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APPLICANT:	Roman Chistyakov		
SERIAL NO.:	10/065,277	GROUP NO.:	1753
FILING DATE:	September 30, 2002	EXAMINER:	McDonald, Rodney G.
TITLE:	HIGH-POWER PULSED MAGNETRON SPUTTERING		

Commissioner for Patents
Alexandria, Virginia 22313-1450

RESPONSE

Sir:

The following amendments and remarks are responsive to the Office Action mailed on August 30, 2004 in the above-identified patent application. Entry and consideration of the following amendments and remarks, and allowance of the claims, as presented, are respectfully requested. A Petition for a three–month extension of time, up to and including February 28, 2005 is submitted herewith. The Commissioner is hereby authorized to charge the extension fee, the additional claims fee, and any other proper fees to Attorney's Deposit Account No. 501211.

Please enter the following amendments and consider the remarks that follow.

Pending Claims:

1. (Previously Presented) A magnetically enhanced sputtering source comprising:

a) an anode;

b) a cathode assembly that is positioned adjacent to the anode, the cathode assembly including a sputtering target;

c) an ionization source that generates a weakly-ionized plasma proximate to the anode and the cathode assembly;

d) a magnet that is positioned to generate a magnetic field proximate to the weakly-ionized plasma, the magnetic field substantially trapping electrons in the weakly-ionized plasma proximate to the sputtering target; and

e) a power supply generating a voltage pulse that produces an electric field between the cathode assembly and the anode, an amplitude and a rise time of the voltage pulse being chosen to increase an excitation rate of ground state atoms that are present in the weakly-ionized plasma to create a multi-step ionization process that generates a strongly-ionized plasma from the weakly-ionized plasma, the multi-step ionization process comprising exciting the ground state atoms to generate excited atoms, and then ionizing the excited atoms within the weakly-ionized plasma to create ions that sputter target material from the sputtering target.

2. (original) The sputtering source of claim 1 wherein the power supply generates a constant power.

3. (original) The sputtering source of claim 1 wherein the power supply generates a constant voltage.

4. (original) The sputtering source of claim 1 wherein the electric field comprises a quasi-static electric field.

5. (original) The sputtering source of claim 1 wherein the electric field comprises a pulsed electric field.

6. (Previously Presented) The sputtering source of claim 1 wherein the rise time of the voltage pulse is chosen to increase the ionization rate of the excited atoms in the weakly-ionized plasma.

7. (Previously Presented) The sputtering source of claim 1 wherein the weakly-ionized plasma reduces the probability of developing an electrical breakdown condition between the anode and the cathode assembly.

8. (original) The sputtering source of claim 1 wherein the ions in the strongly-ionized plasma impact the surface of the sputtering target in a manner that causes substantially uniform erosion of the sputtering target.

9. (original) The sputtering source of claim 1 wherein the strongly-ionized plasma is substantially uniform proximate to the sputtering target.

10. (original) The sputtering source of claim 1 further comprising a substrate support that is positioned in a path of the sputtering flux.

11. (original) The sputtering source of claim 10 further comprising a temperature controller that controls the temperature of the substrate support.

12. (original) The sputtering source of claim 10 further comprising a bias voltage power supply that applies a bias voltage to a substrate that is positioned on the substrate support.

13. (original) The sputtering source of claim 1 wherein a volume between the anode and the cathode assembly is chosen to increase the ionization rate of the excited atoms in the weakly-ionized plasma.

14. (original) The sputtering source of claim 1 wherein the ionization source comprises an electrode.

15. (original) The sputtering source of claim 1 wherein the ionization source comprises a DC power supply that generates an electric field proximate to the anode and the cathode assembly.

16. (original) The sputtering source of claim 1 wherein the ionization source comprises an AC power supply that generates an electric field proximate to the anode and the cathode assembly.

17. (original) The sputtering source of claim 1 wherein the ionization source is chosen from the group comprising a UV source, an X-ray source, an electron beam source, and an ion beam source.

18. (original) The sputtering source of claim 1 wherein the magnet comprises an electro-magnet.

19. (original) The sputtering source of claim 1 wherein the sputtering target is formed of a material chosen from the group comprising a metallic material, a polymer material, a superconductive material, a magnetic material, a non-magnetic material, a conductive material, a non-conductive material, a composite material, a reactive material, and a refractory material.

20. (Previously Presented) A method of generating sputtering flux, the method comprising:

a) ionizing a feed gas to generate a weakly-ionized plasma proximate to a sputtering target;

b) generating a magnetic field proximate to the weakly-ionized plasma, the magnetic field substantially trapping electrons in the weakly-ionized plasma proximate to the sputtering target; and

c) applying a voltage pulse to the weakly-ionized plasma, an amplitude and a rise time of the voltage pulse being chosen to increase an excitation rate of ground state atoms that are present in the weakly-ionized plasma to create a multi-step ionization process that generates a strongly-ionized plasma from the weakly-ionized plasma, the multi-step ionization process comprising exciting the ground state atoms to generate excited atoms, and then ionizing the excited atoms within the weakly-ionized plasma to sputter target material from the sputtering target.

21. (original) The method of claim 20 wherein the applying the electric field comprises a applying a quasi-static electric field.

22. (original) The method of claim 20 wherein the applying the electric field comprises applying a substantially uniform electric field.

23. (original) The method of claim 20 wherein the applying the electric field comprises applying an electrical pulse across the weakly-ionized plasma.

24. (original) The method of claim 23 further comprising selecting at least one of a pulse amplitude and a pulse width of the electrical pulse that increases an ionization rate of the strongly-ionized plasma.

25. (original) The method of claim 23 further comprising selecting at least one of a pulse amplitude and a pulse width of the electrical pulse that reduces a probability of developing an electrical breakdown condition proximate to the sputtering target.

26. (original) The method of claim 23 further comprising selecting at least one of a pulse amplitude and a pulse width of the electrical pulse that causes the strongly-ionized plasma to be substantially uniform in an area adjacent to a surface of the sputtering target.

27. (original) The method of claim 23 wherein the electrical pulse comprises a pulse having a current density that is greater than $1A/cm^2$.

28. (original) The method of claim 23 wherein the electrical pulse comprises a pulse having a pulse width that is greater than 1.0 microseconds.

29. (original) The method of claim 23 wherein the electrical pulse comprises a pulse train having a repetition rate that is substantially between 0.1Hz and 1kHz.

30. (original) The method of claim 20 wherein the ions in the strongly-ionized plasma impact the surface of the sputtering target in a substantially uniform manner.

31. (original) The method of claim 20 wherein the strongly-ionized plasma is substantially uniform proximate to the sputtering target.

32. (original) The method of claim 20 wherein the peak plasma density of the weakly-ionized plasma is less than about 10^{12} cm^{-3}.

33. (original) The method of claim 20 wherein the peak plasma density of the strongly-ionized plasma is greater than about 10^{12} cm^{-3}.

34. (Previously Presented) The method of claim 20 further comprising forming a film on a surface of a substrate from the material sputtered from the sputtering target.

35. (original) The method of claim 34 further comprising controlling a temperature of the film.

36. (original) The method of claim 34 further comprising applying a bias voltage to the film.

37. (original) The method of claim 20 wherein the ionizing the feed gas comprises exposing the feed gas to an electric field.

38. (original) The method of claim 20 wherein the ionizing the feed gas comprises exposing the feed gas to an electrode that is adapted to emit electrons.

39. (original) The method of claim 20 wherein the ionizing the feed gas comprises exposing the feed gas to at least one of a UV source, an X-ray source, an electron beam source, and an ion beam source.

40. (Previously Presented) A magnetically enhanced sputtering source comprising:

a) means for ionizing a feed gas to generate a weakly-ionized plasma proximate to a sputtering target;

b) means for generating a magnetic field proximate to the weakly-ionized plasma, the magnetic field substantially trapping electrons in the weakly-ionized plasma proximate to the sputtering target; and

c) means for applying a voltage pulse to the weakly-ionized plasma, an amplitude and a rise time of the voltage pulse being chosen to increase an excitation rate of ground state atoms that are present in the weakly-ionized plasma to create a multi-step ionization process that generates a strongly-ionized plasma from the weakly-ionized plasma, the multi-step ionization process comprising exciting the ground state atoms to generate excited atoms, and then ionizing the excited atoms within the weakly-ionized plasma to ions that sputter target material from the sputtering target.

41. (Previously Presented) The sputtering source of claim 1 wherein the cathode assembly and the anode are positioned so as to form a gap therebetween.

42. (Previously Presented) The sputtering source of claim 1 wherein the weakly-ionized plasma is generated from a feed gas that comprises the ground state atoms.

43. (Previously Presented) The sputtering source of claim 1 wherein the excited atoms within the weakly-ionized plasma are ionized by electrons to create the ions that sputter material from the sputtering target.

44. (Previously Presented) The sputtering source of claim 1 wherein the rise time of the voltage pulse is approximately between 0.01 and 100V/μsec.

45. (Previously Presented) The sputtering source of claim 1 wherein the amplitude of the voltage pulse is approximately between 100V and 30kV.

46. (Previously Presented) The method of claim 20 wherein the weakly-ionized plasma is generated from a feed gas that comprises the ground state atoms.

47. (Previously Presented) The method of claim 20 wherein a duration of the weakly-ionized plasma is approximately between one microsecond and one hundred seconds.

48. (Previously Presented) The method of claim 20 wherein the ionizing the excited atoms within the weakly-ionized plasma to create ions that sputter material from the sputtering target comprises ionizing the excited atoms with electrons.

49. (Previously Presented) The method of claim 20 wherein the rise time of the voltage pulse is approximately between 0.01 and 100V/μsec.

50. (Previously Presented) The method of claim 20 wherein the amplitude of the voltage pulse is approximately between 100V and 30kV.

REMARKS

Pending Claims

Claims 1-50 are currently pending in the present application. Upon entry of the present Response, reconsideration of claims 1-50 and consideration is respectfully requested.

Provisional Non-Statutory Double Patenting Rejections

The Examiner has rejected claims 1-50 under the judicially created doctrine of double patenting over claims of copending Patent Application Serial No. 10/065,739 in view of Kouznetsov (WO 98/40532). Copending Patent Application Serial No. 10/065,739 is assigned to the assignee of the present application. The Applicant would like to inform the Examiner that copending Patent Application Serial No. 10/065,739 has been allowed and the issue fee was paid on February 9, 2005.

The Applicant is submitting herewith a Terminal Disclaimer to Obviate a Provisional Double Patenting Rejection Over a Pending Second Application in compliance with 37 C.F.R. 1.321. The Terminal Disclaimer was signed by the President of Zond, Inc., who is also the sole inventor of the present application. The Applicant is also submitting a Statement Under 37 CFR 3.73(b) that states that Zond, Inc. is the assignee of the entire right, title, and interest of the Pending Second Application. An Assignment assigning the entire right, title, and interest in the present application to Zond, Inc. was recorded at Reel 013351, Frame 0573.

A fee transmittal authorizing the U.S. Patent Office to charge the $65.00 fee for the Statutory Disclaimer as set forth in 37 CFR § 1.20(d) is enclosed.

Rejections under 35 U.S.C. §102(b) As Being Anticipated by Kouznetsov

Claims 1, 5-10, 13-14, 16, 19-20, 22-31, 34, 37-38, and 40-50 are rejected under 35 U.S.C. §102(b) as being anticipated by Kouznetsov (WO98/40532) (hereinafter "Kouznetsov"). The Applicant respectfully traverses this rejected under 35 U.S.C. §102(b).

To anticipate a claim under 35 U.S.C. §102, a single reference must teach every aspect of the claimed invention either explicitly or impliedly. Any feature not directly taught by the reference must be inherently present in the reference. Thus, a claim is anticipated by a reference only if each and every element of the claim is described, either expressly or inherently, in a single prior art reference.

Independent Claim 1 and Dependent Claims 5-10, 13, 14, 16, and 19

The Applicant respectfully submits that Kouznetsov does not describe each and every element of independent claim 1 as amended in the Response to Office Action dated June 14, 2004. Independent claim 1 recites a magnetically enhanced sputtering source having a power supply that generates a voltage pulse that produces an electric field between the cathode assembly and the anode. The voltage pulse generated by the power supply comprises an amplitude and a rise time that is chosen to increase an excitation rate of ground state atoms that are present in the weakly-ionized plasma to create a multi-step ionization process that generates a strongly-ionized plasma from the weakly-ionized plasma.

The Applicant submits that there is no description in Kouznetsov of the power supply claimed in independent claim 1. Specifically, the Applicant submits that there is no description in Kouznetsov of choosing the amplitude and the rise time of the voltage pulse generated by the power supply to increase the excitation rate of ground state atoms that are present in the weakly-ionized plasma to generate a multi-step ionization process as claimed in independent claim 1.

The last paragraph of page 3 of the Office Action dated August 30, 2004 states that Kouznetsov describes a power supply where each pulse can be in the range of 0.1KW to 1MW and that the pulses can have a duration in the range of less than a hundred microseconds up to hundreds of microseconds and the intervals between pulses can range from milliseconds up to seconds. The Office Action references Kouznetsov, page 4, lines 14-23. The first full paragraph of page 4 of the Office Action dated August 30, 2004 states that Kouznetsov describes that the voltage of the pulses can be hundreds of volts up to several kilovolts. The Office Action references Kouznetsov, page 6, lines 24-25.

The Applicant submits that many pulsed power supplies for experimental apparatus, like the apparatus described in Kouznetsov, can generate at least one of variable power levels, variable pulse durations and variable intervals between pulses. The Applicant submits that merely describing a power supply that can generated pulses with variable parameters does not teach generating pulses with amplitudes and rise times that are chosen to achieve particular ionization characteristics, such as generating a multi-step ionization process as claimed in independent claim 1 and as described in the specification. See, for example, paragraphs 63-67 of the present application for a description of multi-step ionization.

The Office Action dated August 30, 2004 states on the last paragraph of page 2 that the gas in the region between the anode and the cathode will be partially ionized by electrons. The Office Action references Kouznetsov, page 9, lines 21-25. This section of Kouznetsov also states that the electrons will be somewhat trapped or confined by the magnetic field primarily moving in the areas of low magnetic field intensity and that there is a larger concentration of ions in these areas.

The Applicant submits that the terms "partial ionization" and "more ionized" used in Kouznetsov page 9, lines 21-25 refer to the plasma itself. These terms do not imply anything about the ionization process used to generate the ions in the partially or more fully ionized plasmas. The Applicant submits that Kouznetsov page 9, lines 21-25 describes the generation of partially ionized and more fully ionized plasmas by direct ionization or atomic ionization by electron impact (hereinafter "direct ionization") that is used in most known plasma generators. See, for example, paragraphs 27-29 of the present specification for a description of direct ionization.

According to Kouznetsov, the pulsed power source used in the Kouznetsov apparatus provides "pulses in such a way, i.e. that so much power is developed in each pulse, that in the application of such a pulse, for a very short time during the start of the pulse, the state of the gas located at the region in which the electrons are trapped by the magnetic field will very rapidly reach a fully ionized state…" See, for example, Kouznetsov page 5, lines 1-4. Thus, Kouznetsov describes a power supply that generates a pulse having a large voltage (2,000 Volts) in a very short time duration so that the gas very rapidly reaches a fully ionized state.

The Applicant submits that one skilled in the art will appreciate that the application of a very large voltage pulse in a very short time duration will ionize the gas by direct ionization with electrons located in the region having crossed electric and magnetic fields. See, for example, Kouznetsov page 12, lines 22-26. The Applicant further submits that there is no description in Kouznetsov of the multi-step ionization process claimed in independent claim 1. See, for example, paragraphs 63-67 of the present application for a description of multi-step ionization.

The energies required to achieve the multi-step ionization process claimed in independent claim 1 are different from the energies required to achieve the direct ionization that is used to generated plasmas in the apparatus described in Kouznetsov. As described in paragraph 63 of the specification of the present application, an argon atom requires an energy of about 11.55eV to become excited. The excited atoms only require about 4eV of energy to ionize. In contrast, neutral argon atoms ionized by direct ionization require about 15.76eV. Independent claim 1 recites that an amplitude and a rise time of the voltage pulse are chosen to increase an excitation rate of ground state atoms that are present in the weakly-ionized plasma to create a multi-step ionization process that generates a strongly-ionized plasma from the weakly-ionized plasma. For the example given in the specification, the amplitude and rise time are chosen to result in a 11.55eV increase in energy compared with a 15.76eV increase in energy that would be required to ionize neutral argon atoms by direct ionization.

Furthermore, the Applicant submits that one skilled in the art will appreciate that if any multi-step ionization is occurring in plasmas generated using the power supply described in Kouznetsov, that such ionization will be statistically insignificant. Therefore, the Applicant submits that Kouznetsov does not describe the power supply claimed in independent claim 1.

In view of the above remarks, the Applicant respectfully submits that Kouznetsov does not describe each and every element of independent claim 1, either expressly or inherently. Therefore, the Applicant submits that Kouznetsov does not anticipate independent claim 1 under 35 U.S.C. §102(b). Thus, the Applicant submits that independent claim 1 is allowable. The Applicant also submits that dependent claims 5-10, 13, 14, 16, and 19 are allowable as depending from an allowable base claim.

Independent Claim 20 and Dependent Claims 22-31, 34, and 37-38

The Applicant respectfully submits that Kouznetsov does not describe each and every element of independent claim 20 as amended in the Response to Office Action dated June 14, 2004. Independent claim 20 recites the step of applying a voltage pulse to the weakly-ionized plasma. An amplitude and a rise time of the voltage pulse are chosen to increase an excitation rate of ground state atoms in the weakly-ionized plasma to create a multi-step ionization process. The multi-step ionization process generates excited atoms from ground state atoms in the weakly-ionized plasma, and then ionizes the excited atoms in the weakly-ionized plasma.

The Applicant submits that there is no description in Kouznetsov of the method of generating a strongly-ionized plasma using a multi-step ionization process as claimed in independent claim 20. As described in connection with the rejection of independent claim 1 under 35 U.S.C. §102(b), Kouznetsov describes a power supply that generates a pulse having a large voltage (2,000 Volts) in a very short time duration so that the gas very rapidly reaches a fully ionized state. The Applicant submits that one skilled in the art will appreciate that the application of a very large voltage pulse in a very short time duration will ionize the gas by direct ionization. Furthermore, the Applicant believes that if any multi-step ionization is occurring in plasma generated using the method described in Kouznetsov, that such ionization will be statistically insignificant.

In view of the above remarks, the Applicant respectfully submits that Kouznetsov does not describe each and every element of independent claim 20. Therefore, the Applicant submits that Kouznetsov does not anticipate independent claim 20. Thus, the Applicant submits that independent claim 20 and dependent claims 22-31, 34, 37, and 38 are allowable under 35 U.S.C. §102(b).

Independent Claim 40 and Dependent Claims 41-50

The Applicant respectfully submits that Kouznetsov does not describe each and every element of independent claim 40 as amended in the Response to Office Action dated June 14, 2004. Independent claim 40 recites a means for applying a voltage pulse to a weakly-ionized plasma. An amplitude and a rise time of the voltage pulse is chosen to increase an excitation rate of ground state atoms that are present in the weakly-ionized plasma to create a multi-step ionization process that generates a strongly-ionized plasma from the weakly-ionized plasma.

Also, the multi-step ionization process comprises exciting the ground state atoms to generate excited atoms, and then ionizing the excited atoms within the weakly-ionized plasma to ions that sputter target material from the sputtering target.

The Applicant submits that there is no description in Kouznetsov of the means for applying a voltage pulse to the weakly-ionized plasma as claimed in independent claim 40. As described in connection with the rejection of independent claim 1 under 35 U.S.C. §102(b), Kouznetsov describes a power supply that generates a pulse having a large voltage (2,000 Volts) in a very short time duration so that the gas very rapidly reaches a fully ionized state. The Applicant submits that one skilled in the art will appreciate that the application of a very large voltage pulse in a very short time duration will ionize the gas by direct ionization. Furthermore, the Applicant believes that if any multi-step ionization is occurring in plasma generated using the method described in Kouznetsov, that such ionization will be statistically insignificant.

In view of the above remarks, the Applicant respectfully submits that Kouznetsov does not describe each and every element of independent claim 40. Therefore, the Applicant submits that Kouznetsov does not anticipate independent claim 40. Thus, the Applicant submits that independent claim 40 and dependent claims 41-50 are allowable under 35 U.S.C. §102(b).

Rejections under 35 U.S.C. §102(b) as Being Anticipated by Mozgrin

Claims 1, 4-5, 7, 13-14, 16, 19-25, 27-29, 32-33, 37, and 40 are rejected under 35 U.S.C. §102(b) as being anticipated by Mozgrin et al. entitled "High Current Low-Pressure Quasi-Stationary Discharge in a Magnetic Field: Experimental Research", Plasma Physics Reports, Vol. 21, No. 5, 1995, pp. 400-409 (hereinafter "Mozgrin"). The Applicant respectfully traverses this rejected under 35 U.S.C. §102(b).

To anticipate a claim under 35 U.S.C. §102, a single reference must teach every aspect of the claimed invention either explicitly or impliedly. Any feature not directly taught by the reference must be inherently present in the reference. Thus, a claim is anticipated by a reference only if each and every element of the claim is described, either expressly or inherently, in a single prior art reference.

Independent Claim 1 and Dependent Claims 4-5, 7, 13-14, 16, and 19

The Applicant respectfully submits that Mozgrin does not describe each and every element of independent claim 1 as amended in the Response to Office Action dated June 14, 2004. Independent claim 1 recites a magnetically enhanced sputtering source having a power supply that generates a voltage pulse that produces an electric field between the cathode assembly and the anode. The voltage pulse generated by the power supply comprises an amplitude and a rise time that is chosen to increase an excitation rate of ground state atoms that are present in the weakly-ionized plasma to create a multi-step ionization process that generates a strongly-ionized plasma from the weakly-ionized plasma.

The Applicant submits that there is no description in Mozgrin of the power supply claimed in independent claim 1. Specifically, there is no description in Mozgrin of a power supply that generates a voltage pulse having an amplitude and a rise time that are chosen to increase the excitation rate of ground state atoms present in the weakly-ionized plasma to create a multi-step ionization process.

The last two paragraphs of page 4 of the Office Action dated August 30, 2004 states that Mozgrin describes a system for pre-ionization and a pulsed discharge supply unit. The first full paragraph of page 5 of the Office Action dated August 30, 2004 states that Mozgrin describes a pulse duration of 25ms and a repetition frequency of 10Hz.

As described in connection with the 35 U.S.C. §102(b) Kouznetsov rejection, the Applicant submits that merely describing a power supply that can generated pulses with variable parameters does not teach generating pulses with amplitudes and rise times that are chosen to achieve particular ionization characteristics, such as generating a multi-step ionization process, as claimed in independent claim 1 and as described in the specification. See, for example, paragraphs 63-67 of the present application for a description of multi-step ionization.

Furthermore, the Applicant submits that the term "pre-ionization" does not imply anything about the ionization process used to generate the ions and certainly does not imply that a multi-step ionization process as described in the present application is used to generate the discharge. The Applicant submits that Mozgrin describes a power supply that uses very high-power pulses to create a quasi-stationary discharge with direct ionization, not with the multi-step ionization as claimed in independent claim 1. See, for example, paragraphs 27-29 of the present specification for a description of direct ionization. The current and voltage characteristics (CVC) shown in FIG. 4 of Mozgrin includes four parts. The following paragraphs describe each of the four parts of the CVC of the quasi-stationary discharge shown in FIG. 4 of Mozgrin.

Part 1 of the CVC shown in FIG. 4 of Mozgrin is a low current (0.2A) discharge regime that is a pre-ionization stage of the quasi-stationary discharge. The pre-ionization stage is generated using a high-voltage power supply unit that produces a high-voltage, low-current discharge between two electrodes to create a pre-ionized plasma. The pre-ionized plasma density is low. However, the Applicant submits that the ions in the pre-ionized plasma are generated by direct ionization and any ions that are generated by a multi-step ionization process will be statistically insignificant. Furthermore, there is no description related to Part 1 of the CVC of choosing an amplitude and a rise time as claimed in independent claim 1.

Part 2 of the CVC shown in FIG. 4 of Mozgrin is a high-current, high-voltage discharge regime having a discharge current that is in the range of 0.2A-15A and a discharge voltage that is in the range of 350V-500V. The plasma discharge is formed by using a square voltage pulse. The resulting plasma discharge appears to be a typical magnetron plasma discharge that is commonly generated in plasma processing systems. The Applicant submits that the ions in Part 2 of the CVC are generated by direct ionization and any ions that are generated by a multi-step ionization process will be statistically insignificant. Furthermore, there is no description related to Part 2 of the CVC of choosing an amplitude and a rise time as claimed in independent claim 1. Instead, Mozgrin describes varying the plasma discharge conditions by changing the pressure and magnetic field strength. See Mozgrin page 403 lines 8-13.

Part 3 of the CVC shown in FIG. 4 of Mozgrin is a high-current discharge regime in which the discharge voltage remains stationary at 90V over a current that is in the range of 15A-1,000A. Part 3 of the CVC corresponds to a prior art magnetron discharge for high-pressure (10^{-1} torr) plasma processing. The voltage drops sharply in this regime until the current reaches a quasi-stationary value that maintains the discharge power at a constant value. The Applicant submits that the ions are generated by direct ionization and any ions that are generated by a multi-step ionization process will be statistically insignificant. Furthermore, there is no description related to Part 3 of the CVC of choosing an amplitude and a rise time as claimed in independent claim 1.

Part 4 of the CVC shown in FIG. 4 of Mozgrin is a high-current, low-voltage arc discharge regime having a current that is greater than 1kA and a voltage that is in the range of 10-30V. Arc discharges are generally undesirable for most plasma processing applications. Arc discharges are observed in conventional magnetrons when too much power is applied to the plasma. The Applicant submits that the ions generated by the arc discharge are generated by direct ionization and any ions that are generated by a multi-step ionization process will be statistically insignificant. Furthermore, there is no description related to Part 4 of the CVC of choosing an amplitude and a rise time as claimed in independent claim 1.

Thus, the Applicant submits that direct ionization is used to generate the quasi-stationary discharge described in Mozgrin. As described in connection with the 35 U.S.C. §102(b) Kouznetsov rejection, the energies required to achieve the multi-step ionization process claimed in independent claim 1 are different from the energies required to achieve direct ionization. Therefore, Mozgrin does not describe choosing an amplitude and a rise time to increase an excitation rate of ground state atoms that are present in the weakly-ionized plasma to create a multi-step ionization process that generates a strongly-ionized plasma from the weakly-ionized plasma as described in independent claim 1. In view of the above remarks, the Applicant respectfully submits that Mozgrin does not describe each and every element of independent claim 1, either expressly or inherently. Therefore, the Applicant submits that Mozgrin does not anticipate independent claim 1. Thus, the Applicant submits that independent claim 1 and dependent claims 4-5, 7, 13-14, 16, and 19 are allowable under 35 U.S.C. §102(b).

Independent Claim 20 and Dependent Claims 21-25, 27-29, 32, 33, and 37

The Applicant believes that Mozgrin does not describe each and every element of independent claim 20 as amended in the Response to Office Action dated June 14, 2004. Independent claim 20 recites the step of applying a voltage pulse to the weakly-ionized plasma. An amplitude and a rise time of the voltage pulse are chosen to increase an excitation rate of ground state atoms in the weakly-ionized plasma to create a multi-step ionization process. The multi-step ionization process generates excited atoms from ground state atoms in the weakly-ionized plasma, and then ionizes the excited atoms in the weakly-ionized plasma.

The Applicant submits that there is no description in Mozgrin of the method of generating a strongly-ionized plasma using a multi-step ionization process as claimed in independent claim 20. As described in connection with the rejection of independent claim 1 under 35 U.S.C. §102(b), the Applicant respectfully submits that the ionization described in Mozgrin is direct ionization and there is no description of choosing an amplitude and a rise time as claimed in independent claim 20.

In view of the above remarks, the Applicant respectfully submits that Mozgrin does not describe each and every element of independent claim 20, either expressly or inherently. Therefore, the Applicant submits that Mozgrin does not anticipate independent claim 20 and dependent claims 21-25, 27-29, 32, 33, and 37 under 35 U.S.C. §102(b). Thus, the Applicant submits that independent claim 20 and dependent claims 21-25, 27-29, 32, 33, and 37 are allowable.

Independent Claim 40

The Applicant respectfully submits that Mozgrin does not describe each and every element of independent claim 40 as amended in the Response to Office Action dated June 14, 2004. Independent claim 40 recites a means for applying a voltage pulse to a weakly-ionized plasma. An amplitude and a rise time of the voltage pulse is chosen to increase an excitation rate of ground state atoms that are present in the weakly-ionized plasma to create a multi-step ionization process that generates a strongly-ionized plasma from the weakly-ionized plasma. Also, the multi-step ionization process comprises exciting the ground state atoms to generate excited atoms, and then ionizing the excited atoms within the weakly-ionized plasma to ions that sputter target material from the sputtering target.

The Applicant submits that there is no description in Mozgrin of the means for applying a voltage pulse to the weakly-ionized plasma where an amplitude and a rise time of the voltage pulse are chosen to increase an excitation rate of ground state atoms that are present in the weakly-ionized plasma to create a multi-step ionization process as claimed in independent claim 40. As described in connection with the rejection of independent claim 1 under 35 U.S.C. §102(b), the Applicant respectfully submits that the ionization described in Mozgrin is direct ionization and there is no description of choosing an amplitude and a rise time as claimed in independent claim 40.

In view of the above remarks, the Applicant respectfully submits that Mozgrin does not describe each and every element of independent claim 40, either expressly or inherently. Therefore, the Applicant submits that Mozgrin does not anticipate independent claim 40. Thus, the Applicant submits that independent claim 40 is allowable.

Rejections under 35 U.S.C. §103(a)

Claims 1-3 are rejected under 35 U.S.C. §103(a) as being unpatentable over Kouznetsov. Claims 1-3, 17, 20, and 39 are rejected under 35 U.S.C. §103(a) as being unpatentable over Mozgrin. Claims 1, 10-12, 15, 20, 34-36 are rejected under 35 U.S.C. §103(a) as being unpatentable over Kouznetsov in view of Chaing. Claims 1 and 18 are rejected under 35 U.S.C. §103(a) as being unpatentable over Kouznetsov in view of Kadlec.

In view of the above remarks, the Applicant respectfully traverses the rejections under 35 U.S.C. §103(a). The Applicant submits that independent claim 1 is not obvious under 35 U.S.C. §103(a) in view of the above reference alone or in combination because none of these references teach or suggest choosing an amplitude and a rise time of the voltage pulse generated by a power supply to increase the excitation rate of ground state atoms that are present in the weakly-ionized plasma to generate a multi-step ionization process as claimed in independent claim 1. Furthermore, the Applicant submits that independent claim 20 is not obvious under 35 U.S.C. §103(a) in view of the above reference alone or in combination because none of these references teach or suggest a method of generating a strongly-ionized plasma using a multi-step ionization process as claimed in independent claim 20.

CONCLUSION

Claims 1-50 are currently pending in the present application. In view of the foregoing, reconsideration and allowance of all pending claims (i.e., claims 1-50) is respectfully requested.

The Commissioner is hereby authorized to charge the extension fee and the terminal disclaimer fee, and any other proper fees to Attorney's Deposit Account No. 501211.

If, in the Examiner's opinion, a telephonic interview would expedite prosecution of the present application, the undersigned attorney would welcome the opportunity to discuss any outstanding issues, and to work with the Examiner toward placing the application in condition for allowance.

Respectfully submitted,

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Reg. No. 40,137

Kurt Rauschenbach, Ph.D.
Attorney for Applicant
Rauschenbach Patent Law Group, LLC
Post Office Box 387
Bedford, MA 01730

Tel. No.: (781) 271-1503
Fax No.: (781) 271-1527