

target/electrode has a rectangular dimension of 1.5 m or greater for the length and 1.5 m or greater for the width or if the assembly plate is circular, a circular diameter of at least 1.5 m. Preferred dimensions are 1.5 to about 3 m in length and from about 1.5 to about 3 m in width. Similarly, the circular diameter can be from about 1.5 to about 3 m or more.

As indicated above, with such large sputter surface areas, the need for mosaic sputter targets or a series of sputter targets placed next to each other can be avoided or minimized. By using a single target or less targets to form the mosaic, a more uniform sputtered thin film can be achieved for a variety of uses including the capacitor area, plasma screen area, and the like. Furthermore, the sputter cathode assembly can be a hollow cathode magnetron sputter target and can be other forms of sputter targets such as planar magnetron assemblies incorporating stationary or rotating permanent or electrode magnets.

[0025] The thicknesses of the electrode and the target material can be any suitable thickness used for forming sputter cathode assemblies. Alternatively, the electrode and the target material or other metal plate to be attached to the electrode can be any suitable thickness for the desired application. Examples of suitable thicknesses of the electrode and of the target material include, but are not limited to, an electrode with a thickness of from about 0.25 or less to about 2 inches or more in thickness, and targets with a thickness ranging from about 0.06 inches to about 1 inch or greater.

[0026] The target member used to practice the present invention includes two opposing sides, a sputter surface, and a mating surface. The electrode member used to practice the present invention includes two opposing sides, a mating surface and a back surface. Preferably, the back surface is adapted to be water cooled. The assembly described in U.S. Patent No. 5,676,803, incorporated in its entirety by reference, can be used in the present invention. An attachment interface is defined by an area between the mating surfaces of the

target member and the electrode member. The temporary mechanical attachment between the assembly members by the method of the present invention preferably results in substantial contact between the mating surfaces such that thermal and electrical contact is made between assembly members.

[0027] When the thermal expansion coefficient of the sputter target material is large, the sputter target can be attached directly to the electrode. Examples of materials with comparatively large thermal expansion coefficients include aluminum and its alloys, and copper and its alloys. However, other sputter target materials of practical interest have low thermal expansion coefficients and therefore, can be difficult to attach directly. Examples of these materials include tantalum, tungsten, niobium, cobalt and titanium. For these materials, a high thermal expansion material can be bonded to the sputter target material and this backing plate material can have projections or grooves formed in this bonded layer. Methods for bonding this backing plate material to the target material include diffusion bonding, explosion bonding, soldering, friction welding, welding and press fitting. Any conventional bonding technique can be used. The schematic diagram provided in Fig. 2 shows a backing plate material between the sputter target and the electrode.

[0028] According to one embodiment of the present invention, the sputter cathode assembly includes a backing plate and/or an interlayer disposed between the sputter target and the electrode. As stated above, the backing plate is preferably bonded to the mating surface of the sputter target by any conventional method such as explosion bonding, diffusion bonding, friction welding, press fitting, resistance welding, soldering, braising, or welding. As such, the backing plate surface which makes contact with the electrode by attachment therewith according to the present invention, is the mating surface which defines an attachment interface along with the mating surface of the electrode. The backing plate assembly member can be any suitable material, including, but not limited to,

zirconium, titanium, copper, aluminum, chromium, tantalum, niobium, silver, and alloys thereof, or steel. As used herein, the description of the features formed in the mating surface of the sputter target according to a method of the present invention, also refers to the mating surface of the optional backing plate assembly member.

[0029] The sputter cathode assembly members of the present invention can be made from materials having dissimilar coefficients of thermal expansion. Grooves can be formed in the mating side of the assembly member (i.e., target, electrode, or backing plate) having a thermal expansion coefficient that is greater or less than that of the material from which the assembly member having the projections formed thereon. Grooves can be formed on the mating surface of the sputter target, the backing plate, or the electrode, by any suitable method including machining and/or milling. The grooves can be formed to have a lengthwise dimension so that an extended groove track, or channel is formed. Preferably, the groove channel is annular so as to form a continuous recessed track. One or more groove channels can be formed in the mating surface. Multiple groove channels can be arranged concentrically.

[0030] The opening of the groove channel is adapted to receive the projections on the assembly member having the projections. That is, the groove opening is of a sufficient dimension and shape to allow the projection to pass into the opening. Interior to the opening of the grooves, the diameter of the grooves can increase, decrease, or remain constant. The interior of the grooves can be any shape and/or volume. Groove shapes can be regular or irregular. A cross-section of a groove can generally form a square, rectangle, "T", "L", semi circle, truncated triangle, cusp, bowtie, and the like. Also, as to an assembly member having more than one groove channel, the shape of any of the groove channels can be dissimilar. Also any one groove channel can vary in shape along the length of the groove channel. The grooves can be any depth such as from about 0.01 inch or less to

about 0.5 inch or more and, preferably, from about 0.025 inch to about 0.075 inch.

[0031] Projections can be formed in the mating surface of any assembly member, i.e., the sputter target, the electrode, or the backing plate. The projections can be formed in the mating surface of the assembly member by any suitable method including machining and milling. The projection has a distal end and an opposing proximal end that is attached at the mating surface of the assembly member. The distal end is of such a shape and a dimension as to permit the projection to enter the opening of the corresponding groove in the groove-containing assembly member. The projection can be of any size or shape. A cross-section of a projection can generally form a rectangle, triangle, or other suitable shape. The projection can be of any regular or irregular shape. The projection can be in the shape of a cylinder, cone, truncated cone, cube, cuboid, pyramid, ovaliscue, wedge, etc.

[0032] The projections are arranged on the mating side of the assembly member such that the projections can be mated with a corresponding groove on the mating side of another assembly member. Notably, the groove-containing member may include a larger number of groove channels than the number of projections on the projection-containing member. That is, every groove need not have a corresponding projection. The projections can be spaced apart as desired. For example, the projections can be spaced so close to one another in a row so as to approximate a continuous ridge. Multiple projections can be arranged in rows. Preferably, the projections are arranged circularly. Multiple rows of projections can be used to mate with the grooves in the groove-containing member. Preferably, multiple rows of projections are arranged concentrically. The shape and dimension of any one projection in a row can be similar or dissimilar to other projections in the same row. Likewise, concentric rows of projections can contain projections of similar or dissimilar shape and dimension. The height of the projection measured from its proximal end to its distal end can be from about 0.01 inch or less to about 0.5 inch or more,

and preferably from about 0.05 inch to about 0.2 inch. The projection can be any cross-section such as from about 0.0001 square inch to about 0.25 square inch. Preferably, the projection is made from a high strength copper-zirconium, copper-chromium, or copper-zinc alloy.

[0033] Preferably, once the thermal contact grooves and projections are formed, the sputter target can be attached to the electrode by rotating the target about the center line so that the preferred four corners of the target are outside of the electrode. The target is then moved into the electrode so that the grooves and projections mesh. The target is then rotated so that the target is aligned or in registration with the electrode. Figure 3 provides a schematic diagram of one target attachment method. Positioning the first assembly member and the second assembly member involves aligning one adjacent to the other so that each projection has a corresponding groove into which the projection is received. Preferably, the projections are fully received within the grooves such that the mating surfaces of the first and second assembly member are placed in substantial contact. Preferably, positioning includes rotating the first assembly member and the second assembly member relative to one another, whereby the projections are received in the grooves.

[0034] Heating the first assembly member, the second assembly member, or both, can be by any method, and is preferably achieved by the sputtering process. Heating can be from any temperature, and is preferably from an ambient temperature or a room temperature. Heating of an assembly member can be to any temperature below the melting point of the assembly member. Preferably, at the ambient temperature, a gap is present between at least one side wall of a projection and at least one side wall of each groove. Heating is preferably to a temperature whereby thermal expansion causes contacting of the side walls of the projections and the side walls of the grooves at a contact temperature. The

contact temperature is the temperature at which the projections on the first assembly member make contact from thermal expansion with the grooves in the second assembly member. Prior to the target reaching the contact temperature, the target temperature increases rapidly with increasing sputtering power density. Prior to contact being achieved, heat transfer between the target and electrode is marginal. However, once contact is achieved, the area of the contact provides good heat transfer between the target and the preferably water-cooled electrode. The rate of temperature rise in the target is then greatly reduced so that a stable target temperature is maintained. The change in target temperature with sputtering power for two contact temperatures, 50° C and 80° C, is provided in Fig. 4.

[0035] Contacting of the side walls of the projections and the side walls of the grooves preferably forms a temporary mechanical attachment between the first assembly member and the second assembly member. Preferably, the location and the dimensions of the grooves and the projections are predetermined such that each groove and its corresponding projection make contact due to thermal expansion during heating of the first assembly member, the second assembly member, or both. More preferably, the location and dimensions of the grooves and the projections are predetermined such that each groove and its corresponding projections make contact due to thermal expansion at the same contact temperature. The predetermined location and dimension of each projection/groove combination can be determined by the thermal expansion equation for the target material. For example, at room temperature (e.g., 20° C), the gap between the projection and the groove is given by: $D = R \alpha (T_c - 20)$, where R is the radial distance of the projection/groove from the assembly center, α is the thermal expansion coefficient of the projection material, and T_c is the temperature at which contact occurs between the side walls of the projections and the side walls of the grooves. Preferably, the electrode is actively cooled during the sputtering process, such that it maintains a temperature near

about 20° C. Table 1 provides relative gap dimension data for projections/grooves at various radii (R) from the assembly center, and at various contact temperatures (T_c) for a C18200 Cu-Cr alloy target interlayer, having an expansion coefficient (α) of 1.76E-05 ppm/C.

Table 1

	Contact Temperature (°C)				
	50	80	120	150	200
Radius (cm)	Gap (mm)				
1	0.005	0.011	0.018	0.023	0.032
5	0.026	0.053	0.088	0.114	0.158
10	0.053	0.106	0.176	0.229	0.317
20	0.106	0.211	0.352	0.458	0.634
50	0.264	0.528	0.880	1.144	1.584

[0036] Contacting of the side walls of the projections and the side walls of the grooves at the contact temperature preferably forms a temporary mechanical attachment between the first assembly member and the second assembly member. Preferably the gaps present between the side walls have predetermined dimensions such that contact between the side walls occurs substantially simultaneously for each projection. Preferably, the gaps include predetermined dimensions such that the contact temperature is from about 30 to about 300° C or more. This temperature range is just one possible range. The type of metal used will determine the best temperature range. For instance, an increase in the contact temperature can decrease the yield strength of the side wall materials, thus lower contact temperatures are preferable. The contact temperature for the target assembly is preferably a temperature at which the stress created at the contact surfaces of the side walls is less than the yield stress for the side wall materials. Preferably, the temporary mechanical attachment places the mating surfaces of the assembly members in thermal contact. The first assembly member can be a sputter target, and the second assembly member can be a backing plate. The first assembly member can be an electrode, and the second assembly member can be a

sputter target. Alternatively, the first assembly member can be a backing plate that is bonded to a sputter target, and the second assembly member can be an electrode. Furthermore, the first assembly member can be an electrode, and the second assembly member can be a backing plate that is bonded to a sputter target. By cooling or allowing the assembly members to cool to temperatures below the contact temperature, contact between the sidewalls of the projections/grooves is lost, causing the temporary mechanical attachment to end. At such time, the sputter target can be nondestructively removed from the electrode. Another sputter target can then be attached to the electrode by a method of the present invention.

[0037] According to one embodiment of the present invention, the method of forming a sputter cathode assembly further includes mechanically interlocking the first assembly member and the second assembly member together. Mechanically interlocking can be achieved before, during, or after positioning of the first and second assembly members such that the projections are received in the grooves. Preferably, mechanically interlocking occurs simultaneously with positioning of the first and second assembly members. Preferably, mechanically interlocking includes rotating the first assembly member and the second assembly member relative to one another. To achieve mechanical interlocking, at least one mechanical interlock can be provided on the mating surfaces. The mechanical interlock can be formed on the mating surfaces by any suitable method such as milling or machining. Mechanically interlocking the first and second assembly members can place the mating surfaces in electrical, thermal, or physical contact. Preferably, mechanically interlocking is sufficient to maintain physical contact between the mating surfaces until the heating of the sputter cathode assembly forms a temporary mechanical attachment between the assembly members. The mechanical interlock can be formed of any combination of a recess formed in one mating surface and a corresponding protrusion formed in the other

mating surface such that surfaces of the recess and the protrusion are abutting, thereby creating an interlock. For example, the mechanical interlock can include a trapezoid shaped recess adapted to receive a trapezoid shaped protrusion. The mechanical interlock can include a "T" shaped recess adapted to receive a "T" shaped protrusion. The mechanical interlock can include an "L" shaped groove adapted to receive an "L" shaped protrusion. Also, the mechanical interlock can include a triangle shaped recess adapted to receive a triangular shaped protrusion. Preferably, the mating surfaces contain both protrusions and recesses.

[0038] In one embodiment of the present invention, the mechanical interlock features are provided at one or more corners of rectangular assembly members so that mechanical interlocking is achieved by positioning the assembly members such that their center lines are offset, and then rotating one or the other assembly member or both to bring the rectangular assembly members in substantial registration. In the process, the protrusions are inserted and received into the corresponding recesses and the assembly members thereby interlocked. In one embodiment of the present invention, mechanical interlock features are provided in the center regions of the assembly members. In this particular embodiment, the recess includes an opening slot that is large enough to permit the protrusion to enter into the recess when the mating surfaces are placed adjacent to one another, and such that the protrusion is then rotated to a final position within the recess by rotating the assembly members relative to each other. Preferably, mechanical interlocking allows the assembly members to be fixed together at their mating surfaces without separating during handling, or upon placement within a sputtering chamber in a vertical or suspended horizontal position, for example. A schematic diagram of the trapezoid groove and protrusion for forming the mechanical interlock is provided in Fig. 2.

[0039] The previously described versions of the present invention have many advantages, including that in assembling large rectangular sputter assemblies using thermal expansion contact to provide thermal contact between the sputter target and the electrode, no soldering is required and the target can be replaced without removing the electrode from the sputtering system. This greatly reduces the time required to change targets. In addition, this assembly method allows the target to be of a single piece construction which greatly reduces target arcing during sputtering, thereby reducing defects in the deposited film.

[0040] Other embodiments of the present invention will be apparent to those skilled in the art from consideration of the present specification and practice of the present invention disclosed herein. It is intended that the present specification and examples be considered as exemplary only with a true scope and spirit of the invention being indicated by the following claims and equivalents thereof.

WHAT IS CLAIMED IS:

1. A method of forming a sputter assembly, comprising:

positioning a first assembly member having a mating surface with a plurality of projections having side walls, and a second assembly member having a mating surface with a plurality of corresponding grooves having side walls, whereby said projections are received in said grooves, wherein gaps are present between the side walls of said projections and the side walls of said grooves; and

heating said first assembly member or said second assembly member or both, whereby thermal expansion causes contacting of the side walls of said projections and the side walls of said grooves at a contact temperature to form a temporary mechanical attachment between said first assembly member and said second assembly member.

2. The method of claim 1, further comprising mechanically interlocking said first assembly member and said second assembly member.

3. The method of claim 2, wherein said mechanically interlocking is achieved by rotating said first assembly member and said second assembly member relative to one another.

4. The method of claim 1, further comprising providing at least one mechanical interlock on said mating surfaces.

5. The method of claim 1, wherein said positioning comprises rotating said first assembly member and said second assembly member relative to one another, whereby said projections are received in said grooves.

6. The method of claim 1, wherein said first assembly member comprises a sputter target, and said second assembly member comprises a backing plate.

7. The method of claim 1, wherein said first assembly member comprises an electrode, and said second assembly member comprises a sputter target.

8. The method of claim 1, wherein said first assembly member or said second assembly member is a sputter target, and wherein said sputter target has a rectangular shape.

9. The method of claim 1, wherein said first assembly member or said second assembly member is a sputter target comprising cobalt, titanium, copper, aluminum, tantalum, niobium, nickel, molybdenum, zirconium, hafnium, gold, silver, or alloys thereof.

10. The method of claim 1, wherein said first assembly member or said second assembly member is an electrode comprising copper, aluminum, titanium, molybdenum, niobium, alloys thereof, or steel.

11. The method of claim 1, wherein said first assembly member comprises a backing plate that is bonded to a sputter target, and wherein said second assembly member comprises an electrode.

12. The method of claim 11, wherein said backing plate comprises aluminum, chromium, copper, tantalum, titanium, alloys thereof, or steel.

13. The method of claim 1, wherein said first assembly member comprises an electrode, and wherein said second assembly member comprises a backing plate that is bonded to a sputter target.

14. The method of claim 13, wherein said backing plate comprises copper, aluminum, titanium, alloys thereof, or steel.

15. The method of claim 1, wherein said heating comprises sputtering.

16. The method of claim 1, wherein said projections are cylindrical, or combinations thereof.

17. The method of claim 1, wherein said projections comprise concentric rows.

18. The method of claim 1, wherein said grooves comprise a groove channel.

19. The method of claim 1, wherein said grooves comprise concentric groove channels.

20. The method of claim 1, wherein said gaps include predetermined dimensions such that said contact occurs substantially simultaneously for each of said projections.

21. The method of claim 1, wherein said gaps include predetermined dimensions such that said contact temperature is from about 30 to about 300° C.

22. The method of claim 1, wherein said mating surfaces are placed in thermal contact by said mechanical attachment.

23. A sputter assembly comprising:

a first assembly member having a mating surface with a plurality of projections having side walls; and

a second assembly member having a mating surface with a plurality of corresponding grooves having sidewalls, wherein said projections are received in said grooves, and wherein the side walls of said projections and the side walls of said grooves are adapted to form a temporary mechanical attachment between said first assembly member and said second assembly member at a contact temperature.

24. The sputter assembly of claim 23, further comprising a mechanical interlock for interlocking said first assembly member and said second assembly member.

25. The sputter assembly of claim 23, wherein said first assembly and said second assembly are adapted to be mechanically interlocked by rotation of said mating surfaces relative to each other.

26. The sputter assembly of claim 24, wherein said mechanical interlock is formed on said mating surfaces for interlocking said first assembly member and said second assembly member.

27. The sputter assembly of claim 26, wherein said mechanical interlock includes a trapezoid shaped recess adapted to receive a trapezoid shaped protrusion.

28. The sputter assembly of claim 26, wherein said mechanical interlock includes a "T" shaped recess adapted to receive a "T" shaped protrusion.

29. The sputter assembly of claim 26, wherein said mechanical interlock includes an "L" shaped recess adapted to receive an "L" shaped protrusion.

30. The sputter assembly of claim 26, wherein said mechanical interlock includes a triangular shaped recess adapted to receive a triangular shaped protrusion.

31. The sputter assembly of claim 23, wherein said projections are adapted to be received in said grooves by rotation of said first assembly member and said second assembly member relative to one another.

32. The sputter assembly of claim 23, wherein said first assembly member comprises a sputter target, and said second assembly member comprises a backing plate.

33. The sputter assembly of claim 23, wherein said first assembly member comprises an electrode, and said second assembly member comprises a sputter target.

34. The sputter assembly of claim 23, wherein said first assembly member or said second assembly member is a rectangular shaped sputter target.

35. The sputter assembly of claim 23, wherein said first assembly member or said second assembly member is a sputter target comprising cobalt, titanium, copper, aluminum, tantalum, niobium, nickel, molybdenum, zirconium, hafnium, gold, silver, or alloys thereof.

36. The sputter assembly of claim 23, wherein said first assembly member or said second assembly member is an electrode comprising copper, aluminum, titanium, molybdenum, niobium, alloys thereof, or steel.

37. The sputter assembly of claim 23, wherein first assembly member comprises a backing plate that is bonded to a sputter target, and wherein said second assembly member

comprises an electrode.

38. The sputter assembly of claim 37, wherein said backing plate comprises aluminum, copper, tantalum, titanium, alloys thereof, or steel.

39. The sputter assembly of claim 37, wherein said backing plate is bonded to said sputter target by explosion bonding, diffusion bonding, friction welding, press fitting, resistance welding, soldering, brazing, or welding.

40. The sputter assembly of claim 23, wherein said first assembly member comprises an electrode, and wherein said second assembly member comprises a backing plate that is bonded to a sputter target.

41. The sputter assembly of claim 40, wherein said backing plate comprises aluminum, copper, tantalum, titanium, alloys thereof, or steel.

42. The sputter assembly of claim 40, wherein said backing plate is bonded to said sputter target by explosion bonding, diffusion bonding, friction welding, press fitting, resistance welding, soldering, brazing, or welding.

43. The sputter assembly of claim 23, wherein said thermal expansion is achieved by sputtering said sputtering target assembly.

44. The sputter assembly of claim 23, wherein said projections are cylindrical, rectangular, or any combinations thereof.

45. The sputter assembly of claim 23, wherein said projections comprise concentric rows.

46. The sputter assembly of claim 23, wherein said grooves comprise a groove channel.

47. The sputter assembly of claim 23, wherein said grooves comprise concentric groove channels.

48. The sputter assembly of claim 23, wherein each of said projections contacts a respective groove substantially simultaneously.

49. The sputter assembly of claim 23, wherein said contact temperature is from about 30 to about 300° C.

50. The sputter assembly of claim 23, wherein said mating surfaces are adapted to be placed in thermal contact by said mechanical attachment.

51. The sputter assembly of claim 23, wherein a gap exists between said side walls of said grooves and said side walls of said projections when said grooves and said projections are at a temperature that is less than said contact temperature.

52. The sputter assembly of claim 51, wherein each of said gaps are adapted to close simultaneously by thermal expansion of said side walls of said projections, said side walls of said grooves, or both.