United States Patent

Murakami et al.

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[54] **REFLECTOR ASSEMBLY FOR REFLECTING THE VAPORS OF HIGH TEMPERATURE VOLATILE MATERIALS**

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[52] **U.S. Cl.** ....**118/49,** 34/DIG. 3, 138/103, 138/DIG. 3, 159/DIG. 15, 219/203, 219/522, 244/129 W

[51] **Int. Cl.** **C23c 13/08**

[58] **Field of Search** ....118/48–49.5, 620; 117/106–117.2, 93.44; 203/86; 34/DIG. 3; 159/DIG. 15; 350/61; 219/522, 543, 547, 549, 528, 385, 203; 338/212, 308, 309; 138/DIG. 3, 103, 33; 244/129 W; 52/171

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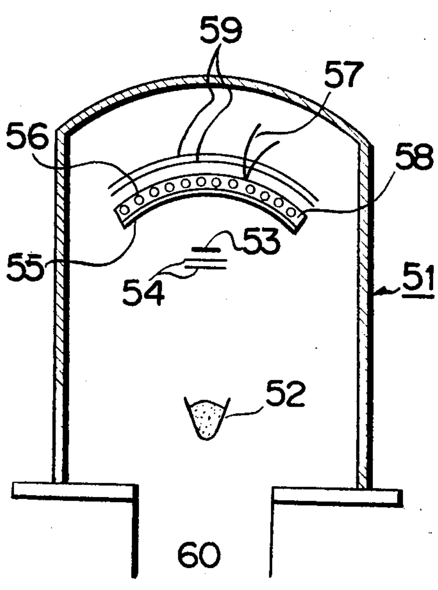
[57] **ABSTRACT**

A vapor reflector assembly disposed in a vapor deposition chamber comprises a thin, fluorinated resin film coated onto a support body and means to heat said film to an elevated temperature.

12 Claims, 14 Drawing Figures



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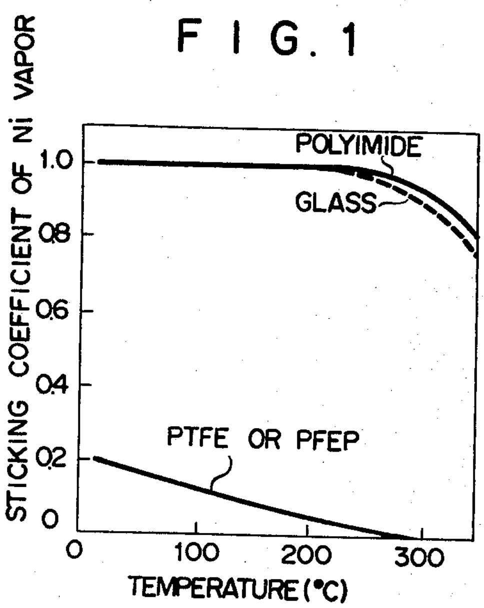

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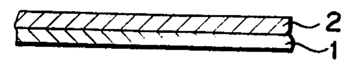

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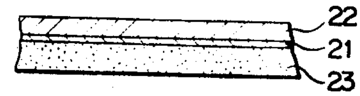

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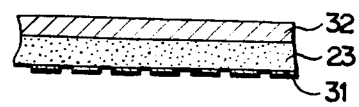

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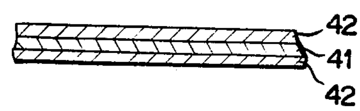

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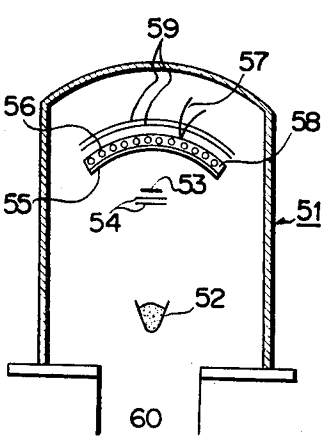

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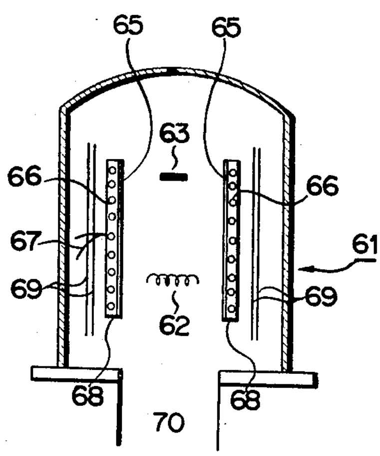

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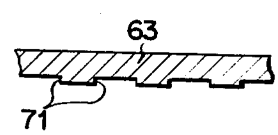

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FIG. 8

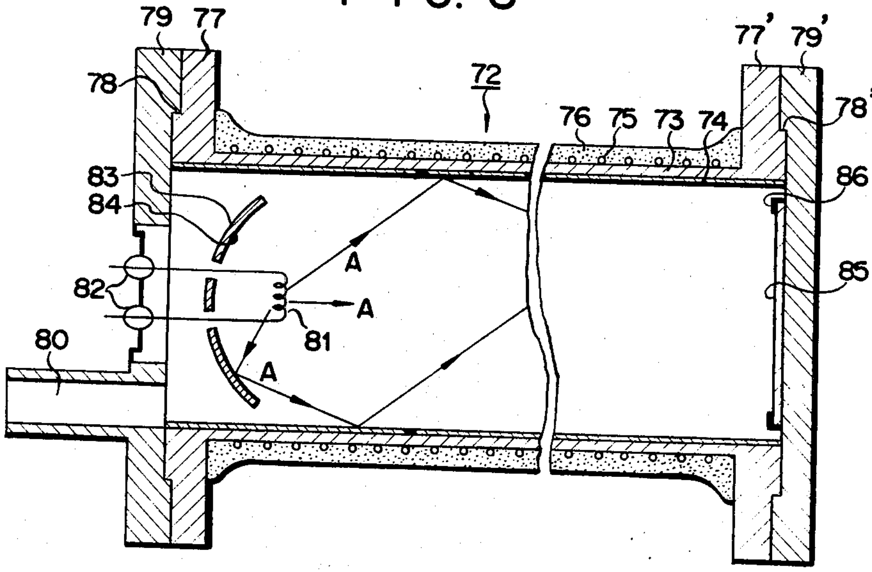


FIG. 9

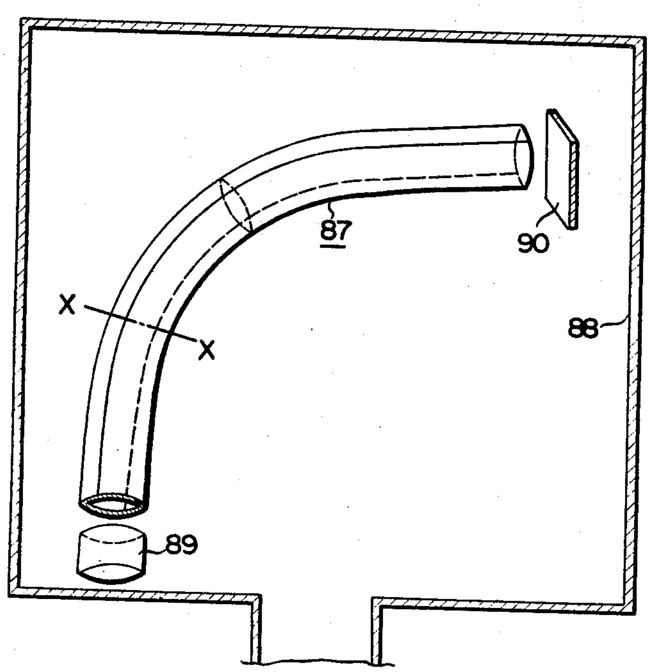
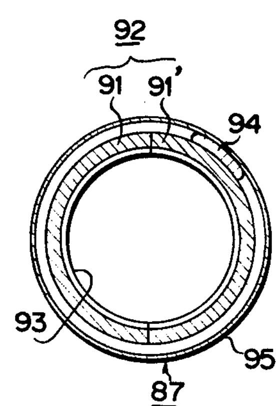


FIG. 10



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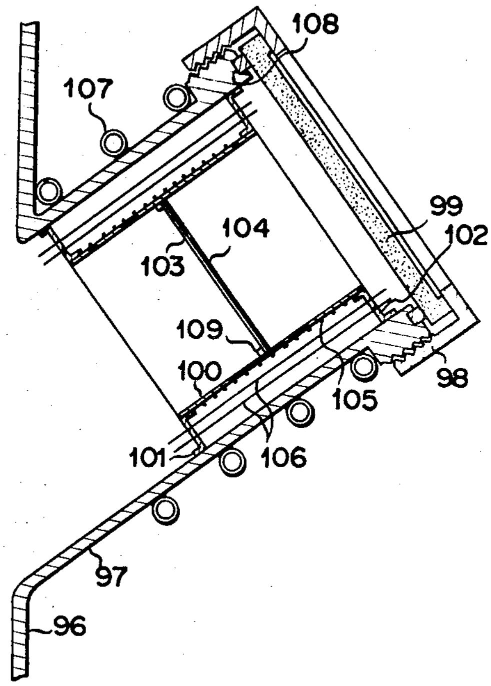

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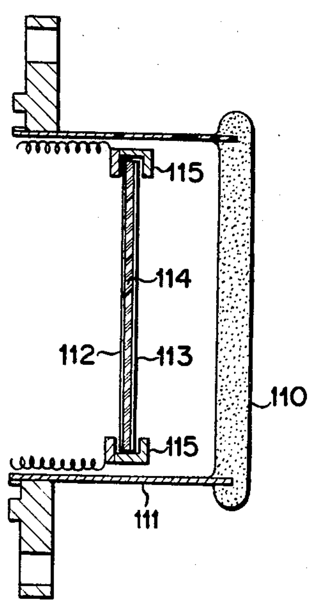

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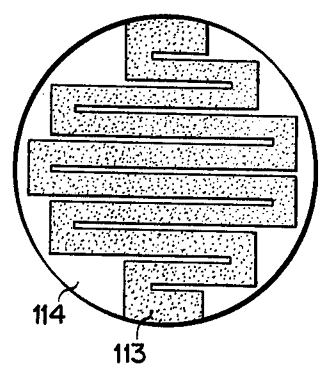

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REFLECTOR ASSEMBLY FOR REFLECTING THE VAPORS OF HIGH TEMPERATURE VOLATILE MATERIALS

BACKGROUND OF THE INVENTION

The present invention relates to a reflector assembly for reflecting the vapors of high temperature volatile materials which consists in reflecting substantially all said vapors in any desired direction without their deposition.

The term "high temperature volatile materials", as used in the present invention, is defined to mean those materials which have a low vapor pressure at normal temperature and can not be quickly vaporized unless heated to high temperatures.

In an apparatus evacuated to treat the aforementioned vapors, for example, in a vacuum evaporator, if it is possible to change the direction of atomic or molecular beams, then there will be obtained considerable convenience, enabling vacuum deposition to be utilized in wider fields. Since, however, neutral atoms or molecules only advance in a bee-line in an evacuated space, it is impossible to deflect their travelling course, unless they are ionized in advance by impingement of electrons thereon and the resulting ionized beams are diverted by an electric or magnetic field. However, creation of high concentrated ionized beams is accompanied with great difficulty and moreover requires expensive equipment. In this connection, it may be contemplated to reflect neutral atoms or molecules on a solid or liquid surface as a means of diverting their proceeding course. While it is not fundamentally impossible to use a solid or liquid surface as a reflection plane, the temperature of said reflection plane should generally be maintained at a level approximating the evaporation temperature of a material whose vapors are to be diverted by said reflection plane, (as used herein, the evaporation temperature is defined to mean that at which the vapor pressure of said material stands at 10^{-2} torr). That is, the reflection plane should be considerably heated, for example, to about 1,450° C for the vapors of gold and about 1,500° C for those of nickel. At such high temperatures, there often occur problems in connection with the vapor pressure and dissociation pressure of a material constituting the reflection plane itself and its reaction with the vapors of other materials which are to be diverted by said reflection plane. Since the radiant energy emitted from the reflection plane grows large in proportion to the fourth-power of the absolute temperature of the reflection plane, it is often technically difficult to provide a broad reflection plane kept at high temperatures within an evaporation chamber. There are also known other processes of reflecting the vapors of certain high temperature volatile metals using a grease surface maintained at approximately normal temperature. Since, however, these materials are normally in liquid form and have so low a viscosity as to leak out upon exposure to high temperatures most likely to contaminate the interior of the evaporation chamber and decompose or polymerize themselves under impingement of high temperature vapors, they fail to serve as a practical reflector.

Further, the viewing window of a vacuum evaporator or vacuum melting furnace is located at a point permitting naked eye observation of a source of vaporizing materials and the molten portion thereof and directly receives vapors from said source of molten portion. Therefore the inside of said window is readily clouded with vapor deposits. For example, the viewing window is rendered opaque when there are deposited gold vapors to a thickness of only several hundred A. units. Among the known devices, therefore, is one wherein the inside of the viewing window is fitted with a shutter plate so designed as to be opened only when required. However, this type of device is unadapted for the case where there should be continuously performed a close watch. In addition, there has been proposed another device wherein there is used a revolving disc provided with a plurality of glass windows in advance, and in case any of said glass windows is clouded, a fresh clean glass window is brought to the viewing opening. With this device, however, the individual glass windows are unavoidably reduced in size, only permitting a narrow field of view. As described above, any of the devices known to date does not originate with a concept of reflecting substantially all the vapors of high temperature volatile materials to prevent their deposition.

SUMMARY OF THE INVENTION

The present invention has been accomplished in view of the aforementioned situation and is intended to provide a reflector assembly for reflecting substantially all the vapors of high temperature volatile materials in any desired direction in an evacuated vessel.

Another object of the invention is to provide a reflector assembly wherein a fluorinated resin film for reflecting the vapors of high temperature volatile materials and a heat element for heating said film are formed into an integral body.

Still another object of the invention is to provide vacuum evaporators, pipes, viewing windows, etc. in which there is used a reflector assembly according to the invention for reflecting the vapors of high temperature volatile materials.

Namely, the present invention provides a reflector assembly for reflecting the vapors of high temperature volatile materials wherein there is placed in a vacuum chamber a fluorinated resin film, together with a heat element thereof so as to cause substantially all the vapors of said volatile materials to be reflected in any desired direction without their deposition.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a curve diagram showing the sticking coefficient of nickel vapors on the surfaces of various materials;

FIG. 2 is a schematic sectional view of vapor reflecting device as prepared by the present invention;

FIGS. 3, 4 and 5 are schematic sectional views of other embodiments of vapor reflecting devices as prepared by the present invention;

FIGS. 6 and 7(*a*) are schematic sectional views of a vacuum evaporator provided with a vapor reflecting device of the present invention;

FIG. 7(*b*) is a partial sectional view of a substrate to be deposited of a vapor using vacuum evaporator of FIG. 7(*a*);

FIG. 8 is a sectional view of a pipe for conducting vapors of high temperature volatile materials provided with a vapor reflecting device of the present invention;

FIG. 9 is a schematic view of a vacuum evaporator housing a pipe for conducting vapors of high temperature volatile materials provided with a vapor reflecting device of the present invention;

FIG. 10 is a sectional view of the pipe shown in FIG. 9;

FIG. 11 is a sectional side view of a viewing window provided with a vapor reflecting device of the present invention;

FIG. 12 is a sectional side view of another embodiment of a viewing window according to the present invention; and

FIG. 13 is a plane view of the vapor reflecting device as employed in FIG. 12.

DETAILED DESCRIPTION OF THE INVENTION

Thermal evaporation or sputtering of metals, semiconductors and insulation materials in vacuum often causes their vapors to condense to form thin films on that part of the inner wall of the vessel facing said materials. Formation of such films is generally supposed to arise through the following process. Evaporated atoms or molecules (hereinafter referred to as the "atoms") are adsorbed to the inner surface of the vessel upon their arrival and, after being retained there for a certain length of time, are desorbed. The adsorbed atoms move about over said surface as if in the form of a two-dimensional gas. In this case, some of the adsorbed atoms are captured at point defects on said surface or are formed into agglomerates consisting of more than one atom due to collision of the same kind of atoms on each other, thus creating stable nuclei. However, the other portions of said adsorbed atoms which had no chance of growing into nuclei while being retained on the surface are again evaporated. The average retention time of a single atom on the surface is generally determined by the kind of the atom, and the structure, temperature and condition of said surface. Where said retention lasts only for an extremely short time, there does not occur the condensation of vapors due to the lack of a chance of growing into nuclei on the surface for the above-mentioned reason. For full reflection of vapors, therefore, it is only required to find the conditions in which adsorbed atoms are retained for an extremely short time on average.

From this point of view, the present inventors have repeated a large number of experiments. As a result, they have discovered that given the same kind of adsorbed atom and the same temperature of a vapor reflector, said atom indicates appreciably different average retention times depending on the material of said vapor reflector. It has also been disclosed that above all, materials of fluorinated resin base have a surface which is characterized by unique physical properties in this respect, that is, allows atoms adsorbed thereto to be retained for a far shorter period than the surface of any other materials. Among such fluorinated resin materials, polyfluoroethylenepropylene (hereinafter referred to as "P-FEP") and polytetrafluoroethylene (hereinafter referred to as "PTFE") are found to be most preferred.

For example, the surface of the aforementioned PFEP or PTFE at 250° C really prevents the deposition thereto of even high temperature volatile materials such as silver, gold, nickel, iron, chromium, tungsten and carbon. It is known that the vapors of low temperature volatile materials such as cadmium and zinc (cadmium evaporates at about 260° C and zinc at about 340° C) do not sometimes condense on the surface of, for example, a glass substrate even at about normal temperature. In contrast, the vapors of high temperature volatile materials such as gold, nickel and iron never fail to be deposited on the surface of a material kept at a relatively low temperature, except for the aforesaid grease surface.

To illustrate the unique physical properties of the surface of a PTFE or PFEP film, FIG. 1 indicates the sticking coefficient (the density of incoming atoms taken to be about 10^{14} atoms/cm^2 sec.) of nickel vapor on the surfaces of polyimide and glass, as plotted according to the temperature of a substrate. As used herein, the sticking coefficient is expressed in terms of the proportions of permanently condensed atoms among those arriving at a fresh substrate surface on which there does not proceed the growth of a deposit. Said coefficient is closely related to the average retention time of atoms adsorbed on the substrate surface. The initial sticking coefficient of nickel vapor on the surface of a PTFE or PFEP film indicates very low values. Particularly when the substrate surface has a temperature of above 200° C, the coefficient on a PTFE or PFEP film is substantially zero, whereas the coefficient on a polyimide resin film or glass plate is approximately unity.

If it is thick enough to preserve a full mechanical strength by itself, a fluorinated resin film may be used singly as a vapor reflector. The film may be indirectly heated by a nichrome heater or infrared ray lamp. Or to effect uniform distribution of temperature on said film, it is possible to heat-seal it to a block of metal or ceramic material in which there is embedded a heat element. In this case, however, the heating and cooling of said block consumes much time due to its large heat capacity. It has been experimentally shown that replacement of a reflector, if required, after its use of a certain length of time becomes appreciably troublesome. Accordingly, the reflector may be laminated, as illustrated in FIGS. 2 to 5, with a thin film heat element so as to ensure a uniform temperature distribution throughout the integral body.

FIG. 2 represents a laminate reflector assembly prepared by heat-sealing a film of PFEP (throughout the embodiments of the present invention there was used the PFEP material manufactured by du Pont Company commerically known as "-Teflon" FEP Type A) on one side of a metal foil 1. The foil 1 consists of, for example, a layer of nickel, nichrome or stainless steel about 10 to 100 microns thick.

FIG. 3 shows a laminate reflector assembly prepared by depositing a thin layer 21 of tin oxide or other metals on a thin substrate 23 of glass or ceramics, leading out electrodes (not shown) from both ends of said mass and heat-sealing a PFEP film to the surface of said thin layer 21. The thin layer 21 of tin oxide or other metals acts as an electric resistance heat element. The layer 21 of tin oxide is formed by spraying tin chloride on the surface of the substrate heated to about 500° C. Where metals are used in forming said layer 21, nichrome, tantalum or stainless steel is vacuum deposited or sputtered on the substrate 23. The PFEP film 22, 10 to 15 microns thick, is placed on the heat element 21 deposited on the substrate 23. The entire mass is heated to 260° to 280° C in a vacuum furnace to form a reflector assembly.

FIG. 4 indicates a laminate reflector assembly prepared by mounting a ribbon-shaped heat element 31 bent in parallel arrangement illustrated in FIG. 13 on one side of the same kind of substrate 23 as used in FIG. 3 and depositing the PFEP film 32 on the opposite side of said substrate 23.

FIG. 5 illustrates a laminate reflector assembly prepared by depositing the PFEP film 42 on both sides of the same kind of metal foil 41 as used in FIG. 2.

Reflector assemblies shown in FIGS. 2 to 5 can be easily fabricated in any desired size. Since the reflector film is integrally formed with the heat element and directly heated thereby, it permits easy temperature control. Further the laminate reflector assembly is appreciably reduced in heat capacity offering the advantage of being heated and cooled in a short time and moreover causing temperature to be uniformly distributed throughout.

FIGS. 6 and 7(*a*) respectively represent the cases where the reflector assembly of the present invention for reflecting the vapors of high temperature volatile materials is applied in a vacuum evaporator. Referring to FIG. 6, there are provided in an evaporation chamber 51 an evaporation source 52 for thermally evaporating metals placed in a crucible; a substrate 53 having an upward turned surface sensitive to the light and radiant heat from the evaporation source 52; a shield 54 for shutting off the radiant energy and straight advancing vapors from the evaporation source 52; a concave PFEP film reflector 55 kept at a temperature of 200° to 250° C; a copper plate 58 in which there are embedded a nichrome heater 56 and thermocouple 57 to control the temperature of the reflector; and a heat shield 59. The evaporation chamber 51 communicates with an exhaust port 60 disposed below.

In the above-mentioned vacuum evaporator, atoms evaporated from the evaporation source 52 are reflected on the PFEP reflector 55. Part of the reflected atoms is brought back to the substrate 53 whose deposition plane is turned upward. This arrangement enables evaporated atoms to be deposited even on such surface as can not be directly exposed to the light and radiant heat from an evaporation source due to its high sensitivity thereto.

FIG. 7(*a*) denotes the case where a reflector assembly according to another embodiment of the present invention is employed in a vacuum evaporator. In this case, the vacuum evaporator comprises an evaporation source 62 consisting of a tungsten coil packed with metal material to be evaporated; a small substrate 63 having slight irregularities formed on one side as illustrated in FIG. 7(*b*) and disposed at right angles to the direction in which the volatilizable metal material is evaporated from the evaporation source 62; a cylindrical PFEP vapor reflector 65 so disposed as to enclose the evaporation source 62 and substrate 63 and kept at a temperature of 200° to 250° C; a cylindrical copper plate 68 in which there are embedded a nichrome heater 66 and thermocouple 67 so as to control the temperature of the reflector; and a group of heat shields 69. The evaporation chamber 61 communicates with an exhaust port 70 (not shown) disposed below.

In the vacuum evaporator of FIG. 7(*a*), some portions of metal atoms evaporated from the evaporation source 62 are directly brought to the surface of the substrate 63, while the other portions are carried to said surface slantwise after being once or twice reflected on the cylindrical reflector **65**. This permits evaporated atoms to be deposited even on a side wall (FIG. 7(*b*)) which would present difficulties in the deposition of vapors in an ordinary vacuum evaporator.

To this end, there has heretofore been adopted a complicated process of, for example, providing a plurality of evaporation sources and causing a substrate to rotate. In contrast, an evaporator using the reflector assembly of the present invention can attain the object very easily.

As apparent from the aforementioned embodiments of the present invention, an evaporator having a reflector assembly disposed in the evaporation chamber enables the passage of vapors to be changed in any direction desired. Accordingly, the relative positions of the evaporation source, substrate and reflector assembly can of course be changed according to the object. It is also possible to accumulate vapors in a free space or focus them in an arbitrary direction.

The foregoing embodiments relate to the cases where the PFEP film reflector was kept at a temperature of 200° to 250° C which is below its softening point. The PFEP film becomes soft at temperatures of 260° to 280° C at which it is reduced in viscosity. The PTFE resin is supposed to have a softening point of 310° to 330° C. In this range of temperatures, it reversibly turns translucent or transparent from a white opaque condition. Unless heated to a temperature appreciably in excess of the softening point, these PFEP and PTFE resins have the characteristics that they are not turned into liquid form like grease or oil. Further, volumes of gases released from them or amounts of product resulting from their decomposition are small from the standpoint of the vacuum technique, that is, present no problems with the normal evacuation process. If kept at a temperature slightly above the softening point, the PTFE and PFEP films will cause evaporated atoms to be retained for a shorter time than when heated to below the softening point, and reduce the sticking coefficient of evaporated atoms to zero, whereas said coefficient does not fall to zero when said films are heated to below the softening point. This is supposed to arise from the fact that when the PTFE and PFEP films are heated beyond their softening point, the macromolecules of the resin vibrate more vigorously. It is seen, therefore, that heating of the PTFE and PFEP films should not necessarily be limited to a temperature below their softening point, but that there are occasions where heating beyond their softening point rather gives better results.

As far as the present invention is concerned, the reflector film is heated to a relatively low temperature, whether it rises above or falls below its softening point. Accordingly, said heating can be easily carried out by a very common method using, for example, a nichrome heater or infrared lamp, presenting few heat problems, unlike the conventional case where the reflector is considerably heated.

As mentioned above, the present invention enables the passage of vapors to be freely changed, realizing evaporation heretofore considered infeasible, accurate evaporating operation, improved physical properties of vapor deposited materials and increased evaporation efficiency.

FIGS. **8** to **10** relate to the case where the reflector assembly of the present invention is employed in a pipe for conducting vapors of high temperature volatile materials. Referring to FIG. **8**, a pipe assembly **72** is prepared by coating the PTFE film **74** manufactured by du Pont Company commercially known as "Teflon" TFE on the inner wall of a pipe member **73** of stainless steel or other materials generally used in vacuum piping, winding a heater **75** in the form of a coil about the outer periphery of the pipe member **73** and mounting a heat insulating layer **76** made of, for example, glass wool on said coil **75**. Numerals **77** and **77'** denote vacuum flanges fitted to both ends of the pipe assembly **72**. The flange **77** is fitted with a counterpart flange **79** with a gasket **78** interposed therebetween. The counterpart flange **79** is provided with an exhaust port **80** and an input terminal **82** for conducting current to an evaporation source **81** to generate metal vapors. Numeral **83** represents a concave stainless steel reflector for reflecting evaporated metal atoms. The reflector **83** has a PTFE film **84** coated on its reflection plane and is fixed to the counterpart flange **79** by a fitting metal part (not shown). The other vacuum flange **77'** is similarly fitted with a counterpart flange **79'** with a gasket **78'** disposed therebetween. On the inner wall of the counterpart flange **79'** is detachably placed by a holder **86** an evaporation substrate made of glass or ceramics.

In the aforementioned pipe assembly **72**, the PTFE film **74** is coated, for example, in the following manner. Finely divided PTFE powders are suspended in a proper liquid to form a suspension solution at about 45 percent concentration. Said solution is coated on the inner wall of the pipe member **73** which was thoroughly water washed in advance, thermally dried at a temperature of 100° to 200° C for about 2 hours and further heated at about 400° C for about 30 minutes to form a film about 1 to 2 microns.

The pipe assembly **72** constructed as described above is evacuated, and current is conducted through a heater **75** to heat the pipe member **73** to 200° to 300° C. When the evaporation source **81** is electrically heated, minute amounts of vapors released from the evaporation source **81** are scattered in all directions as indicated by the arrows A. Since the inner wall of the pipe member **73** is coated with the PTFE film and kept at a temperature of 200° to 300° C, most or all evaporated atoms impinging on said inner wall are reflected for the aforementioned reason. Eventually, most evaporated atoms are deposited on the surface of the substrate **85**.

Referring to FIG. **9**, a pipe assembly **87** using a PTFE or PFEP film reflector according to the present invention is curvedly disposed in a vacuum chamber **88**. One end of the pipe assembly **87** opens to an evaporation source **89** and the other end to a target **90**. The pipe assembly **87** consists of two hard glass pipe components **91** and **91'** shaped in a semicircular form in section and equally split lengthwise. The inner wall of a pipe member **72** constituted by a combination of said pipe components **91** and **91'** is coated with a PFEP film **93**. The outer periphery of the pipe member **92** is wound with a nichrome heater **94**, which in turn is covered with a heat shield **95**. In this case, the PFEP film can be set in place by heat-sealing or depositing raw PFEP on the inner wall of the hard glass pipe components **91** and **91'**. In this case, the pipe components **91** and **91'** are made to abut against each other after the PFEP film is formed and thereafter sealed together in airtight relationship by proper means.

The aforementioned arrangement enables substantially all vapors released from the evaporation source **89** to arrive at the target **90**, reducing loss of the raw material to be evaporated and in consequence offering economic advantages. Moreover, the somewhat elongate pipe assembly **87** permits an evaporated layer to be formed with a uniform thickness on the target **90**.

FIGS. **11** and **12** relate to the case where the reflector assembly of the present invention is applied in a viewing window. Referring to FIG. **11**, there is fitted a viewing glass member **99** by means of a cover ring **98** to the end of a cylindrical viewing port **97** projecting from the casing **96** of an evaporator or vacuum melting furnace. In the cylindrical viewing port **97** is fixed a quartz glass cylinder **100** concentrically therewith by support members **101** and **102**. In the cylinder **100** is disposed a glass disc **104**, 100 microns thick, coated with a PFEP film **103**, 12 microns thick. The outer periphery of the cylinder **100** is fitted with a heater **105** and reflection plate **106**. Referring to FIG. **11**, numeral **107** denotes a water cooling pipe wound about the cylindrical member **97**, **108** an O ring fitted between the viewing glass disc **99** and said cylindrical member **97**, and **109** a ring for holding another glass disc **104**.

According to the aforementioned arrangement, while an evaporator or vacuum melting furnace is in operation, the heater **105** is energized to heat the glass disc **104** disposed in the quartz glass cylinder **100** to a temperature of 200° to 250° C. Since atoms adsorbed to the PFEP film **103** coated in the inner side of the glass disc 104 are retained for an extremely short time, the formation of nuclei is obstructed to prevent the deposition of evaporated atoms on the surface of the glass disc 104, thereby keeping it clean and transparent over a long period. The viewing glass member 99 is shut off from evaporated materials by the glass disc 104, naturally preventing their deposition thereon and serving as a viewing window for a long time. If there is no need to keep a continuous watch on the interior condition of the evaporator or vacuum melting furnace, there may be provided a shutter like that used in the past between the glass disc 104 and said evaporator or melting furnace. In any case, application of a PTFE or PFEP film reflector assembly according to the present invention enables a viewing glass plate to be used in a satisfactory condition more than 20 times longer than that of the prior art.

FIG. 12 represents the case where the reflector of the present invention is used in a high vacuum or ultra-high vacuum evaporator. In this case, a viewing glass member 110 is directly sealed to a cylindrical member 111 made of Kovar. In the cylindrical member 111 is received a glass disc 114, the inner side of which is coated with PFEP resin about 1,000 A. thick and the other side of which is coated with a transparent conductor film circuit formed of, for example, SnO and arranged in a zigzag form illustrated in FIG. 13. The conductor film circuit 113 is energized by current conducted across the electrodes 115. While the aforesaid evaporator or melting furnace is in operation, the PFEP film 112 is electrically heated to a temperature of about 250° C. Said film is extremely transparent, having substantially the same permeability to infrared rays and visible light as optical glass. When touched by evaporated materials under the aforementioned heated condition, the PFEP film substantially prevents them from being deposited thereon. Application of the viewing window of FIG. 12 using the PFEP film reflector of the present invention in a vacuum evaporator of nickel proved that such viewing window could be used satisfactorily about 50 times longer than the conventional type. Further, direct attachment of the PFEP film to a viewing glass plate placed in a cylindrical viewing member gives the same result.

What we claim is:

1. In apparatus for handling vapors of high temperature volatile material under reduced pressure to deposit a layer of said material upon a substrate comprising a vacuum chamber and means to position as substrate therein for deposition of said layer, the improvement which comprises a reflector assembly for reflecting said vapors of high temperature volatile material positioned within said vacuum chamber, said assembly comprising a thin fluorinated resin film coated on a support surface and heating means to heat said film to an elevated temperature.

2. The reflector assembly according to claim 1 wherein the fluorinated resin is either of polytetrafluoroethylene and polyfluoroethylenepropylene.

3. The reflector assembly according to claim 1 wherein the heat element is disposed on the opposite side of the reflecting plane of the fluorinated resin film.

4. The reflector assembly according to claim 3 wherein the heat element is fabricated in sheet form and directly disposed on the opposite side of the reflecting plane of the fluorinated resin film.

5. The reflector assembly according to claim 4 wherein the heat element is one selected from the group consisting of tin oxide, nichrome, nickel, tantalum and stainless steel.

6. The reflector assembly according to claim 5 wherein the metal constituting the heat element is mounted on a non-conductive substrate in the form of a thin film.

7. The reflector assembly according to claim 6 wherein the non-conductive substrate is either of glass and ceramics.

8. The reflector assembly according to claim 3 wherein the heat element mounted on one side of the non-conductive substrate assumes a ribbon shape bent in parallel arrangement and the reflector is disposed on the opposite side of said substrate.

9. In apparatus for handling vapors of high temperature volatile material under reduced pressure to deposit a layer of said material upon a substrate comprising a vacuum chamber and means to position a substrate therein for deposition of said layer, the improvement which comprises a viewing window for said chamber, said window comprising a transparent member as the body of said window having an inside surface and an outside surface and a reflector assembly positioned adjacent said inside surface, said reflector assembly comprising a thin, fluorinated resin film coated onto a transparent body and heating means to heat said film to an elevated temperature at which said film is transparent.

10. A viewing window assembly for apparatus for handling vapors of high temperature volatile material under reduced pressure to deposit a layer of said material upon a substrate which comprises a plate of transparent material constituting the viewing window, said plate being fitted to and sealing an opening in said apparatus presenting an inside surface across said opening and a reflector assembly positioned adjacent said inside surface, said reflector assembly comprising a thin, fluorinated resin film coating on a transparent body which is substantially parallel to said inside surface and heating means to heat said film to an elevated temperature at which said film is transparent.

11. In vacuum deposition apparatus comprising a vacuum chamber, an opening in said vacuum chamber and a viewing window fitted to and sealing said opening, the improvement which comprises a reflector assembly to mitigate deposition of vapors of high temperature volatile materials existing in said chamber upon the inner surface of said window, said reflector assembly comprising a thin, fluorinated resin film coated onto a transparent body positioned adjacent said inner surface substantially parallel thereto and heating means to heat said film to an elevated temperature at which said film is transparent.

12. A viewing window assembly in vacuum deposition apparatus comprising a tubular member extending from said apparatus and communicating with a vacuum chamber forming part of said apparatus, a plate of transparent material fitted across the outer end of said tubular member forming a seal for said tubular member through which said vacuum chamber may be viewed from without said apparatus, a reflector assembly positioned within said tubular member between said plate and said vacuum chamber, said reflector assembly comprising a glass plate, a thin film of fluorinated resin coated upon the surface of said glass plate opposite to said plate of transparent material and on the opposite side of said glass plate a transparent film of electrically conductive material constituting a heating element for said reflector assembly and electrodes connected to said transparent film by which to energize said film with current to heat the reflector assembly to an elevated temperature at which said film of fluorinated resin is transparent.

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