

Cover Sealing Method and Sealed Cover



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Field of the Invention

- 5 This invention relates to a cover sealing method and a sealed cover and refers particularly, though not exclusively, to a cover sealing method and sealed cover, for hard disk drives for computers, MP3 players, and the like.

Background to the Invention.

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The sealing of covers of hard disk drives for computers, MP3 players, or the like, as well as the radio frequency isolation ("RFI") and electro-magnetic isolation ("EMI") generally comprises two components: an elastomer ring, and an electrically conductive coating. The function of the elastomer is to atmospherically insulate the device from the environment as exposure to the environment may be harmful to the lifetime, and technical performance, of the hard disk drive. The function of the electrically conductive coating, which generally comprises a metallic coating with a low ohmic resistance, is to provide EMI and RFI.

- 20 In the manufacturing of a hard disk drive with a sealing and EMI/RFI shielding system, an elastomeric ring, or form-in-place gasket ("FIPG"), is applied on to the hard disk cover and a conductive coating is applied to the surface of the elastomeric ring by electrochemical plating, or other technologies. Due to stringent requirements for hard disk protection, and technical operation, the conductive coating is required to have sufficient adhesion strength to the elastomeric ring, and sufficient toughness to provide deformability free of chipping and de-lamination, as well as sufficient corrosion resistance.

- 30 Rubber and epoxy resins are widely used for sealing applications. Incorporating conductive particles in such materials can provide a limited conductivity. However, performance cannot meet the requirements for hard disk applications either due to insufficient EMI and RFI shielding effectiveness, or due to particles being released from the sealing materials, which may damage the hard disk drive. Electrochemical plating, or electroless plating, of a metallic coating onto the rubber or epoxy sealing materials can meet the EMI and RFI shielding requirement for a hard disk drive, provided the coating adhesion to the sealing material is sufficient to



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withstand the forces imported on the sealing material during assembly of the cover without de-lamination or chipping.

Summary of the Invention

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In accordance with a preferred aspect of the invention there is provided a method for sealing a cover, the cover having a base and a top, the method comprising:

- (a) forming a polymer seal on a periphery of at least one of the base and the top;
- 10 (b) metallizing all exposed surfaces of the polymer seal by depositing a metallic coating to all exposed surfaces of the polymer seal.

The polymer seal may be of a material selected from: an elastomeric material, polyurethane, or epoxy.

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Before the forming process (a) the at least one of the base and the top may be cleaned. The cleaning process may be by ultrasonically in an alkaline chemical solution, or wet cleaning. The cleaning process may be followed by water rinsing and drying.

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The forming process (a) may be by use of compressed air and a valve, and may be followed by curing and baking; preferably being by ultra-violet light having a wavelength in the range 200 to 400nm. Alternatively, curing may be by a thermal curing process at 160°C for 20 minutes. The baking may be at 150°C for 3 hours.

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Between the forming process (a) and the coating process (b), a further cleaning may be performed. The further cleaning process may be by one or more of: a plasma cleaning process, ultrasonically in an alkaline chemical solution, wet cleaning, and in a diluted sodium hydroxide solution. The plasma cleaning process may be by applying a substrate bias voltage and powering sputter targets at a low power density. The substrate bias voltage may be in the range 200 to 500V, and the low power density may be in the range 0.1 to 0.4W per square centimetre. The substrate bias voltage may be pulsed direct current at a frequency in the range 50KHz to 300KHz. The cleaning process may be for a time in the range 5 to 30 minutes.

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The metallic coating may be one or more of: chromium, aluminium, copper, nickel and titanium. The metallic coating may also be deposited to the at least one of the base and the top; preferably both the base and the top. The seal may be formed on both the base and the top.

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The deposition may be by a magnetron sputtering process. The magnetron sputtering process may be of a power density in the range 2 to 4W per square centimetre; at a deposition pressure in the range 1 to 4 mTorr. A negative direct current voltage in the range 60 to 120V may be applied to the substrate.

10 Alternatively, a negative pulsed direct current voltage may be applied to the substrate at a frequency in the range 20KHz to 100KHz. The metallic coating may be of a thickness in the range 0.5 to 1.5 microns.

15 Alternatively, the depositing may be by electroless plating proceeded by degreasing and etching, and; the metallic coating may be of a thickness in the range of 0.5 to 2 microns.

The cover may be formed of at least one material selected from: stainless steel, aluminium, and an aluminium alloy. The cover may be of a hard disk drive.

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In another preferred aspect there is provided a cover of a hard disk drive processed in accordance with the above method.

25 In a final preferred aspect there is provided a hard disk drive comprising a cover and a disk drive, the cover comprising a top and a base, a polymer seal at a periphery of the top and the base and sealing with the top and the base; exposed surfaces of the polymer seal being metallized by deposition of a metal coating on exposed surfaces of the seal. The metallic coating may also be on the top and the base. The metallic coating may be one or more of chromium, aluminium, copper,
30 nickel and titanium; and the polymer seal may be of an elastomeric material, polyurethane or epoxy.

The seal is preferably formed in situ before assembly, and the metallic coating applied subsequently.

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Brief Description of the Drawings

In order that the invention may be fully understood and readily put into practical effect, there shall now be described by way of non-limitative example only preferred embodiments of the present invention, the description being with reference to the accompanying illustrative drawings in which:

Figure 1 is a front perspective view of a preferred embodiment of a cover in accordance with the present invention;

Figure 2 is a top perspective view of the cover of Figure 1;

Figure 3 is a cross-sectional view of the elastomeric seal of Figure 1;

Figure 4 is a plan view of a deposition chamber for use in performance of a preferred embodiment of the method of the present invention; and

Figure 5 is a flow chart of the preferred embodiment of the method of Figure 4.

Detailed Description of Preferred Embodiment

The drawings show a hard disk drive 2 for a computer, MP3 player, or the like. The hard disk drive apparatus (not shown) is contained within a cover 4. Cover 4 has a base 8 and a top 6. An elastomeric seal 10 is used to provide a seal between base 8 and top 6. Elastomeric seal 10 is formed on either or both of the base 8 and top 6 before assembly of top 6 and base 8 to form cover 4. Seal 10 therefore provides an effective seal between top 6 and base 8 when cover 4 is assembled. Elastomeric seal 10 extends around the periphery of base 8 and/or top 6.

A metallic coating 14 is deposited on the elastomeric seal 10 to metallize the elastomeric seal 10. This may be applied by using physical vapour deposition. This is suitable for hard disk drive sealing and EMI/RFI shielding applications. The metallization process may use an unbalanced magnetron sputtering process.

By using the unbalanced magnetron sputtering process, the elastomeric seal can be metallized by depositing various metals onto the elastomeric seal 10 at low temperature without affecting its elastic properties. An effective plasma cleaning prior to coating deposition enhances the adhesion of the coating 14 to elastomeric seal without changing the properties of material 10.

Various elastomers may be used for seal 10, and various metals such as, for example, chromium, aluminium, copper, nickel and titanium may be used for the metallization process and the coating 14. Preferably, polyurethane is used for the seal 10, and metallic chromium or nickel is used for the coating 14. This combination of materials has shown good atmospheric sealing and good EMI and RFI shielding functions without de-lamination, chipping or performance degradation observed under the hard disk drive application conditions.

Preferably, and as shown in Figure 5, the elastomeric material for forming the elastomeric seal 10 is plotted onto, or formed on, the periphery 12 of top 6 and/or base 8 to form the seal 10. The cover 4 preferably comprises a metal such as, for example, stainless steel and/or aluminium or aluminium alloy. A prior passivation and wet cleaning process (50) is preferred. In this way the seal 10 is formed in situ on the periphery of top 6 and/or base 8.

The elastomeric material for forming seal 10 is preferably plotted onto the periphery 12 of the top 6 and/or base 8 using compressed air and a mechanically-operated dispensing valve or servo valve, followed by a curing process (51) preferably using Ultra-Violet ("UV") light. The preferred wavelength of the UV light is in the range of 200 to 400nm, more preferably 300 to 400nm and the preferred UV light intensity is at about 5,000 milijoules. A post baking process (53) at 150°C for about 3 hours is preferred for outgassing.

Alternatively, the seal 10 may be formed of an epoxy by plotting the epoxy onto the periphery 12 of the top 6 and/or base 8 using compressed air and a mechanical dispensing valve, followed by a thermal curing process at a temperature of 160°C for 20 minutes. This is to prevent the epoxy slumping. A post thermal baking process at 150°C for about 3 hours is preferred.

Following the formation of the seal 10, ultrasonic cleaning (54) for two minutes in an alkaline chemical solution may be performed. This may be followed by water rinsing and drying (55).

After loading the cover 4 into a magnetron sputtering system (56) and evacuation of the chamber (57), a plasma cleaning process (58) prior to coating deposition (59) may be used. A negative DC or pulsed DC substrate bias voltage in the range of 200 to 500 V is applied, with the targets 20, 22, 24, 26 being powered at low

power density preferably in the range of 0.1 to 0.4W per square centimetre. In the case of pulsed DC, a frequency of 50 kHz to 300 kHz is preferred. The cleaning time can be in the range of 5 to 30 minutes depending on the plasma parameters to be used for the plasma cleaning process.

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The metallic EMI/RFI shielding coating 14 may be deposited (59) by magnetron sputtering technology to the exposed surfaces of seal 10 and the entire surface of the cover 4. The exposed surfaces of the seal 10 are those not in direct contact with a surface of top 6 and/or base 8. A direct current ("DC") power source is used to generate an argon plasma to sputter the metallic targets. The power density is preferred to be in the range of 2 to 4 W per square centimetre, depending on the target material used. A higher level of power may be used to increase the deposition rate provided that the sample temperature raised by the plasma bombardment will not cause decomposition or degradation of the elastomeric material of seal 10. The deposition pressure is preferred to be in the range of 1 to 4 mTorr.

Figure 4 is a schematic diagram of the magnetron sputtering system. The configuration of the system can be in various forms depending on the production requirements. As shown, there is a shaft 16 on which the cover 4 is placed. Argon is introduced at 18. Four magnetron targets 20, 22, 24 and 26 are provided for the emission of the metal for depositing the metallic coating 14, in this case chromium.

Preferably, a DC or pulsed DC negative substrate bias in the range of 60 to 120 V is applied to the cover 4 to improve the coating quality. In the case of pulsed DC, a frequency in the range of 20 kHz to 100 kHz is preferred.

Preferably, the thickness of coating 14 is in the range of 0.5 to 1.5 microns, depending on the material to be used.

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In the case of depositing copper as the EMI and RFI shielding coating, a thin top coating of other metals such as chromium and aluminium may be deposited for oxidation/corrosion protection, and also for a change in colour, if it is desired.

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Example 1:

Ten stainless steel hard disk casing covers with a polyurethane seal formed along the cover edge were ultrasonically cleaned (54) for two minutes in an alkaline chemical solution, followed by water rinsing and drying (55). The samples were loaded (56) into the deposition chamber of an unbalanced magnetron sputtering system, as shown in Figure 4, and the system was evacuated (57) to 8×10^{-6} Torr. Plasma cleaning (58) was then conducted under the following conditions:

10	Discharge gas:	Argon (99.995%)
	Chamber pressure:	1.6m Torr
	DC current density applied to chromium target:	$0.8\text{mA}/\text{cm}^2$
	Pulsed DC bias voltage applied to the samples:	-300V
	Frequency of Pulsed DC bias power:	300kHz
15	Cleaning time:	20 minutes

The metallization process (59) was conducted immediately after the plasma cleaning process. The deposition parameters were:

20	Discharge gas:	Argon (99.995%)
	Deposition pressure:	1.8m Torr
	DC current density applied to chromium target:	$8\text{mA}/\text{cm}^2$
	DC bias voltage applied to the samples:	-110V
	Deposition time:	20 min

25 From this process a 1-micron thick chromium coating was uniformly deposited onto the whole surface of the cover 4 including the polyurethane seal 10. Tape tests for up to twenty times showed that the coating had a good bonding strength to both the cover 4 and polyurethane seal 10. Press tests for up to thirty cycles showed
30 that the coating had a good toughness and deformability; and no chipping and delamination was observed during and after the tests.

As is shown in Figure 3, as the metallization of seal 10 is after formation of seal 10, and as seal 10 is formed on periphery 12, only the exposed portion of seal 10 will
35 have coating 14 applied thereto.

Alternatively, the metallization coating 14 may be applied using electrochemical, or electroless plating. This plating process is suitable for hard disk drive sealing and EMI/RFI shielding applications.

5 By using an electroless plating technology nickel, copper or chromium metals may be deposited onto elastomeric materials at low temperature without affecting their elastic properties. A pre-treatment process including degreasing and etching/cleaning prior to coating plating enhances a satisfactory adhesion of the coating to elastomeric material without changing the materials properties.

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Preferably, the coating thickness is the range of 0.5 to 2 microns, depending on the material used. In this case, the cover 4 may be a plastic moulded metal cover. Again, when copper is used as the EMI and RFI shielding coating, a thin top coating of other metals such as chromium or nickel may be deposited for
15 oxidation/corrosion protection, and also for a change of colour if it is desired.

Example 2:

Five stainless steel hard disk casing covers with a polyurethane seal formed along
20 the cover edge were pre-treated for degreasing in diluted sodium hydroxide solution for five minutes, followed by wet etching in diluted HCl solution for surface preparation, followed by water rinsing. The samples were loaded into the electroless nickel (EN) plating bath and plating followed. The plating bath comprised:

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	NiSO ₄ (g/l):	25 -30
	NaH ₂ PO ₂ .HO ₂ (g/l):	28 -30
	CH ₃ COONa.3HO ₂ (g/l):	35 - 45
	Latic Acid (85%) (ml/l):	20 -25
30	Thiourea (mg/l):	3 -5
	PH:	4.8
	Temperature:	88 -90°C

As can be seen, the present invention in one preferred form relates to a method
35 that applies a polymer, in particular polyurethane or other elastomer materials, to atmospherically isolate the hard disk from the environment, followed by

metallization using plating or vapour deposition to provide EMI and RFI functions for hard disk drives.

5 Whilst there has been described in the foregoing description preferred embodiments of the present invention, it will be understood by those skilled in the technology concerned that many variations or modifications in details of design, construction or operation may be made without departing from the present invention.

The claims

1. A method for sealing a cover, the cover having a base and a top, the method comprising:
 - 5 (a) forming a polymer seal on a periphery of at least one of the base and the top;
 - (b) metallizing all exposed surfaces of the polymer seal by depositing a metallic coating to all exposed surfaces of the polymer seal.
- 10 2. A method as claimed in claim 1, wherein the polymer seal is of a material selected from the group consisting of: an elastomeric material, polyurethane, and epoxy.
- 15 3. A method as claimed in claim 1 or claim 2, wherein before the forming process (a) the at least one of the base and the top is cleaned.
- 20 4. A method as claimed in claim 3, wherein the cleaning process is by at least one selected from the group consisting of: ultrasonically in an alkaline chemical solution, wet cleaning, and in a diluted sodium hydroxide solution.
- 25 5. A method as claimed in claim 4, wherein the cleaning process is followed by water rinsing and drying.
6. A method as claimed in any one of claims 1 to 5, wherein the forming process (a) is by use of compressed air and a valve and is followed by curing and baking.
- 30 7. A method as claimed in claim 6, wherein curing is by ultra-violet light having a wavelength in the range 200 to 400nm.
8. A method as claimed in claim 6, wherein curing is a thermal curing process at 160°C for 20 minutes.
- 35 9. A method as claimed in any one of claims 6 to 8, wherein the baking is at 150°C for 3 hours.

10. A method as claimed in any one of claims 1 to 9, wherein between the forming process (a) and the coating process (b), a further cleaning is performed.
- 5 11. A method as claimed in claim 10, wherein the further cleaning process is by one or more selected from the group consisting of: a plasma cleaning process, ultrasonically in an alkaline chemical solution, wet cleaning, and in a diluted sodium hydroxide solution.
- 10 12. A method as claimed in claim 11, wherein in the plasma cleaning process a negative substrate bias voltage is applied and a sputter target powered at a low power density, the substrate bias voltage being in the range 200 to 500V and the low power density being in the range 0.1 to 0.4W per square centimetre.
- 15 13. A method as claimed in claim 11 or claim 12, wherein the substrate bias voltage is pulsed direct current at a frequency in the range 50KHz to 300KHz.
- 20 14. A method as claimed in any one of claims 10 to 13, wherein the cleaning process is for a time in the range 5 to 30 minutes.
15. A method as claimed in any one of claims 1 to 14 wherein the metallic coating is one or more selected from the group consisting of: chromium, aluminium, copper, nickel and titanium.
- 25 16. A method as claimed in any one of claims 1 to 15, wherein the metallic coating is also deposited to the at least one of the base and the top.
- 30 17. A method as claimed in claim 16, wherein the metallic coating is deposited to both the base and the top.
18. A method as claimed in any one of claims 1 to 17, wherein the seal is formed on both the base and the top.
- 35 19. A method as claimed in any one of claims 1 to 18, wherein the depositing is by a magnetron sputtering process.

20. A method as claimed in claim 19, wherein the magnetron sputtering process is of a power density in the range 2 to 4W per square centimetre; at a deposition pressure in the range 1 to 4 mTorr.
- 5 21. A method as claimed in claim 19 or claim 20, wherein a negative direct current substrate voltage is applied in the range 60 to 120V.
22. A method as claimed in claim 21, wherein the substrate voltage is pulsed
10 at a frequency in the range 20KHz to 100KHz.
23. A method as claimed in any one of claims 19 to 22, wherein the metallic coating is of a thickness in the range 0.5 to 1.5 microns.
- 15 24. A method as claimed in any one of claims 1 to 18, wherein the depositing is by electroless plating proceeded by degreasing and etching.
25. A method as claimed in claim 24, wherein etching is wet etching in a diluted hydrochloric acid solution, and degreasing is in a diluted sodium
20 hydroxide solution, etching being followed by rinsing.
26. A method as claimed in claim 24 or claim 25, wherein the metallic coating is of a thickness in the range of 0.5 to 2 microns.
- 25 27. A method as claimed in any one of claims 1 to 26, wherein the cover is formed of at least one material selected from the group consisting of: stainless steel, aluminium, and an aluminium alloy.
28. A method as claimed in any one of claims 1 to 26, wherein the cover is of a
30 hard disk drive.
29. A cover of a hard disk drive processed in accordance with the method of any one of claims 1 to 28.
- 35 30. A hard disk drive comprising a cover and a disk drive, the cover comprising:
(a) a top;

- (b) a base;
 - (c) a polymer seal at a periphery of the top and the base and sealing with the top and the base; and
 - (d) all exposed surfaces of the polymer seal being metallized by the deposition of a metallic coating on the exposed surfaces of the polymer seal.
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31. A hard disk drive as claimed in claim 30, wherein the metallic coating is on the top and the base.
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32. A hard disk drive as claimed in claim 30 or claim 31, wherein the metallic coating is one or more selected from the group consisting of: chromium, aluminium, copper, nickel and titanium.
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33. A hard disk drive as claimed in any one of claims 30 to 32, wherein the polymer seal is of a material selected from the group consisting of: an elastomeric material, polyurethane and epoxy.
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34. A hard disk drive as claimed in any one of claims 30 to 33, wherein the polymer seal is formed in situ before the deposition of the metallic coating.