[00012] In a second aspect, a method of preparing a sub-atmospheric storage and delivery vessel configured for delivery of a steady, sustained and sufficient flow of a high purity, vapor phase of antimony source material from therein at ambient conditions, comprising the steps of: providing a container with multiple walls having a thermal conductivity of 5 W/m*K; introducing an antimony-containing material in a liquid phase into the container in a presence of an inert gas, said antimony-containing material having a purity level at least equal to the high purity of the vapor phase of the antimony source material; creating a predetermined headspace volume of greater than or equal to about 1 Liter, said predetermined headspace volume having trace amounts of impurities; evaporating a sufficient amount of the antimony containing material to form the high purity, vapor phase in the predetermined headspace volume, wherein said step of evaporating is performed with an absence of external heating; freezing the liquid phase of the antimony containing material to form frozen antimony containing material; condensing the high purity, vapor phase of the antimony containing material from the predetermined headspace volume to form a condensed high purity, vapor phase; evacuating nitrogen, water vapor, the inert gas and any other gaseous impurities from the predetermined headspace volume; allowing the condensed high purity, vapor phase to warm under the ambient conditions so as to re-form the high purity, vapor phase within the predetermined headspace volume; allowing the frozen antimony containing material to warm under the ambient conditions to re-form the liquid phase.

[00013] In a third aspect, a method of using a sub-atmospheric storage and delivery vessel filled with antimony-containing material, comprising: operably connecting the vessel to a downstream ion implant tool; establishing a pressure downstream of the sub-atmospheric storage and delivery vessel that is less than the vapor pressure of a high purity, vapor phase of the antimony-containing material occupying a predetermined headspace volume of the vessel; actuating a valve into the open position; dispensing the antimony-containing material from the predetermined headspace volume of the vessel at ambient conditions in an absence of heating, said antimony-containing material dispensed as a high purity, vapor phase at a flowrate in an absence of a carrier gas; and flowing the high purity, vapor phase of the antimony-containing material in an absence of the carrier gas at the flowrate towards the ion implant tool, said vapor phase of the antimony-containing material having a purity of 95 vol% greater based on the pre-determined headspace volume; and evaporating additional antimony-containing material from a corresponding liquid phase in the vessel in the absence of heating at an evaporation rate that is

Claims

1. A sub-atmospheric storage and delivery vessel configured for delivering a steady, sustained and sufficient flow of a high purity, vapor phase of antimony-containing material from therein at ambient conditions, comprising:

a storage and delivery vessel, said storage and delivery vessel configured for holding said antimony-containing material in a liquid phase under sub-atmospheric conditions, whereby said liquid phase is in substantial equilibrium with the high purity, vapor phase occupying a predetermined volume of headspace in the storage and delivery vessel, and said high purity, vapor phase exerting a vapor pressure less than atmospheric pressure, said high purity, vapor phase equal to about 95 vol% or greater based on the predetermined volume;

said predetermined volume of the headspace being sized so as to receive a sufficient amount of the high purity, vapor phase of the antimony-containing material;

said storage and delivery vessel comprising multiple walls having sufficient surface area contact with the liquid phase, and further wherein said multiple walls exhibit a thermally conductivity to enhance heat conduction into the liquid at the ambient conditions;

said storage and delivery vessel characterized by an absence of external heating and an absence of a carrier gas during dispensing of the high purity, vapor phase antimony-containing material.

2. The sub-atmospheric storage and delivery vessel of claim 1, wherein the predetermined volume is about 1 Liter or greater.

3. The sub-atmospheric storage and delivery vessel of claim 1, wherein the high purity, vapor phase antimony-containing material is delivered to a downstream ion source, and further wherein the antimony-containing material is represented by a non-carbon containing chemical formula to reduce or eliminate formation of carbon-based deposits in an arc chamber of the ion implanter and throughout other regions of the ion source.

4. The sub-atmospheric storage and delivery vessel of claim 1, wherein the sub-atmospheric storage and delivery vessel is capable of providing the sustained and sufficient flow

of the high purity, vapor phase of the antimony-containing material at a flow rate of about 0.3 sccm to about 10 sccm.

5. The sub-atmospheric storage and delivery vessel of claim 1, wherein the predetermined volume of the headspace is about 1.5 Liters or greater.

6. The sub-atmospheric storage and delivery vessel of claim 1, wherein the predetermined volume of the headspace is greater than about 1.5 Liters, the thermal conductivity of the multiple walls ranges from 5 to 425 W/m-K, the antimony-containing material is represented by a non-carbon containing chemical formula to reduce or eliminate formation of carbon-based deposits in the arc chamber and throughout other regions of the ion source, the sub-atmospheric storage and delivery vessel is capable of providing the sustained and sufficient flow of the high purity, vapor phase antimony-containing material to an ion implant tool at a flow rate of about 1 sccm to about 5 sccm.

7. The sub-atmospheric storage and delivery vessel of claim 1, further comprising a dual port valve, said dual port valve comprising a fill port valve and a discharge port valve, wherein the fill port valve is in fluid communication with an interior of the vessel to introduce the antimony-containing material therein, and a discharge port valve is in fluid communication with a flow discharge path extending from the interior to the exterior of the cylinder to discharge the high purity, vapor phase antimony-containing material therefrom.

8. The sub-atmospheric storage and delivery vessel of claim 1, further comprising a packing material located inside of the vessel, wherein said packing material is at least partially immersed in the liquid phase of the antimony-containing material to enhance heat conduction through the multiple walls and into the liquid and enhance evaporation of the liquid phase of the antimony-containing material into the predetermined volume of the headspace.

9. The sub-atmospheric storage and delivery vessel of claim 1, wherein a surface area of the liquid phase that is exposed to the high purity, vapor phase is at least about 50 cm2.

10. The sub-atmospheric storage and delivery vessel of claim 1, wherein the vessel is configured to operate so that a rate of evaporation of the antimony-containing material in the liquid phase to form the corresponding high purity, vapor phase in the predetermined volume of the headspace in the absence of external heating is equal to or greater than a rate of withdrawal of the corresponding vapor phase from the predetermined volume of the headspace during dispensing of the high purity, vapor phase in an absence of a carrier gas.

11. A method of preparing a sub-atmospheric storage and delivery vessel configured for delivery of a steady, sustained and sufficient flow of a high purity, vapor phase of antimony source material from therein at ambient conditions, comprising the steps of:

providing a container with multiple walls having a thermal conductivity of 5 W/m*K;

introducing an antimony-containing material in a liquid phase into the container in a presence of an inert gas, said antimony-containing material having a purity level at least equal to the high purity of the vapor phase of the antimony source material;

creating a predetermined headspace volume of greater than or equal to about 1 Liter, said predetermined headspace volume having trace amounts of impurities;

evaporating a sufficient amount of the antimony containing material to form the high purity, vapor phase in the predetermined headspace volume, wherein said step of evaporating is performed with an absence of external heating;

freezing the liquid phase of the antimony containing material to form frozen antimony containing material;

condensing the high purity, vapor phase of the antimony containing material from the predetermined headspace volume to form a condensed high purity, vapor phase;

evacuating nitrogen, water vapor, the inert gas and any other gaseous impurities from the predetermined headspace volume;

allowing the condensed high purity, vapor phase to warm under the ambient conditions so as to re-form the high purity, vapor phase within the predetermined headspace volume;

allowing the frozen antimony containing material to warm under the ambient conditions to re-form the liquid phase.

12. The method of claim 11, further comprising performing each of the steps of (i) condensing, (ii) evacuating, and (iii) allowing the condensed high purity, vapor phase and the frozen antimony containing material to warm so as to re-form the liquid phase and to reform the high purity, vapor phase within the predetermined headspace volume two or more times.

13. The method of claim 11, wherein the step of evaporating the sufficient amount of the antimony containing material to form the high purity, vapor phase in the predetermined headspace volume occurs by an absence of external heating.

14. The method of claim 11, further comprising performing each of the steps of (i) condensing, (ii) evacuating, and (iii) allowing the condensed high purity, vapor phase and the frozen antimony containing material to warm so as to re-form the liquid phase and to reform the high purity, vapor phase within the predetermined headspace so as to reduce a combined total of the nitrogen, water vapor, the inert gas and any other the of the gaseous impurities in the predetermined headspace volume to no greater than about 5 vol% based on the predetermined headspace volume

15. The method of claim 11, further comprising inserting a packing material located inside of the vessel, wherein said packing material is at least partially immersed in the liquid phase of the antimony-containing material.

16. A method of using a sub-atmospheric storage and delivery vessel filled with antimony-containing material, comprising:

operably connecting the vessel to a downstream ion implant tool;

establishing a pressure downstream of the sub-atmospheric storage and delivery vessel that is less than the vapor pressure of a high purity, vapor phase of the antimony-containing material occupying a predetermined headspace volume of the vessel;

actuating a valve into the open position;

dispensing the antimony-containing material from the predetermined headspace volume of the vessel at ambient conditions in an absence of heating, said antimony-containing material dispensed as a high purity, vapor phase at a flowrate in an absence of a carrier gas; and

flowing the high purity, vapor phase of the antimony-containing material in an absence of the carrier gas at the flowrate towards the ion implant tool, said vapor phase of the antimony-containing material having a purity of 95 vol% greater based on the pre-determined headspace volume; and

evaporating additional antimony-containing material from a corresponding liquid phase in the vessel in the absence of heating at an evaporation rate that is equal to or greater than the flowrate of the high purity, vapor phase of the antimony-containing material being dispensed to supply the flowrate of the high purity, vapor phase of the antimony-containing material.

17. The method of claim 16, wherein the flowrate is about 0.3 sccm to about 10 sccm.