



**PATENT**  
Attorney Docket No.: ZON-002

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

APPLICANT: Roman Chistyakov  
SERIAL NO.: 10/065,629      GROUP NO.: 2821  
FILING DATE: November 04, 2002      EXAMINER: Lee, Wilson  
TITLE: METHODS AND APPARATUS FOR GENERATING  
HIGH-DENSITY PLASMA

Commissioner for Patents  
Alexandria, Virginia 22313-1450

**AMENDMENT AND RESPONSE**

Sir:

The following amendments and remarks are responsive to the Office Action mailed on October 07, 2003 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 two-month extension of time, up to and including Monday, March 08, 2004 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.

Amendments to the Claims:

Please amend claims 1, 3, 10, 12, 16, 22, 33, 43, and 44, cancel claims 21, 28, and 42 without prejudice, and add claims 45 and 46 as follows.

1. (currently amended): An apparatus for generating a strongly-ionized plasma in a chamber, the apparatus comprising:

an ionization source that generates a weakly-ionized plasma from a ~~volume of~~ feed gas, the weakly-ionized plasma reducing the probability of developing an electrical breakdown condition in the chamber;

a power supply that ~~applies~~ supplies power to the weakly-ionized plasma ~~though an electrical pulse applied across the weakly-ionized plasma, the electrical pulse having a magnitude and a rise-time that is sufficient to increase the density of the weakly-ionized plasma~~ to generate a strongly-ionized plasma; and

a gas line that supplies feed gas to ~~means for exchanging~~ the strongly-ionized plasma, the feed gas diffusing the strongly-ionized plasma, thereby allowing additional power from the pulsed power supply to be absorbed by the ~~with a second volume of feed gas applying the electrical pulse across the second volume of feed gas to generate an additional~~ strongly-ionized plasma.

2. (original): The apparatus of claim 1 wherein the power supply applies the electrical pulse across the weakly-ionized plasma to excite atoms in the weakly-ionized plasma and to generate secondary electrons, the secondary electrons ionizing the excited atoms, thereby creating the strongly-ionized plasma.

3. (currently amended): The apparatus of claim 1 ~~further comprising a wherein the gas line~~ supplies additional feed gas that gas exchange means for exchanging the weakly-ionized plasma ~~with a third volume of feed gas while applying the electrical pulse across the third volume of feed gas.~~

4. (original): The apparatus of claim 1 wherein the power supply generates a constant power.
5. (original): The apparatus of claim 1 wherein the power supply generates a constant voltage.
6. (original): The apparatus of claim 1 wherein the ionization source is chosen from the group comprising an electrode coupled to a DC power supply, an electrode coupled to an AC power supply, a UV source, an X-ray source, an electron beam source, an ion beam source, an inductively coupled plasma source, a capacitively coupled plasma source, and a microwave plasma source.
7. (original): The apparatus of claim 1 further comprising a magnet that is positioned to generate a magnetic field proximate to the weakly-ionized plasma, the magnetic field trapping electrons in the weakly-ionized plasma.
8. (original): The apparatus of claim 7 wherein the magnet comprises an electro-magnet.
9. (original): The apparatus of claim 7 wherein the magnet is movable.
10. (currently amended): A method for generating a strongly-ionized plasma in a chamber, the method comprising:

ionizing a ~~volume of feed~~ gas to form a weakly-ionized plasma that reduces the probability of developing an electrical breakdown condition in the chamber;

supplying power to the weakly-ionized plasma by applying an electrical pulse across the weakly-ionized plasma to generate the, the electrical pulse having a magnitude and a rise-time that is sufficient to increase the density of the weakly-ionized plasma to generate a strongly-ionized plasma; and

diffusing the strongly-ionized plasma with additional feed gas thereby allowing exchanging the strongly-ionized plasma to absorb additional energy from the power supply with a second volume of feed gas while applying the electrical pulse across the second volume of feed gas to generate an additional strongly ionized plasma.

11. (original): The method of claim 10 wherein the applying the electrical pulse across the weakly-ionized plasma excites atoms in the weakly-ionized plasma and generates secondary electrons, the secondary electrons ionizing the excited atoms, thereby creating a strongly-ionized plasma.
12. (currently amended): The method of claim 10 further comprising exchanging the weakly-ionized plasma with additional feed gas ~~exchanging the weakly-ionized plasma with a third volume of feed gas while applying the electrical pulse across the third volume of feed gas.~~
13. (original): The method of claim 10 wherein the applying the electrical pulse comprises applying a quasi-static electric field across the weakly-ionized plasma.
14. (original): The method of claim 10 further comprising selecting at least one of a pulse amplitude and a pulse width of the electrical pulse in order to increase an ionization rate of the strongly-ionized plasma.
15. (original): The method of claim 10 further comprising selecting at least one of a pulse amplitude and a pulse width of the electrical pulse in order to cause the strongly-ionized plasma to be substantially uniform.
16. (currently amended): The method of claim 10 wherein the electrical pulse comprises a rise time that is less than about 100V/ $\mu$ sec. ~~between about 0.1 microsecond and 10 seconds.~~
17. (original): The method of claim 10 wherein the peak plasma density of the weakly-ionized plasma is less than about  $10^{12} \text{ cm}^{-3}$ .
18. (original): The method of claim 10 wherein the peak plasma density of the strongly-ionized plasma is greater than about  $10^{12} \text{ cm}^{-3}$ .
19. (original): The method of claim 10 wherein the ionizing the feed gas comprises exposing the feed gas to one of a static electric field, an pulsed electric field, UV radiation, X-ray radiation, electron beam radiation, and an ion beam.

20. (original): The method of claim 10 further comprising generating a magnetic field proximate to the weakly-ionized plasma, the magnetic field trapping electrons in the weakly-ionized plasma.
21. (canceled).
22. (currently amended): An apparatus for generating a strongly-ionized plasma, the apparatus comprising:
- an anode;
- a cathode that is positioned adjacent to the anode and forming a gap there between;
- an ionization source that generates a weakly-ionized plasma proximate to the cathode, the weakly-ionized plasma reducing the probability of developing an electrical breakdown condition between the anode and the cathode; and
- a power supply that produces an electric field across the gap, the electric field generating excited atoms in the weakly-ionized plasma and generating secondary electrons from the cathode, the secondary electrons ionizing the excited atoms, thereby creating the strongly-ionized plasma.
23. (original): The apparatus of claim 22 wherein the power supply generates a constant power.
24. (original): The apparatus of claim 22 wherein the power supply generates a constant voltage.
25. (original): The apparatus of claim 22 wherein the electric field comprises a quasi-static electric field.
26. (original): The apparatus of claim 22 wherein the electric field comprises a pulsed electric field.

27. (original): The apparatus of claim 22 wherein a rise time of the electric field is chosen to increase an ionization rate of the excited atoms in the weakly-ionized plasma.
28. (canceled).
29. (original): The apparatus of claim 22 wherein the strongly-ionized plasma is substantially uniform proximate to the cathode.
30. (original): The apparatus of claim 22 wherein a dimension of the gap between the anode and the cathode is chosen to increase an ionization rate of the excited atoms in the weakly-ionized plasma.
31. (original): The apparatus of claim 22 wherein the ionization source is chosen from the group comprising an electrode coupled to a DC power supply, an electrode coupled to an AC power supply, a UV source, an X-ray source, an electron beam source, an ion beam source, an inductively coupled plasma source, a capacitively coupled plasma source, and a microwave plasma source.
32. (original): The apparatus of claim 22 further comprising a magnet that is positioned to generate a magnetic field proximate to the weakly-ionized plasma, the magnetic field trapping electrons in the weakly-ionized plasma proximate to the cathode.
33. (currently amended): A method for generating a strongly-ionized plasma, the method comprising:

ionizing a feed gas to generate a weakly-ionized plasma proximate to a cathode, the weakly-ionized plasma reducing the probability of developing an electrical breakdown condition proximate to the cathode; and

applying an electric field across the weakly-ionized plasma in order to excite atoms in the weakly-ionized plasma and to generate secondary electrons from the cathode, the secondary electrons ionizing the excited atoms, thereby creating the strongly-ionized plasma.

34. (original): The method of claim 33 wherein the applying the electric field comprises applying a quasi-static electric field.
35. (original): The method of claim 33 wherein the applying an electric field comprises applying the electric field at a constant power.
36. (original): The method of claim 33 wherein the applying an electric field comprises applying the electric field at a constant voltage.
37. (original): The method of claim 33 wherein the applying the electric field comprises applying an electrical pulse across the weakly-ionized plasma.
38. (original): The method of claim 37 further comprising selecting at least one of a pulse amplitude and a pulse width of the electrical pulse in order to increase an ionization rate of the strongly-ionized plasma.
39. (original): The method of claim 37 further comprising selecting at least one of a pulse amplitude and a pulse width of the electrical pulse in order to cause the strongly-ionized plasma to be substantially uniform in an area adjacent to a surface of the cathode.
40. (original): The method of claim 33 wherein the strongly-ionized plasma is substantially uniform proximate to the cathode.
41. (original): The method of claim 33 further comprising generating a magnetic field proximate to the weakly-ionized plasma, the magnetic field trapping electrons in the weakly-ionized plasma.
42. (canceled).
43. (currently amended): An apparatus for generating a strongly-ionized plasma in a chamber, the apparatus comprising:

means for ionizing a ~~volume of~~ feed gas to form a weakly-ionized plasma that reduces the probability of developing an electrical breakdown condition in the chamber;

means for supplying power to the weakly-ionized plasma by applying an electrical pulse across the weakly-ionized plasma to generate the, the electrical pulse having a magnitude and a rise-time that is sufficient to increase the density of the weakly-ionized plasma to generate a strongly-ionized plasma; and

means for diffusing the strongly-ionized plasma with additional feed gas to allow additional power to be absorbed by exchanging the strongly-ionized plasma with a second volume of feed gas while applying the electrical pulse across the second volume of feed gas to generate an additional strongly-ionized plasma.

44. (currently amended): An apparatus for generating a strongly-ionized plasma, the apparatus comprising:

means for ionizing a feed gas to generate a weakly-ionized plasma proximate to a cathode, the weakly-ionized plasma reducing the probability of developing an electrical breakdown condition proximate to the cathode; and

means for applying an electric field across the weakly-ionized plasma in order to excite atoms in the weakly-ionized plasma and to generate secondary electrons from the cathode, the secondary electrons ionizing the excited atoms, thereby creating the strongly-ionized plasma.

45. (new): The apparatus of claim 1 wherein the power supply comprises the ionization source.
46. (new): The apparatus of claim 22 wherein the power supply comprises the ionization source.

## **REMARKS**

### **Pending Claims:**

Claims 1-20, 22-27, 29-41, and 43-46 are currently pending in the present application. Claims 1, 3, 10, 12, 16, 22, 33, 43, and 44 are amended by the present Amendment. Claims 21, 28, and 42 are canceled without prejudice to Applicant's right to pursue these claims in this or a subsequent patent application. Claims 45 and 46 are added. No new matter is added by these amendments. Upon entry of the present Amendment, reconsideration of claims 1-20, 22-27, 29-41, 43, and 44 and consideration of new claims 45 and 46 is respectfully requested.

### **New Claims**

New dependent claims 45 and 46 recite that the power supply comprises the ionization source. The Applicant submits that new claims 45 and 46 are supported by the originally filed specification and that no new matter is added by these claims. See, for example, paragraph 35, which states that in one embodiment, the pulsed power supply 202 is a component in an ionization source that generates a weakly-ionized plasma 232.

### **Allowable Subject Matter**

The Applicant acknowledges with appreciation the Examiner's statement made in page 10 of the Office Action dated October 07, 2003 that claims 25, 27-30, 34, 38-40, and 42 would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. The Applicant has amended independent claim 22 to include the limitation of dependent claim 28, which the Examiner has indicated is allowable. In addition, the Applicant has amended independent claim 33 to include the limitation of dependent claim 42, which the Examiner has also indicated is allowable. Therefore, the Applicant submits that independent claims 22 and 33 are now allowable as currently amended. In addition, the Applicant submits that dependent claims 25, 27, 29, 30, 34, and 38-40 are now allowable as depending from allowable base claims.

**Drawing Objections:**

The drawings are objected to under 37 C.F.R. §1.83(a). Claims 1, 3, 10, 12, and 43 have been amended to remove references to features not explicitly illustrated in the drawings. Therefore, the Applicant submits that the objections to the drawings are now moot.

**Rejections under 35 U.S.C. §112:**

Claims 1-21, and 43 are rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the enablement requirement. The Office Action states that these claims contain subject matter which was not described in the specification in such a way as to enable one skilled in the art to make and/or use the invention. The Applicant has amended independent claims 1 and 43 and dependent claims 3, 10, and 12 to remove limitations not explicitly disclosed in the specification. Therefore, the Applicant submits that claims 1-21 and 43 as currently amended overcome the rejections under 35 U.S.C. §112.

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

Claims 1, 2, 4-11, 19, 20, 22-24, 26, 31-33, 35-37, 41, 43, and 44 are rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,041,760 issued to Koloc (hereinafter “Koloc”). Independent claims 1, 10, 22, 33, 43, and 44 are herein amended to more clearly recite the invention. No new matter is added by these amendments.

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 2, 4-9, and 45**

The Applicant respectfully submits that Koloc does not describe each and every element of independent claim 1 as currently amended. Independent claim 1 has been amended to recite an ionization source that generates a weakly-ionized plasma from a feed gas where the weakly-

ionized plasma reduces the probability of developing an electrical breakdown condition in the chamber. This amendment to claim 1 is supported by the originally-filed specification. See, for example, paragraph 43 of the originally-filed specification, which states that “[f]orming the weakly-ionized or pre-ionized plasma 232 substantially eliminates the probability of establishing a breakdown condition in the chamber...”

The Applicant believes that there is no description in Koloc of a weakly-ionized plasma that reduces the probability of developing an electrical breakdown condition in the chamber. Instead, the Applicant believes that Koloc describes a source of ionizing energy that is oriented to project or focus ionizing energy into a particular region, such as a helical path. Koloc describes applying a high voltage potential between two electrodes in order to create a discharge current. The discharge current causes a buildup of magnetic energy that induces energetic image currents that explosively displaces conductive matter or ionized gas in the region. The force resulting from the explosive displacement creates an evacuated region surrounding the helical discharge current. See, for example, Col. 5, lines 5-35. The Applicant believes that the source of ionizing energy in Koloc is intended to provide a helical discharge path for the high-voltage discharge.

In view of the above remarks, the Applicant respectfully submits that Koloc does not describe each and every element of independent claim 1 as currently amended, either expressly or inherently. Therefore, the Applicant submits that Koloc does not anticipate independent claim 1 as currently amended under 35 U.S.C. §102(b). Thus, the Applicant submits that independent claim 1 as currently amended is allowable. The Applicant also submits that dependent claims 2, 4-9, and new claim 45 are allowable as depending from an allowable base claim.

#### Independent Claim 10 and Dependent Claims 11 and 13-20

The applicant respectfully submits that Koloc does not describe each and every element of independent claim 10 as currently amended. Independent claim 10 is herein amended to recite the step of ionizing a feed gas to form a weakly-ionized plasma. The weakly-ionized plasma reduces the probability of developing an electrical breakdown

condition in the chamber. This amendment is supported by the originally-filed specification of the present application. See, for example, paragraph 43 of the present specification.

As previously discussed with reference to independent claim 1, there is no description in Koloc of a weakly-ionized plasma that reduces the probability of developing an electrical breakdown condition in the chamber. Instead, the Applicant believes that Koloc describes a source of ionizing energy that is oriented to project or focus ionizing energy into a particular region.

In view of the above remarks, the Applicant respectfully submits that Koloc does not describe each and every element of independent claim 10 as currently amended, either expressly or inherently. Therefore, Applicant submits that Koloc does not anticipate independent claim 10 as currently amended under 35 U.S.C. §102(b). Thus, the Applicant submits that independent claim 10 as currently amended is allowable. The Applicant also submits that dependent claims 11 and 13-20 are allowable as depending from an allowable base claim.

Independent Claim 22 and Dependent Claims 23-27, 29-32 and 46

Independent claim 22 has been amended to include the limitations in objected-to claim 28. The Applicant respectfully submits that in view of this amendment, Koloc does not anticipate independent claim 22 as currently amended under 35 U.S.C. §102(b). Thus, the Applicant submits that independent claim 22 as currently amended is allowable. The Applicant also submits that dependent claims 23-24, 26, 31-32, and new claim 46 are allowable as depending from an allowable base claim. In addition, the Applicant submits that objected-to claims 25, 27, 29, and 30 are allowable as depending from allowable base claim 22.

Independent Claim 33 and Dependent Claims 34-41

Independent claim 33 has been amended to include the limitations of objected-to claim 42. Applicant respectfully submits that in view of this amendment, Koloc does not anticipate independent claim 33 as currently amended under 35 U.S.C. §102(b). Thus, the Applicant submits that independent claim 33 as currently amended is allowable. The Applicant also submits that dependent claims 35-37 and 41 are allowable as depending from an allowable base

claim. In addition, the Applicant submits that objected-to claims 34 and 38-40 are allowable as depending from allowable base claim 33.

#### Independent Claim 43

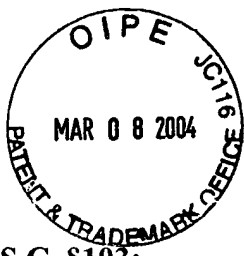
Applicant respectfully submits that Koloc does not describe each and every element of independent claim 43 as currently amended. Independent claim 43 is herein amended to recite a means for ionizing a feed gas to form a weakly-ionized plasma where the weakly-ionized plasma reduces the probability of developing an electrical breakdown condition in the chamber. This amendment is supported by the originally-filed specification of the present application.

As previously discussed with reference to independent claim 1, there is no description in Koloc of a weakly-ionized plasma that reduces the probability of developing an electrical breakdown condition in the chamber. Instead, the Applicant believes that Koloc describes a source of ionizing energy that is oriented to project or focus ionizing energy into a particular region.

In view of the above remarks, the Applicant respectfully submits that Koloc does not describe each and every element of independent claim 10 as currently amended, either expressly or inherently. Therefore, Applicant submits that Koloc does not anticipate independent claim 10 as currently amended under 35 U.S.C. §102(b). Thus, the Applicant submits that independent claim 43 as currently amended is allowable.

#### Independent Claim 44

Independent claim 44 has been amended to include the limitations in the objected-to claim 42. Applicant respectfully submits that in view of this amendment, Koloc does not anticipate independent claim 44 as currently amended under 35 U.S.C. §102(b). Thus, the Applicant submits that independent claim 44 as currently amended is allowable.



**Rejections under 35 U.S.C. §103:**

Claim 16 is rejected under 35 U.S.C. §103(a) as being unpatentable over Koloc. Dependent claim 16 has been amended to more clearly recite the invention and depends from independent claim 10. Independent claim 10 has been amended herein to recite the step of ionizing a feed gas to form a weakly-ionized plasma that reduces the probability of developing an electrical breakdown condition in the chamber. The Applicant believes that this step is neither taught nor suggested by Koloc. Therefore, the Applicant respectfully submits that dependent claim 16 is not obvious over Koloc. Thus, the Applicant believes that dependent claim 16 is allowable.

**CONCLUSION**

Claims 1-20, 22-27, 29-41, and 43-46 are currently pending in the present application. Claims 1, 3, 10, 12, 16, 22, 33, 43, and 44 are amended by the present Amendment. Claims 21, 28, and 42 are canceled without prejudice. Claims 45 and 46 are added. In view of the foregoing amendments and remarks, reconsideration and allowance of all pending claims (i.e., claims 1-20, 22-27, 29-41, and 43-46) is respectfully requested.

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.

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.

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Reg. No. 40,137

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

Respectfully submitted,

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