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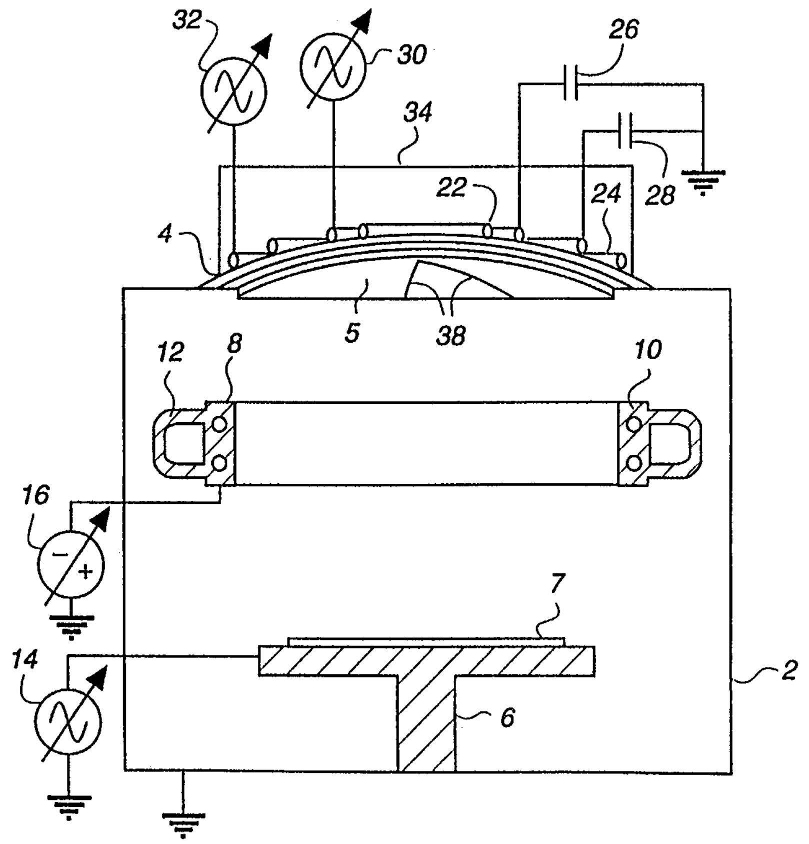
(57) Abstract

An apparatus and method for processing workpieces, which include a chamber having a coil for inductively coupling RF energy through a dielectric window into the chamber to energize a plasma, and a shield positioned between a sputtering target and the dielectric window to reduce or eliminate deposition of sputtered material onto a portion of the dielectric window. In the illustrated embodiment, the window shield is spaced from the dielectric window to define a gap and has at least one opening, which permits RF energy to be coupled through the gap and through the window shield opening to the interior of the chamber. As a consequence, the coil may be positioned exterior to the chamber to simplify construction and operation of the chamber.



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APPARATUS FOR SPUTTERING IONIZED MATERIAL IN A MEDIUM TO HIGH DENSITY PLASMA

BACKGROUND OF THE INVENTION

The present invention relates to apparatus and methods for sputtering ionized material from a solid target, or cathode, onto a workpiece with the aid of an inductively coupled plasma.

A number of semiconductor device fabrication procedures include processes in which a material is sputtered from a target onto a workpiece, such as a semiconductor wafer. Material is sputtered from the target, which is appropriately biased, by the impact of ions created in the vicinity of the target. A certain proportion of the sputtered material is ionized by a plasma and the resulting ions are attracted to the wafer.

The wafer is mounted on a support and is biased to a DC potential selected to attract the sputtered, ionized material. Typically, the sputtered material is composed of positive ions and the workpiece is negatively biased.

There are several known techniques for exciting a plasma with RF fields including capacitive coupling, inductive coupling and wave heating. In a standard inductively coupled plasma (ICP) generator, RF current passing through a coil induces electromagnetic currents in the plasma. These currents heat the conducting plasma by ohmic heating, so that it is sustained in steady state. As shown in U.S. Pat. No. 4,362,632, for example, current through a coil is supplied by an RF generator coupled to the coil through an impedance matching network, such that the coil acts as the primary winding of a transformer. The plasma acts as a single turn secondary winding of the transformer.

In a number of deposition chambers such as a physical vapor deposition chamber, the chamber walls are often formed of a conductive metal such as stainless steel. Because of the conductivity of the chamber walls, it is often necessary to place the RF coils or electrodes within the chamber itself because the conducting chamber walls would block or substantially attenuate the electromagnetic energy radiating from the antenna. As a result, the coil may be directly exposed to the deposition flux and energetic plasma particles. This is a potential source of contamination of the film deposited on the wafer, and therefore may be undesirable in some applications. To protect the coils, shields can be made from nonconducting materials, such as ceramics. However, many deposition processes involve deposition of conductive materials such as aluminum on the electronic device being fabricated. Because the conductive material will coat the ceramic shield, it will soon become conducting, thus again substantially attenuating penetration of electromagnetic radiation into the plasma.

U.S. Patent No. 5,346,578 describes a system in which a plasma is created for the performance of various types of wafer processing operations, including etching and chemical vapor deposition in a hemispherical quartz vessel surrounded by a similarly shaped exterior induction coil. RF energy is transmitted from the coil through the dome into the chamber to energize the plasma. In the operation of the apparatus discussed in this patent, a reactive gas is introduced into the treatment chamber in order to be ionized by the plasma, the resulting ions being directed to a wafer under the influence of a suitable electric field. It is believed that the apparatus described in this reference is not suitable for the performance of conductive material sputtering processes because sputtered material tends to coat all interior surfaces of a chamber. Hence, the quartz dome would soon become relatively opaque to the RF energy from the coil.

Published European Patent Application 0607797 describes a device for generating a plasma in order to perform low pressure chemical vapor deposition or reactive ion etching operations. The system includes a processing chamber having, at its top, a planar spiral coil producing an electromagnetic field which will be coupled with a plasma within the processing chamber, the coil itself being isolated from the interior of the chamber by a flat dielectric window. The window is associated with a conductive shield which is positioned between the window and the coil. The purpose of the shield is to prevent dielectric material from being sputtered from the window. This publication suggests that the window and coil may, alternatively, be domed or hemispherical.

The material which is to be ionized in order to be deposited on a wafer or to perform etching is introduced into the chamber in the form of a process gas. As in the case of the apparatus described in U.S. Patent No. 5,346,578, *supra*, the surface of the dielectric window which communicates with the interior of the chamber is prone to being coated with deposition material. Therefore, it is believed that this chamber is likewise not well suited to sputtering processes.

BRIEF SUMMARY OF THE INVENTION

It is an object of the present invention to provide an inductively coupled plasma processing apparatus which avoids drawbacks possessed by prior art apparatus of this type.

A more specific object of the invention is to produce a more uniform plasma in a processing chamber which contains a metal sputtering target.

Another object of the invention is to protect a dielectric window forming part of the boundary of the processing chamber against deposition of sputtered material.

A further object of the invention is to provide an improved sputtering apparatus having an external coil for inductively coupling energy into the plasma in the processing chamber.

The above and other objects and advantages are achieved, according to the present invention, by an apparatus and method for processing workpieces, which include a chamber having a coil for inductively coupling RF energy through a dielectric window into the chamber to energize a plasma, and a shield positioned between a sputtering target and the dielectric window to reduce or eliminate deposition of sputtered material onto a portion of the dielectric window. In the illustrated embodiment, the window shield is spaced from the dielectric window to define a gap and has at least one opening, which permit RF energy to be coupled through the gap and through the window shield opening to the interior of the chamber. As a consequence, the coil may be positioned exterior to the chamber to simplify construction and operation of the chamber.

In another aspect of the invention, the formation of a plasma having more uniform characteristics is facilitated. For example, by placing the plasma energizing coil outside the chamber, the coil may be readily shaped and positioned to achieve a desired plasma distribution without concern for the interaction between the coil structure and the flow of sputtered material in the chamber. Still further, multiple coils can be used while avoiding the expense and complexity of connecting multiple coils to external RF sources through the walls of the chamber.

In yet another aspect of the invention, the formation of a more uniform sputter deposition material flux may be facilitated. For example, by placing the plasma energizing coil or coils outside the chamber, the sputtering target or targets may be more readily shaped and positioned to achieve a desired deposition flux without concern for the interaction between any internal coil structure and the target. In various illustrative embodiments, the target has an annular ring structure which may improve the uniformity of deposition onto the workpiece.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

Fig. 1 is a simplified, elevational view, partly in cross section, of a first embodiment of apparatus according to the invention.

Fig. 2 is a plan view of one embodiment of the window shield of Fig. 1.

Figs. 3 is a partial cross-sectional view of a portion of the window and window shield of Fig. 1;

Figs. 4 and 5 are views similar to those of Fig. 1 showing further embodiments of apparatus according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

Fig. 1 is a simplified illustration of processing apparatus in which an inductively coupled plasma ionizes material sputtered from a target for delivery to a workpiece. Components of such apparatus which are conventional in this art are not illustrated so that novel components according to the invention can be viewed and comprehended more easily. Such conventional components include conduits for delivering a gas which is used to form the plasma, components for supporting the target and its associated magnet assembly and components for appropriately displacing the workpiece support.

The processing apparatus includes a vacuum chamber 2 having at its top an opening which is closed by a dielectric window 4. As explained in greater detail below, in accordance with one aspect of the invention, positioned in front of the window 4 is a sputter shield 5 which permits RF energy to be transmitted from a source exterior to the sputtering chamber 2, through the window 4 and inductively coupled with the plasma in the interior of the chamber, notwithstanding the deposition of sputtered conductive material onto the inner surface of the window 4.

The vacuum chamber 2 also has a second metal shield (not shown separately) that is coextensive with all of the chamber walls and normally electrically grounded, as shown. Within chamber 2 there is installed a workpiece support 6 providing a support surface. A workpiece 7 that may be constituted by one or a plurality of semiconductor wafers or panels is mounted on the support surface provided by workpiece support 6.

Within chamber 2 there is mounted, in any suitable manner known in the art for conventional sputtering targets, a ring-shaped metal sputtering target 8. Target 8 may be a solid body of an appropriate sputtering metal and may be formed to have an internal helical passage 10 through which a cooling fluid can be caused to flow.

Target 8 is surrounded by a permanent magnet assembly 12 which generates a magnetic flux configured to facilitate the creation of ions adjacent to the target 8. These ions strike one or more external surfaces of target 8 in order to dislodge, or sputter, atoms or clusters of atoms from target 8. Magnet assembly 12 may be mounted to be stationary or to rotate about a vertical center axis of chamber 2 which is concentric with target 8.

Support 6 and target 8 may be appropriately biased, in accordance with conventional practice in the art, to suitable , typically negative, potentials by AC and DC voltage sources 14 and 16, respectively. Although illustrated as contained wholly within the chamber 2, it is contemplated that the target 8 and assembly 12 may be mounted in the walls of the chamber 2 so that the outer portion of the target 8 and the assembly 12 are on the exterior of the chamber 2.

The dielectric window 4 is made, for example, of quartz and having a domed shape. This shape may be, for example, in the form of a segment of a sphere. However, other pressure resistant shapes are also possible. The window 4 may be formed of other nonconductive materials such as ceramic.

Above window 4 there are mounted two conductive coils 22 and 24 which are wound to conform to the domed shape of window 4. Coils 22 and 24 are spiral wound with respect to a vertical center axis (not shown) that may be coaxial with the vertical center axis of chamber 2, with coil 22 being enclosed, or surrounded, by coil 24. One end of each of coils 22 and 24 is connected to ground via a respective DC isolation capacitor 26, 28, while the other end of each of coils 22 and 24 is connected to a suitable, adjustable RF power source 30, 32. Each RF power source 30, 32 may be of any suitable conventional type. Coils 22 and 24 are enclosed in an RF shielding can 34.

The surface of dielectric window 4 which faces the interior of chamber 2 is covered by the metal shield 5, in the form of a dome-shaped sheet or plate. Window shield 5 is preferably made of an electrically conductive material and is coextensive with window 4 in order to cover the entire surface of window 4 which faces the interior of chamber 2. Window shield 5 may be conductively connected to the lower wall shield of chamber 2 and grounded thereby. In addition, window shield 5 may be of the same material as the wall shield of chamber 2.

As shown more clearly in Fig. 2, window shield 5 is provided with a plurality of radially extending slots 38 which are distributed around the circumference of shield 5. Preferably, slots 38 extend from the outer edge of shield 5 substantially to the center thereof. Thus, slots 38 divide shield 5 into a plurality of segments 36 which are substantially electrically insulated from one another. If necessary for support purposes, adjacent segments of shield 5 may be connected together by coupling members made of electrical insulating material. Slots 38 minimize the appearance of eddy currents in window shield 5, while allowing for efficient coupling of RF energy from the coils to the interior of the processing chamber.

As best seen in Fig. 3, window shield 5 is spaced a small distance from window 4 by a gap 40. As a result, even if portions of the inner surface 41 of window 4 which are aligned with slots 38 become coated with conductive deposition material as represented by a coating 42, those portions 43 of window inner surface 41 behind the window shield segments 36 will remain substantially uncoated as shown in Fig. 3. Consequently, paths for flow of magnetic field energy from coils 22, 24 into chamber 2 will exist in gap 40 between window 4 and window shield 36 and in slots 38, as represented by path 44. Although some stray deposition material may deposit on the window inner surface portions 43, it is believed that the deposition will remain sufficiently sparse to permit substantial RF coupling through the window portions 43.

In the illustrated embodiment, the gap 40 between the window 4 and the window shield 5 is approximately 1-2 mm in which the length of the segments 36 have a width which varies from near zero at the center of the window shield 5 to a width of approximately 2 cm (five inches) at the perimeter. The gap 40 is preferably selected to be small enough to minimize the intrusion of deposition material behind the window shield segments 36 and hence minimize the coating of deposition material onto the window inner surface portions 43 behind the segments 36. On the other hand, the gap 40 should be sufficiently large to allow a large number of layers of successive coatings 42 of conductive deposition material to be built up on the window inner surface during successive wafer treatments without the stack of coatings 42 being sufficiently thick to bridge the gap 40 to the window shield 5 and hence block the paths 44 through the gaps 40.

Once the number of coatings has reached a level in which the gaps 40 may begin to close, the window 4 and window shield 5 may be cleaned in situ or alternatively, the window 4 may be replaced with a clean window. In some applications, partial closing of the gaps 40 may be tolerated without adversely affecting the plasma density level and hence the ionization rate of the deposition material.

According to preferred embodiments of the invention, as illustrated in the drawing, coils 22 and 24 are independently powered, coaxially mounted solenoid coils. Outer coil 24 preferably has an outer diameter substantially equal to the diameter of dielectric window 4, while inner coil 22 preferably has an outer diameter in a range of 3 to 2 of the diameter of dielectric window 4. By adjusting the relation between the power supplied to the two coils, nonuniformities in the plasma created within chamber 2 can be reduced or eliminated. In particular, more homogeneous plasma densities throughout the processing region can be established and maintained.

In further accordance with preferred embodiments of the invention, coils 22 and 24 have a uniform coil pitch, i.e. the spacing between adjacent turns of each coil, and preferably also between the outer turn of coil 22 and the inner turn of coil 24, will be substantially identical. However, the winding pitch can also be made nonuniform in order to improve plasma uniformity in a given installation.

In the disclosed embodiments, coils 22 and 24 may be tubular, ribbon shaped, etc., and may contain a channel for circulation of cooling water. Because the coils 22 and 24 are entirely external to the pressure chamber 2, coupling the coils to suitable RF and coolant sources is readily facilitated because such couplings need not pass through the pressure chamber walls.

In the embodiment shown in Fig. 1, magnet assembly 12 surrounds target 8. The magnetic field produced by magnet assembly 12 serves to enhance ionization within the portion of the plasma field adjacent target 8 and promotes increased deposition rates and uniform target etching according to principles already known in the art.

The second embodiment shown in Fig. 4 is identical to the embodiment of Fig. 1 except for the structural arrangement of the target and its associated magnet assembly. Specifically, in the embodiment shown in Fig. 3, magnet assembly 52 is positioned above target 48, i.e. between target 48 and coils 22, 24. Here again, magnet assembly 52 may be either stationary or rotatable about the vertical center axis of chamber 2. In the embodiment of Fig. 4, the magnetic field produced by magnet assembly 52 will be oriented at right angles to the magnetic field produced by magnet assembly 12 of the embodiment shown in Fig. 1.

Target 48 has a ring, or annular, shape, as does target 8 of Fig. 1, and both targets 8 and 48 have an inner diameter which is not smaller than the diameter of the workpiece support surface of support 6. However, target 48 is shaped to be compatible with the orientation of the magnetic field produced by magnet assembly 52.

Yet another embodiment shown in Fig. 5 differs from that of Fig. 4 solely with respect to the dimensions of the target and its associated magnet assembly. In the embodiment shown in Fig. 5, target 58 and magnet assembly 62 are dimensioned and positioned to be located in a vertical projection of the space between the outer turn of coil 22 and the inner turn of coil 24. However, there may be some horizontal overlap between the inner and outer diameters of target 58 and magnet assembly 62, on the one hand, and the outer diameter of coil 22 and the inner diameter of coil 24, on the other hand.

According to one feature of the present invention, it is believed that the combination of an annular, or ring-shaped, target as a source of sputtering material and a domed spiral coil for producing an inductively coupled plasma which ionizes metal sputtered from the target, can serve to produce a medium to high density inductively coupled plasma having a more homogeneous plasma density and ionized metal flux than previous ionized sputtering arrangements. In addition, the provision of a slotted metal shield covering the dielectric window can prevent a deposited metal film from covering the entire window while allowing sufficient RF energy to be coupled through the window and shield into the processing region enclosed by chamber 2.

It will, of course, be understood that modifications of the present invention, in its various aspects, will be apparent to those skilled in the art, some being apparent only after study, others being matters of routine mechanical and electronic design. Other embodiments are also possible, their specific designs depending upon the particular application. As such, the scope of the invention should not be limited by the particular embodiments herein described but should be defined only by the appended claims and equivalents thereof.

WHAT IS CLAIMED IS:

1. An apparatus for processing a workpiece, said apparatus comprising:

a processing chamber having a first wall;

a workpiece support disposed in said processing chamber;

a sputtering target disposed in said processing chamber and comprising a material to be sputtered from said target;

a dielectric member forming a part of said first wall of said processing chamber;

at least one coil disposed outside of said processing chamber and adjacent said dielectric member, said coil being adapted to receive an RF current and generate RF magnetic fields through said dielectric member into said chamber in order to create an inductively coupled plasma in said chamber to ionize said sputtered material for deposition on said workpiece; and

a shield disposed within said processing chamber between said dielectric member and said target to prevent deposition of sputtered material onto at least a portion of said dielectric member.

2. The apparatus according to claim 1 wherein said at least one coil is a spiral coil carried by said dielectric member outside of said processing chamber.

3. The apparatus according to claim 2 wherein said dielectric member has a dome-shaped surface and said at least one spiral coil is wound to conform to said dome-shaped surface.

4. The apparatus according to claim 3 wherein said shield is composed of a sheet of electrically conductive material.

5. The apparatus according to claim 4 wherein said sheet is provided with a plurality of slots providing paths for flow of magnetic field energy from said at least one coil into said processing chamber.

6. The apparatus according to claim 1 wherein said shield defines a plurality of slots providing paths for flow of magnetic field energy from said at least one coil into said processing chamber, and wherein said dielectric member has an inner surface adjacent to but spaced from said shield, and a plurality of slot-shaped coatings of

conductive metal deposition material sputtered onto said inner surface.

7. The apparatus according to claim 6 wherein said shield is spaced from said dielectric member to create a gap between said shield and said dielectric member.

8. The apparatus according to claim 7 wherein said said target comprises a conductive metal material and said dielectric member has an inner surface which includes a first inner surface portion adjacent a shield slot, said first inner surface portion having a coating of conductive material sputtered from a target and wherein said dielectric member inner surface includes a second inner surface portion positioned behind said shield, said second inner surface portion being substantially free of said conductive material coating wherein energy from said coil may be coupled through said dielectric member second inner surface portion and through said gap to said plasma inside said chamber.

9. The apparatus according to claim 7 wherein said shield has a circular form and said slots extend substantially radially between the edge and the center of said shield.

10. The apparatus according to claim 9 wherein said dielectric member is a dome-shaped member, said shield is a dome-shaped sheet conforming in shape to said dielectric member and said shield extends across the entirety of said dielectric member.

11. The apparatus according to claim 10 wherein said shield is electrically grounded.

12. The apparatus according to claim 1 wherein said shield is composed of a sheet of electrically conductive material.

13. The apparatus according to claim 12 wherein said sheet is provided with a plurality of slots providing paths for flow of magnetic field energy from said at least one coil into said processing chamber.

14. The apparatus according to claim 13 wherein said shield is spaced from said dielectric member to create a gap between said shield and said dielectric member.

15. The apparatus according to claim 14 wherein said shield has a circular form and said slots extend substantially radially between the edge and the center of said shield.

16. The apparatus according to claim 15 wherein said dielectric member is a dome-shaped member, said shield is a dome-shaped sheet conforming in shape to said dielectric member and said shield extends across the entirety of said dielectric member.

17. The apparatus according to claim 16 wherein said shield is electrically grounded.

18. The apparatus according to claim 1 wherein said at least one coil comprises two spiral coils, and said apparatus further comprises two RF power sources each connected to a respective one of said two spiral coils.

19. The apparatus according to claim 18 wherein each of said RF power sources is adjustable.

20. The apparatus according to claim 18 wherein one of said spiral coils is an inner spiral coil and the other of said spiral coils is an outer spiral coil surrounding said inner spiral coil.

21. The apparatus according to claim 20 wherein said dielectric member is a dome-shaped member having a dome-shaped surface and a diameter, and said two spiral coils are wound to conform to said dome-shaped surface, said outer spiral coil having an outer diameter substantially equal to the diameter of the dome-shaped member and said inner spiral coil having an outer diameter substantially equal to 3 to 2 of the diameter of the dome-shaped member.

22. The apparatus according to claim 21 wherein said sputtering target is an annular body.

23. The apparatus according to claim 1 wherein said sputtering target is an annular body.

24. The apparatus according to claim 23 further comprising a permanent magnet assembly disposed adjacent said annular body.

25. The apparatus according to claim 24 wherein said permanent magnet

assembly surrounds said annular body.

26. The apparatus according to claim 24 wherein said permanent magnet assembly is positioned between said annular body and said shield.

27. The apparatus according to claim 26 wherein said at least one coil is a spiral coil having an outer diameter and said annular body has an inner diameter at least as large as the outer diameter of said spiral coil.

28. The apparatus according to claim 27 wherein: said at least one spiral coil comprises two spiral coils; said apparatus further comprises two RF power sources each coupled to a respective one of said two spiral coils; one of said spiral coils is an inner spiral coil and the other of said spiral coils is an outer spiral coil surrounding said inner spiral coil; said inner spiral coil has an outer diameter; said outer spiral coil has an inner diameter; and at least a part of said annular body is located between said inner and outer diameters.

29. The apparatus according to claim 28 wherein said annular body is located substantially entirely between said inner and outer diameters.

30. The apparatus according to claim 24 wherein said permanent magnet assembly is stationary.

31. The apparatus according to claim 24 wherein said permanent magnet assembly is rotatable about said annular body.

32. A method of processing deposition material, comprising:

sputtering conductive material in a processing chamber having a window comprising a dielectric member;

shielding a portion of an inner surface of said dielectric member using a shield to prevent depositing a coating of said conductive material onto said portion; and

inductively coupling RF energy through said dielectric member inner surface portion and an opening in said shield to a plasma in the interior of a chamber from an RF coil positioned outside said chamber to ionize said sputtered material for deposition onto a workpiece.

33. The method according to claim 32 wherein said coil is a spiral coil carried by said dielectric member outside of said processing chamber.

34. The method according to claim 33 wherein said dielectric member has a dome-shaped outer surface and said spiral coil is wound to conform to said dome-shaped surface.

35. The method according to claim 32 wherein said shield is composed of a sheet of electrically conductive material.

36. The method according to claim 35 wherein said sheet is provided with a plurality of slot-shaped openings providing paths for flow of RF magnetic field energy from said coil into said processing chamber.

37. The method according to claim 36 wherein said shield is spaced from said dielectric member to create a gap between said shield and said dielectric member.

38. The method according to claim 37 wherein said dielectric member has an inner surface which includes a first inner surface portion adjacent a shield slot, said first inner surface portion having a coating of conductive material sputtered from a target and wherein said dielectric member inner surface includes a second inner surface portion positioned behind said shield, said second inner surface portion being substantially free of said conductive material coating wherein energy from said coil may be coupled through said dielectric member second inner surface portion and through said gap to said plasma inside said chamber.

39. The method according to claim 37 wherein said shield has a circular form defining a peripheral edge and a center, said slots extending substantially radially between the edge and the center of said shield.

40. The method according to claim 39 wherein said dielectric member is a dome-shaped member, said shield is a dome-shaped sheet conforming in shape to said dielectric member and said shield extends across the entirety of said dielectric member.

41. The method according to claim 40 wherein said shield is electrically grounded.

42. The method according to claim 32 wherein said coupling further comprises using two spiral coils, and two RF power sources, each coupled to a respective one of said two spiral coils.

43. The method according to claim 42 wherein each of said RF power sources is adjustable.

44. The method according to claim 42 wherein one of said spiral coils is an inner spiral coil and the other of said spiral coils is an outer spiral coil surrounding said inner spiral coil.

45. The method according to claim 44 wherein said dielectric member is a dome-shaped member having a dome-shaped outer surface and said two spiral coils are wound to conform to said dome-shaped surface, said outer spiral coil having an outer diameter substantially equal to the diameter of the dome-shaped member and said inner spiral coil having an outer diameter substantially equal to 3 to 2 of the diameter of the dome-shaped member.

46. The method according to claim 45 wherein said sputtering includes using a target having an annular body.

47. The method according to claim 32 wherein said sputtering includes using a target having an annular body.

48. The method according to claim 47 wherein said sputtering includes using a permanent magnet assembly disposed adjacent said annular body.

49. The method according to claim 48 wherein said permanent magnet assembly surrounds said annular body.

50. The method according to claim 24 wherein said permanent magnet assembly is positioned between said annular body and said shield.

51. The method according to claim 50 wherein said coil is a spiral coil having an outer diameter and said annular body has an inner diameter at least as large as the outer

diameter of said spiral coil.

52. The method according to claim 51 wherein said coupling comprises a second spiral coil and two RF power sources each connected to a respective one of said two spiral coils; one of said spiral coils is an inner spiral coil and the other of said spiral coils is an outer spiral coil surrounding said inner spiral coil; said inner spiral coil has an outer diameter; said outer spiral coil has an inner diameter; and at least a part of said annular body is located between said inner and outer diameters.

53. The method according to claim 52 wherein said annular body is located substantially entirely between said inner and outer diameters.

54. The method according to claim 24 wherein said permanent magnet assembly is stationary.

55. The method according to claim 54 wherein said permanent magnet assembly is positioned in the interior of said chamber

56. The method according to claim 24 wherein said permanent magnet assembly is rotatable about said annular body.

57. A method of processing deposition material, comprising:

sputtering conductive material from a sputtering target in a chamber onto a dielectric member and onto a shield positioned between said target and said dielectric member, said sputtering including depositing conductive material through an opening of said shield onto a first portion of an inner surface of said dielectric member to form a first coating of said conductive material, and blocking deposition of said conductive material onto a second portion of said inner surface of said dielectric member using said shield to prevent depositing a coating of said conductive material onto said second portion; and

inductively coupling RF energy through said dielectric member inner surface second portion and said shield opening to a plasma in the interior of a chamber from an RF coil positioned outside said chamber, to ionize said material.

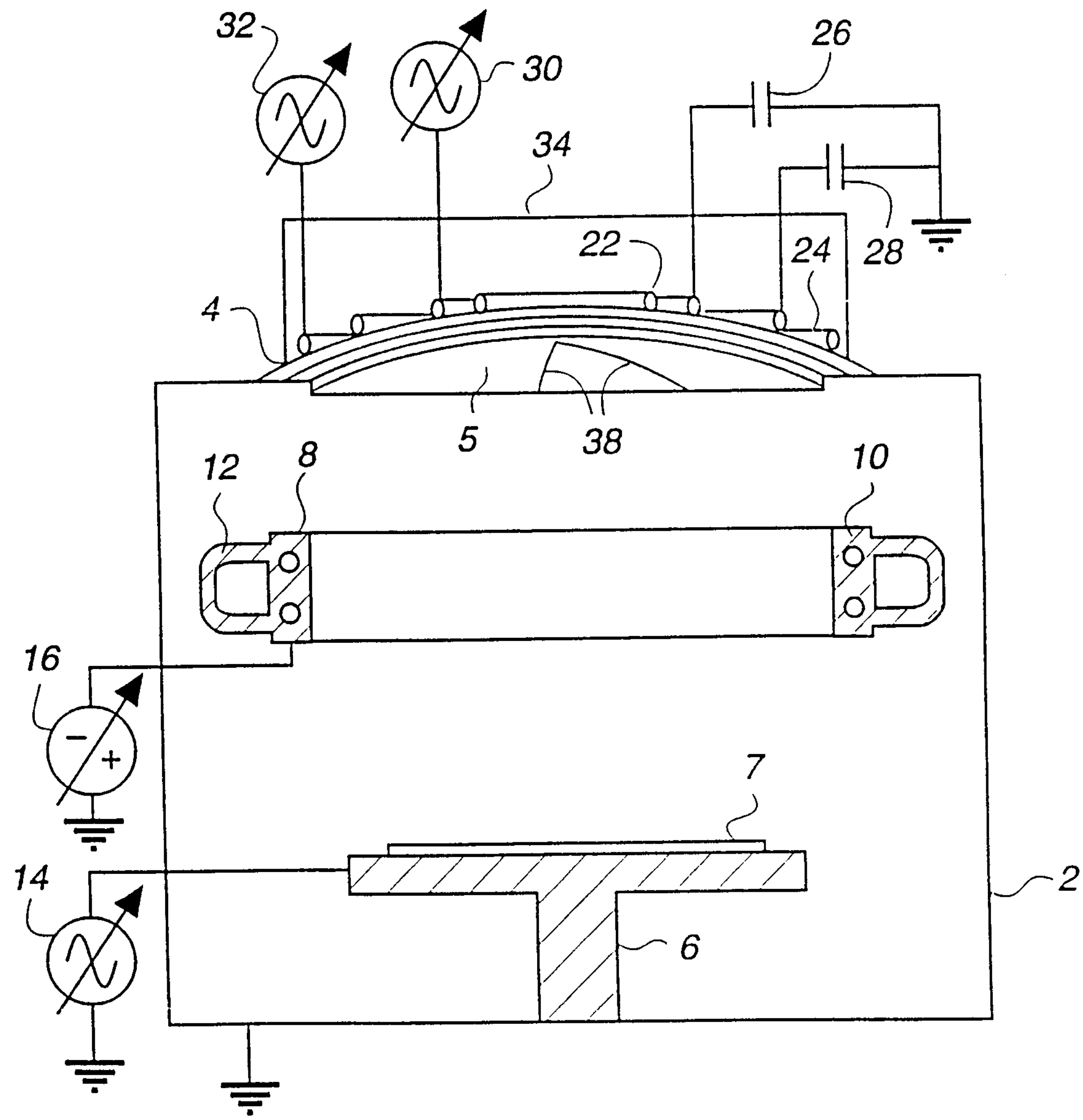

Fig. 1

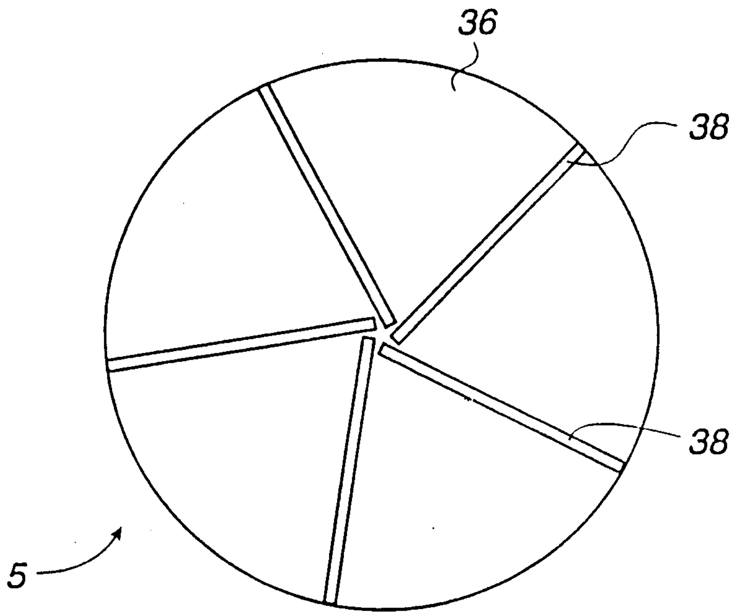

Fig. 2

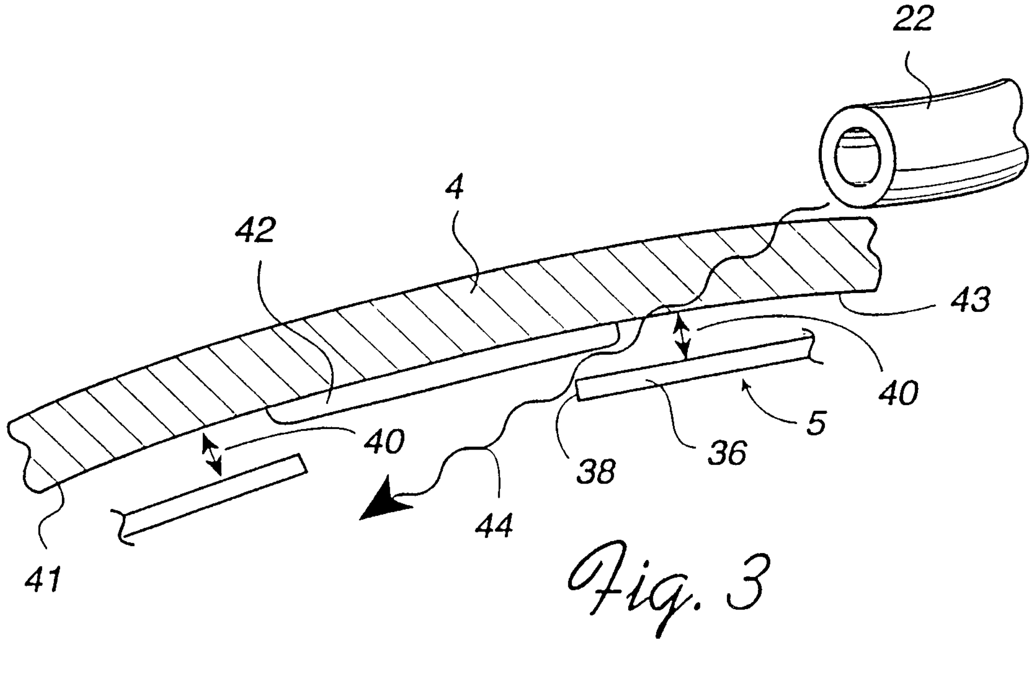

Fig. 3

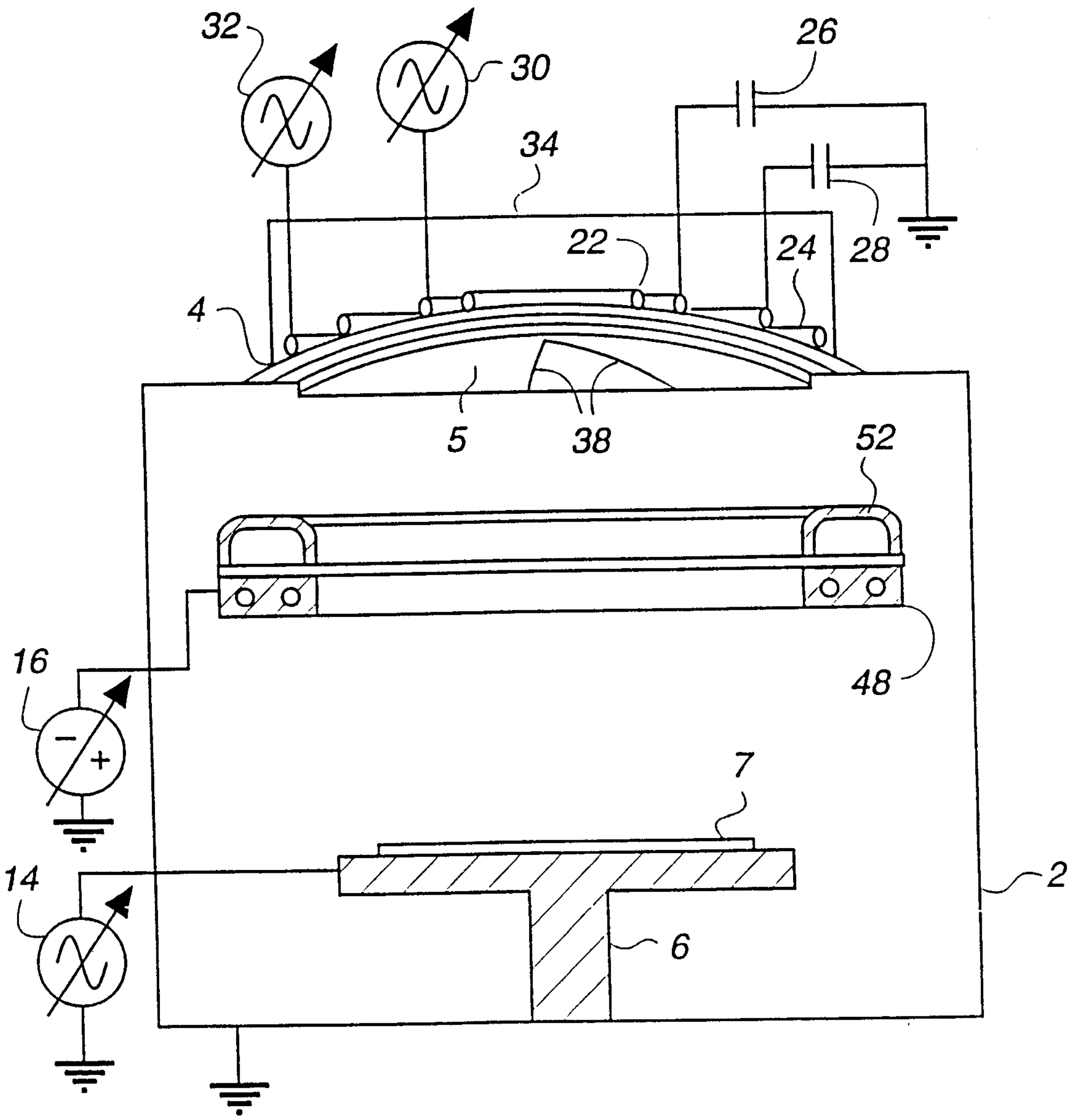

Fig. 4

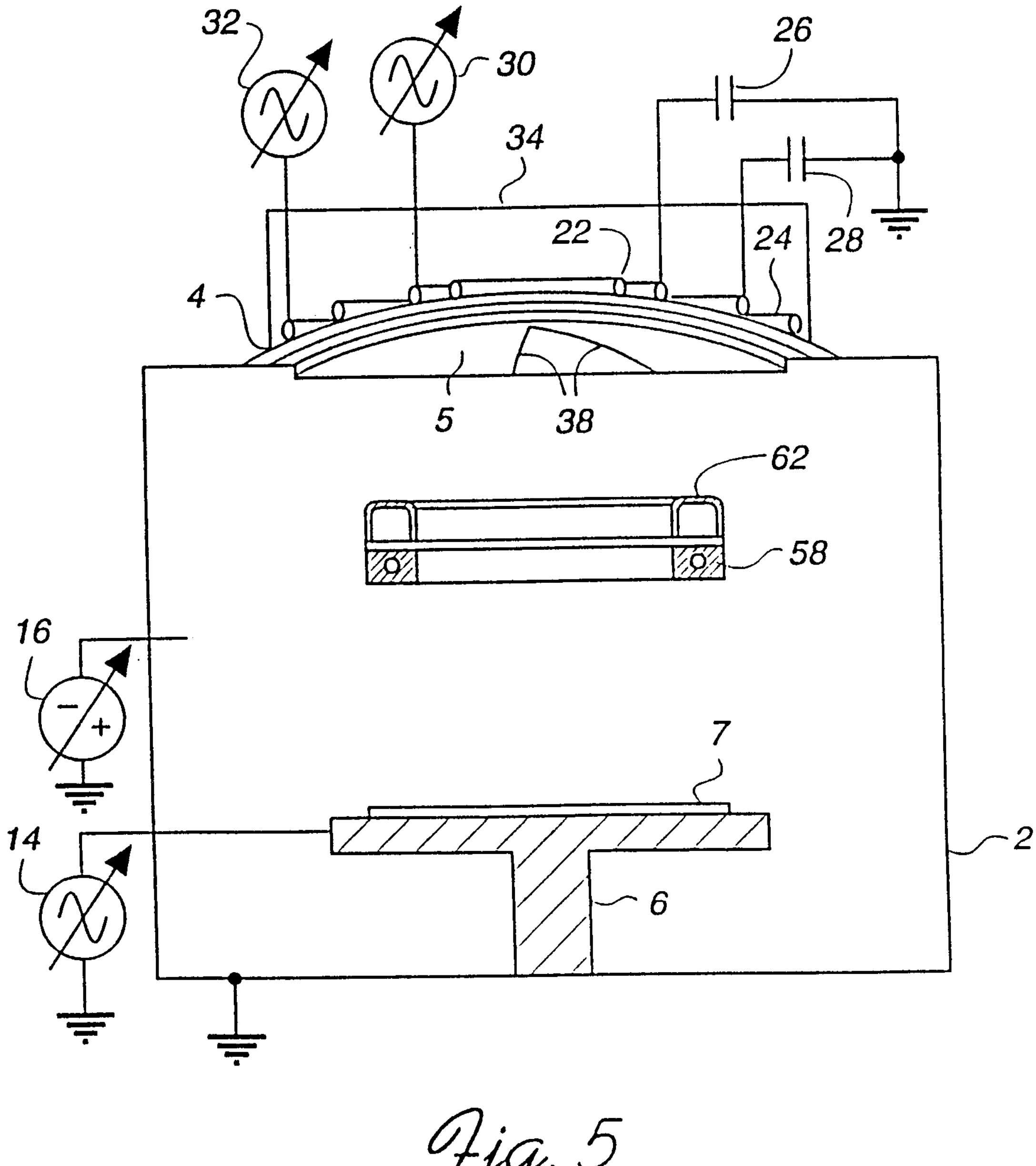

Fig. 5

INTERNATIONAL SEARCH REPORT

Inte... onal Application No
PCT/US 98/19295

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H01J37/32 H01J37/34

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	EP 0 801 413 A (VARIAN ASSOCIATES) 15 October 1997 see column 4, line 57 - column 5, line 20 see column 6, line 51 - column 7, line 30 see column 10, line 33 - column 11, line 1; figures 5-10	1,2,4-9, 12-15, 32,33, 35-39,57
P,X	US 5 800 688 A (LICATA THOMAS J ET AL) 1 September 1998 see the whole document	1,32,57
A	EP 0 782 172 A (APPLIED MATERIALS INC) 2 July 1997 see column 2, line 6 - line 19 see column 5, line 7 - column 6, line 34; figure 1	1,32,57

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 January 1999	18/01/1999
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Schaub, G

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INTERNATIONAL SEARCH REPORT

Inte ,onal Application No
PCT/US 98/19295

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 540 800 A (QIAN XUEYU) 30 July 1996 see the whole document -----	3,10,34, 40

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter onal Application No
PCT/US 98/19295

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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US 5800688 A	01-09-1998	WO 9848444 A	29-10-1998
EP 0782172 A	02-07-1997	US 5763851 A	09-06-1998
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