(12) UK Patent Application (19) GB (11) 2608816 (13) A

(43) Date of A Publication 18.01.2023

(21) Application No: 2110047.4

(22) Date of Filing: 13.07.2021

(51) INT CL:
F23G 7/06 (2006.01) ***B01D 53/70*** (2006.01)
F23D 14/16 (2006.01) ***F23D 14/58*** (2006.01)

(56) Documents Cited:
EP 2132485 A1 **EP 0694735 A1**
WO 2010/054291 A2

(58) Field of Search:
INT CL **B01D, F23G, F23J**

(71) Applicant(s):
Edwards Limited
Innovation Drive, BURGESS HILL, Sussex, RH15 9TW, United Kingdom

(72) Inventor(s):
Andrew James Seeley
David Frederick Bartz
Michael Jay Silberstein

(74) Agent and/or Address for Service:
Edwards Limited
Innovation Drive, BURGESS HILL, Sussex, RH15 9TW, United Kingdom

(54) Title of the Invention: **Abatement apparatus**
Abstract Title: **Abatement apparatus with a combustion chamber formed by a foraminous sleeve and a wetted sleeve**

(57) An apparatus 10 is suitable for the abatement of an effluent stream from a semiconductor processing tool. An upstream portion 120A of a combustion chamber 120 is formed by a foraminous sleeve 90, the upstream portion having an effluent stream inlet 60. A downstream portion 120B of the combustion chamber is formed by a wetted sleeve 1020 in fluid communication with the foraminous sleeve. The foraminous sleeve provides a foraminous axial surface 1010 facing downstream towards the downstream portion of the combustion chamber. The foraminous axial surface may be orthogonal to the wetted sleeve. The combustion chamber may be cylindrical or cuboid, with an annular or annular quadrilateral foraminous axial surface. The foraminous sleeve may be housed in an outer sleeve 1050 extending along an axial length of the foraminous sleeve to define a plenum 100 for delivery of combustion materials through the foraminous sleeve. The outer sleeve may expose an outer edge 1060 of the foraminous axial surface on which combustion is supported. A purge conduit 1070 may deliver purge gas to an exposed outer surface of the foraminous sleeve. A corresponding method is also claimed.

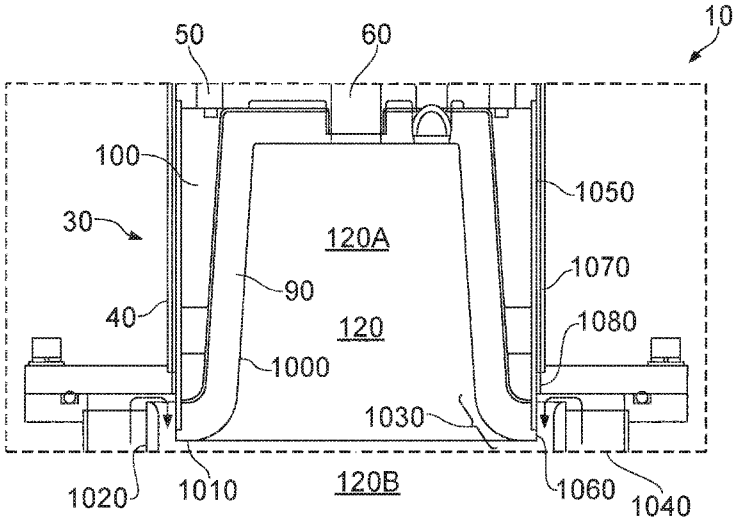

FIG. 1

GB 2608816 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

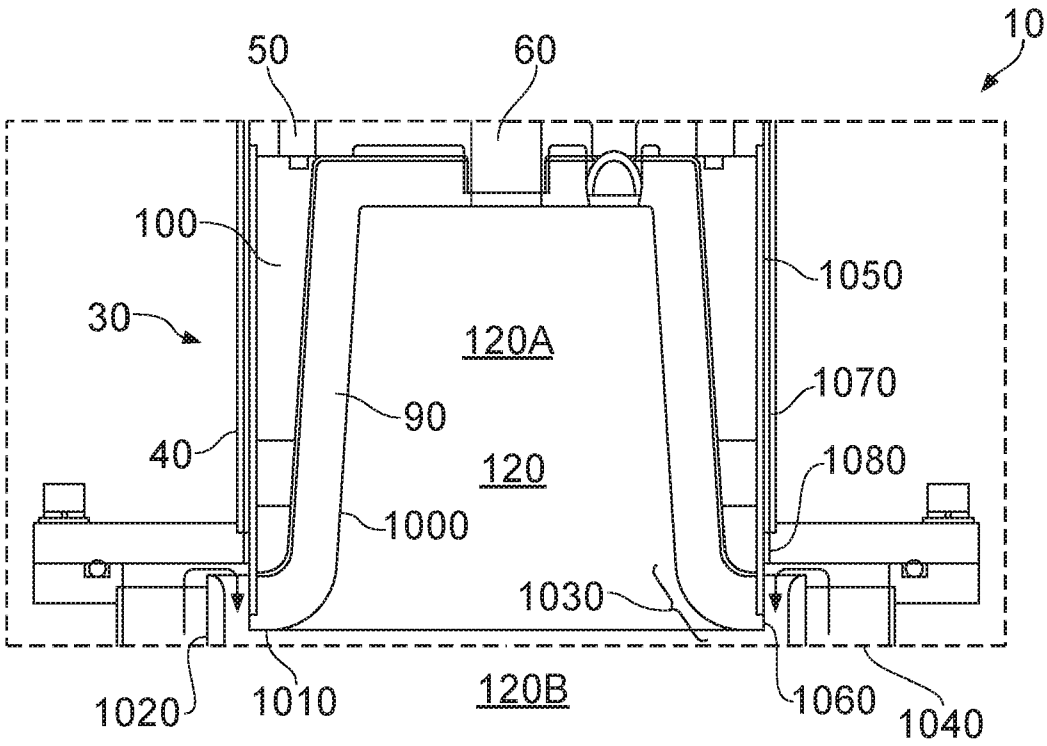
10
50
60
100
30
120A
1050
1070
90
40
120
1080
1000
1030
1020
1010
120B
1060
1040

FIG. 1

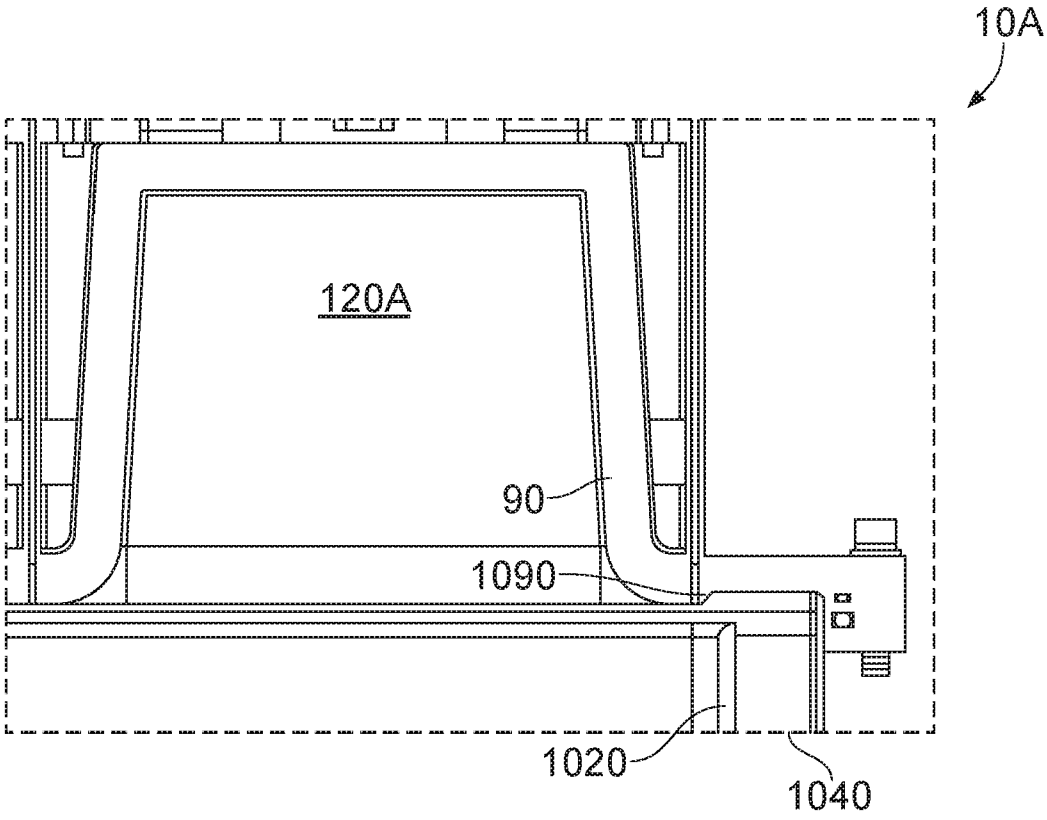
10A
120A
90
1090
1020
1040

FIG. 2

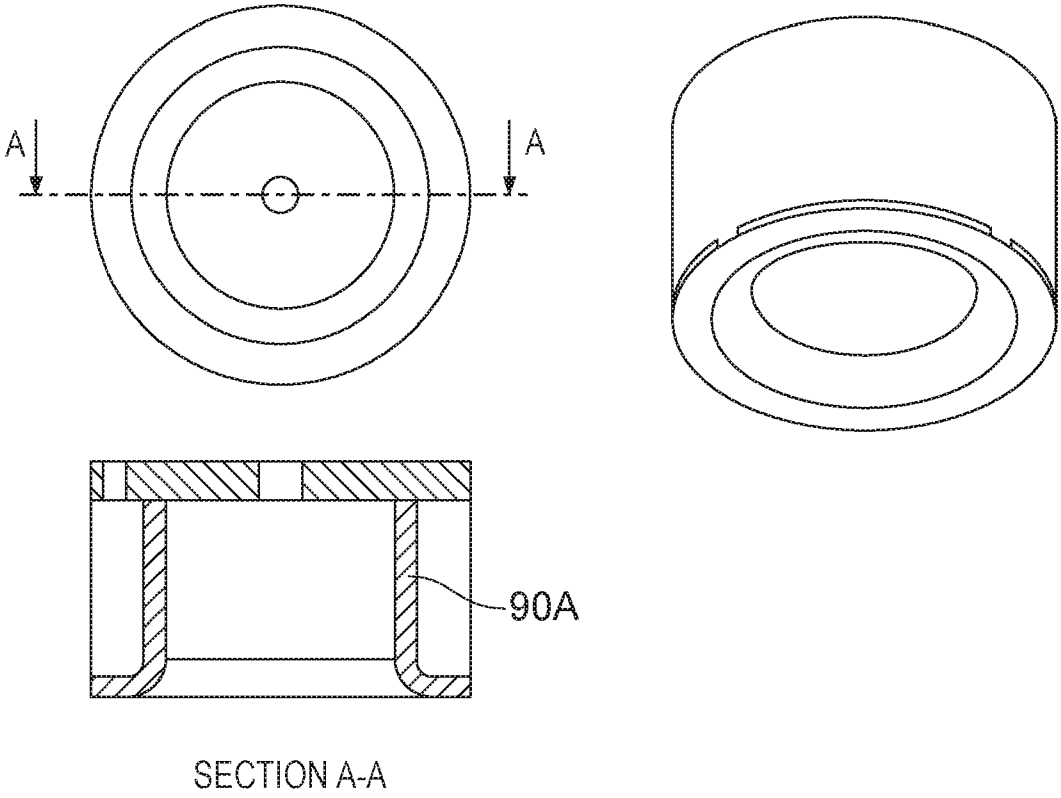

FIG. 3

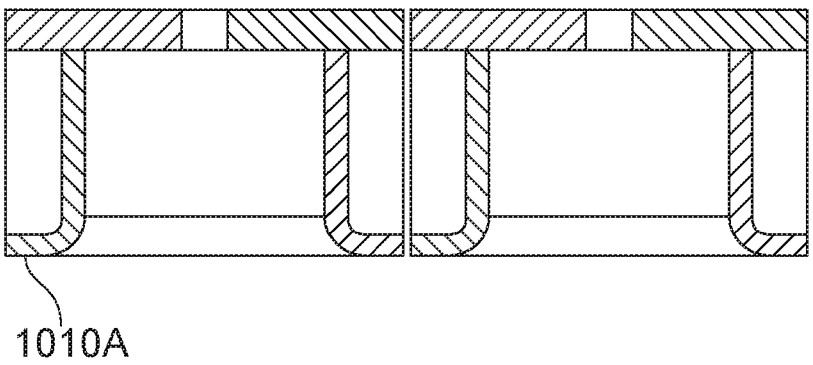

FIG. 4

ABATEMENT APPARATUS

FIELD OF THE INVENTION

The field of the invention relates to an abatement apparatus and a method.

BACKGROUND

Abatement apparatus, such as radiant burners or other types of abatement apparatus, are known and are typically used for treating an effluent gas stream from a manufacturing processing tool used in, for example, the semiconductor or flat panel display manufacturing industry. During such manufacturing, residual perfluorinated compounds (PFCs) and other compounds exist in the effluent gas stream pumped from the process tool. PFCs are difficult to remove from the effluent gas and their release into the environment is undesirable because they are known to have relatively high greenhouse activity.

Known radiant burners use combustion to remove the PFCs and other compounds from the effluent gas stream, such as that described in EP 0 694 735. Typically, the effluent gas stream is a nitrogen stream containing PFCs and other compounds. The effluent stream is conveyed into a combustion chamber that is laterally surrounded by the exit surface of a foraminous gas burner. In some cases treatment materials, such as fuel gas, can be mixed with the effluent gas stream before entering the combustion chamber. Fuel gas and air are simultaneously supplied to the foraminous burner to affect combustion at the exit surface. The products of combustion from the foraminous burner react with the effluent stream mixture to combust compounds in the effluent stream.

Although arrangements of abatement apparatus exist, they each have their own shortcomings. Accordingly, it is desired to provide an improved arrangement for abatement apparatus.

SUMMARY

According to a first aspect, there is provided an abatement apparatus for abatement of an effluent stream from a semiconductor processing tool, comprising: a combustion chamber formed by a foraminous sleeve defining an upstream portion of the combustion chamber for treating the effluent stream, the upstream portion of the combustion chamber having an inlet for receiving the effluent stream and a wetted sleeve fluidly coupled with foraminous sleeve, the wetted sleeve defining a downstream portion of the combustion chamber, wherein the foraminous sleeve is configured to provide a foraminous axial surface facing downstream towards the downstream portion of the combustion chamber.

The first aspect recognises that a problem with existing combustion chambers having a foraminous sleeve is that particulates, powder or condensates can form or be deposited, particularly at an interface between the foraminous sleeve and a downstream wetted sleeve. This is because the wetted sleeve cools the surface of a discharge region of the foraminous sleeve and, in addition, the fluid exiting the foraminous sleeve which can help to prevent the accumulation of particulate particulates, powder or condensates only occurs radially, which results in the accumulation of particulates, powder or condensates within the treated effluent stream at this discharge region which can cause bridging or blockages by that accumulated material. Also, it is difficult to abut the wetted sleeve against the foraminous sleeve to help avoid the exposing the surface of the discharge region of the foraminous sleeve since the fluid from the wetted sleeve could wick undesirably into the foraminous sleeve or if a separating gasket is used, then that gasket can likewise cause accumulation of particulate particulates, powder or condensates thereon. Accordingly, an abatement apparatus is provided. The abatement apparatus may be for the abatement of an effluent stream. The effluent stream may be from a semiconductor processing tool. The abatement apparatus may comprise a combustion chamber. The combustion chamber may be formed by a foraminous sleeve and a wetted sleeve. The foraminous sleeve may define an upstream portion of the combustion chamber for treating the

effluent stream. The upstream portion of the combustion chamber may have an inlet for receiving the effluent stream. The wetted sleeve may be fluidly coupled with the foraminous sleeve. The wetted sleeve may define a downstream portion of the combustion chamber. The foraminous sleeve may be configured, shaped or arranged to provide a foraminous axial surface facing downstream towards the downstream portion of the combustion chamber. In this way, the foraminous surface not only faces inwards towards the upstream portion of the combustion chamber, but also faces downstream, towards the downstream portion of the combustion chamber. This facilitates combustion on the surface of the foraminous sleeve, both towards the upstream portion of the combustion chamber and towards the downstream portion of the combustion chamber. This helps to maintain the temperature in the vicinity of the discharge region of the foraminous sleeve, provides a fluid flow (which provides a purge) in this region and avoids needing to abut the foraminous sleeve and wetted sleeve, which helps to prevent condensation of particulate matter occurring in this region and helps to prevent the build-up of particulates, powder or condensates that may cause bridging or blockages.

The foraminous axial surface may be orthogonal or transverse to the wetted sleeve.

The foraminous sleeve may have at least one inward-facing surface defining the upstream portion of the combustion chamber. The foraminous axial surface may at least partially define an upstream portion outlet.

At least a portion of the foraminous axial surface may be orthogonal or transverse to the inward-facing surface.

The inward-facing surface may be orientated to be generally parallel to a major direction of flow of the effluent stream in or through the combustion chamber. At least a portion of the foraminous axial surface may be orientated to be generally orthogonal or transverse to the major direction of flow of the effluent stream.

The inward-facing surface and the foraminous axial surface may have a lofted transition. This helps to reduce the presence of any discontinuities which may otherwise interfere with the flow of the effluent stream and/or act as a trap for particulates, powder or condensates.

The foraminous axial surface may be planar and/or curved.

The combustion chamber may be tubular. It will be appreciated that such a tubular combustion chamber need not be cylindrical but may be other tubular shapes.

The combustion chamber may be cylindrical and the foraminous axial surface may be annular.

The combustion chamber may be cuboid. The foraminous axial surface may be an annular quadrilateral.

The foraminous sleeve may be at least partially housed within a radially outer sleeve extending at least partially along an axial length of the foraminous sleeve to define a plenum for delivery of combustion materials to be conveyed or provided through the foraminous sleeve for combustion thereon.

The foraminous sleeve may be configured to convey combustion materials to the foraminous axial surface for combustion thereon. Accordingly, the combustion materials may combust on the foraminous axial surface to maintain the temperature and help prevent the accumulation of particulates, powder or condensate in this region.

The outer sleeve may fail to extend to the foraminous axial surface to expose or reveal at least a radially outer edge of the foraminous axial surface to support combustion thereon. Accordingly, combustion may occur on an outer surface of

the foraminous sleeve, facing towards the wetted sleeve and help prevent the accumulation of particulates, powder or condensate in this region.

The wetted sleeve may be housed within a wetted sleeve housing. The foraminous axial surface may be positioned at least flush with an upstream surface of the wetted sleeve housing. Hence, the foraminous axial surface may be positioned at or downstream of the upstream surface of the wetted sleeve housing.

The upstream surface may have a deflecting lip depending or extending from the upstream surface. The foraminous axial surface may be positioned at least flush with an edge of the deflected lip.

The foraminous sleeve may be positioned to extend within the wetted sleeve to position the foraminous axial surface below the upstream surface.

The wetted sleeve may surround at least a portion of the foraminous sleeve concentrically.

The abatement apparatus may comprise a purge conduit configured or arranged to deliver or convey a purge gas to an exposed radial outer surface of the foraminous sleeve extending within the wetted sleeve. Accordingly, that portion of the foraminous sleeve extending within the wetted sleeve may be purged with a purge gas to further help prevent the accumulation of particulates, powder or condensates in this region.

The abatement apparatus may comprise a plurality of upstands configured to extend to at least the foraminous axial surface. This helps to protect the foraminous axial surface from damage during assembly of the abatement apparatus.

According to a second aspect, there is provided a method comprising: defining an upstream portion of a combustion chamber for treating an effluent stream with a foraminous sleeve; defining a downstream portion of the combustion chamber with a wetted sleeve fluidly coupled with the foraminous sleeve; and configuring the foraminous sleeve to provide a foraminous axial surface facing downstream towards the downstream portion of the combustion chamber.

The method may comprise orientating the foraminous axial surface to be orthogonal to the wetted sleeve.

The method may comprise forming the foraminous sleeve with at least one inward-facing surface defining the upstream portion of the combustion chamber and at least partially defining an upstream portion outlet with the foraminous axial surface.

The method may comprise orientating at least a portion of the foraminous axial surface to be orthogonal to the inward-facing surface.

The method may comprise orientating the inward-facing surface to be generally parallel to a major direction of flow of the effluent stream in the combustion chamber and orientating at least a portion of the foraminous axial surface to be generally orthogonal to the major direction of flow of the effluent stream.

The method may comprise forming a lofted transition between the inward-facing surface and the foraminous axial surface.

The method may comprise forming the foraminous axial surface to be at least one of planar and curved.

The method may comprise forming the combustion chamber to be tubular.

The method may comprise forming the combustion chamber to be cylindrical and the foraminous axial surface to be annular.

The method may comprise forming the combustion chamber to be cuboid and the foraminous axial surface to be an annular quadrilateral.

The method may comprise at least partially housing the foraminous sleeve within a radially outer sleeve extending at least partially along an axial length of the foraminous sleeve to define a plenum for delivery of combustion materials to be conveyed through the foraminous sleeve for combustion thereon.

The method may comprise configuring the foraminous sleeve to convey combustion materials to the foraminous axial surface for combustion thereon.

The method may comprise configuring the outer sleeve to fail to extend to the foraminous axial surface to expose at least a radially outer edge of the foraminous axial surface to support combustion thereon.

The method may comprise configuring the outer sleeve to fail to extend to the foraminous axial surface to expose a radially outer ring of the foraminous axial surface to support combustion thereon.

The method may comprise housing the wetted sleeve within a wetted sleeve housing and positioning the foraminous axial surface to be at least flush with an upstream surface of the wetted sleeve housing.

The method may comprise forming the upstream surface with a deflecting lip depending from the upstream surface and positioning the foraminous axial surface to be at least flush with an edge of the deflecting lip.

The method may comprise positioning the foraminous sleeve to extend within the wetted sleeve to position the foraminous axial surface below the upstream surface.

The method may comprise surrounding at least a portion of the foraminous sleeve concentrically with the wetted sleeve.

The method may comprise configuring a purge conduit to deliver a purge gas to an exposed radial outer surface of the foraminous sleeve extending within the wetted sleeve.

The method may comprise configuring a plurality of upstands to extend to at least the foraminous axial surface.

Further particular and preferred aspects are set out in the accompanying independent and dependent claims. Features of the dependent claims may be combined with features of the independent claims as appropriate, and in combinations other than those explicitly set out in the claims.

Where an apparatus feature is described as being operable to provide a function, it will be appreciated that this includes an apparatus feature which provides that function or which is adapted or configured to provide that function.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will now be described further, with reference to the accompanying drawings, in which:

FIG. 1 illustrates a sectional view of a portion of an abatement apparatus according to one embodiment;

FIG. 2 illustrates a sectional view of an abatement apparatus according to one embodiment; and

FIGs. 3 and 4 illustrate a foraminous sleeve according to one embodiment.

DESCRIPTION OF THE EMBODIMENTS

Before discussing embodiments in any more detail, first an overview will be provided. Some embodiments provide a combustion chamber for an abatement apparatus which is at least partially formed by a foraminous sleeve which has an inward-facing surface which supports combustion of combustion reagents in order to heat the combustion chamber for treatment of an effluent stream. In addition to the inward-facing surface, the foraminous sleeve has an at least partially axial facing surface which also supports combustion thereon, in order to provide heat and provide a purge flow in the vicinity of an axial exhaust region of the foraminous sleeve which prevents excessive cooling of the foraminous sleeve in this region to reduce the accumulation of particulates, powder or condensates on the foraminous sleeve, which may otherwise affect the performance of the abatement apparatus and/or cause bridging or blockages. In some embodiments, the foraminous sleeve extends into a downstream wetted sleeve and at least that portion of a radially outer surface of the foraminous sleeve which faces the wetted sleeve is exposed to support combustion thereon. This again helps to provide heat which prevents excessive cooling of the foraminous sleeve in this region prevent the accumulation of particulates, powder or condensates which may otherwise bridge across to the wetted sleeve, potentially causing blockages. In some embodiments, the inward-facing surface of the foraminous sleeve transitions to the axial surface facing downstream continuously in order to provide continuous heating in this region and avoid any sharp transitions which may otherwise encourage accumulation of particulates, powder or condensates.

Abatement Apparatus – 1st Arrangement

FIG. 1 illustrates a portion of an abatement apparatus 10 according to one embodiment. Other components of the abatement apparatus have been omitted to improve clarity. A combustion chamber module 30 is provided which comprises a housing 40 which houses a foraminous sleeve 90, which defines an upstream portion 120A of a combustion chamber 120. In this arrangement, the foraminous sleeve 90 is a tapering cuboid, but other shape sleeves are possible. An inlet nozzle 60 is provided upstream of the combustion chamber 120 which

provides an effluent stream to be treated. The inlet nozzle 60 extends into the housing 40, through an upstream surface of the foraminous sleeve 90.

Downstream of the foraminous sleeve 90 is provided a wetted wall 1020 of a weir which defines a downstream portion 120B of the combustion chamber 120. The wetted wall 1020 is positioned generally downstream of, and concentric to, the foraminous sleeve 90. Fluid, such as water, is provided from an outer jacket 1040 and spills over and flows down an inward-facing surface of the wetted wall 1020.

A plenum 100 is defined between an outer surface of the foraminous sleeve 90 and an inner surface of an outer sleeve 1050 housed within the housing 40. Upstream of the plenum 100 is provided a combustion reagent inlet 50 which conveys combustion reagents into the plenum 100. The plenum 100 feeds the combustion reagents through the foraminous sleeve 90 for combustion on an inward-facing surface 1000 of the foraminous sleeve 90 defining the upper portion 120A of the combustion chamber 120. As well as combustion occurring on the inward-facing surface 1000 of the foraminous sleeve 90, combustion also occurs on an axial surface 1010 of the foraminous sleeve, which faces downstream, towards the downstream portion 120B of the combustion chamber 120 which is defined by the wetted sleeve 1020. In addition, a curved surface 1030 of the foraminous sleeve 90 provides a transition between the inward-facing surface 1000 and the axial surface 1010 which also supports combustion thereon. Hence, combustion not only occurs on the inward-facing surface 1000 but also occurs on the axial surface 1010 and on the curved surface 1030. This provides for enhanced heating at the exhaust or discharge region of the upstream portion 120A of the combustion chamber 120 which would otherwise be cooled by the wetted wall 1020 and which would otherwise result in accumulation of particulates, powder or condensate in this region.

In addition, the outer sleeve 1050 extends towards the axial face 1010 but stops short of the axial face 1010 to expose a radially outer surface 1060 which faces

towards the wetted wall 1020 and which supports the combustion of combustion reagents thereon. Again, this helps to prevent the accumulation of particulates, powder or condensate on this surface which would otherwise grow or bridge towards the wetted wall 1020.

Between the housing 40 and the outer wall 1050 is provided a further plenum 1070 which is fed with a purge gas which exits through an annular purge gas outlet 1080 to shroud the outer facing surface of the discharge end of the combustion chamber module 30 to also help prevent the accumulation of particulates, powder or condensates thereon.

Abatement Apparatus – 2nd Arrangement

FIG. 2 illustrates an abatement apparatus 10A according to one embodiment. This embodiment is similar to that described in FIG. 1 above but has the upstream portion 120A of the combustion chamber 120 positioned further upstream of the wetted wall 1020 such that the foraminous sleeve 90 is positioned completely upstream of the wetted wall 1020. In this embodiment, the ceiling of the outer jacket 1040 has a downwardly tapering protrusion 1090 which helps to deflect any fluid away from the foraminous wall 90.

Foraminous Sleeve – 2nd Arrangement

FIG. 3 illustrates a foraminous sleeve 90A according to one embodiment. In this embodiment, the foraminous sleeve 90A is cylindrical, rather than a cuboid shape as illustrated in FIGS. 1 and 2.

As can be seen in FIG. 4, a pair of foraminous sleeves 90A can be co-located and each has an axial surface 1010A orientated downstream towards a downstream portion of its combustion chamber.

Hence, some embodiments provide an improved plenum / weir or wetted wall construction to address liner or foraminous sleeve wetting and solids deposition issues at the base of the burner. A rectangular burner element or foraminous

sleeve is constructed with bell-mouth form, that is to say at the discharge end of the foraminous material that supports combustion is formed around the trailing edge to give both radial and axial firing surfaces. The slender, high velocity plenum minimises footprint. This slender plenum extends down into the weir or wetted wall section; the over-flowing water surface starts a significant distance upstream of the axial firing surface with a minimal radial clearance between the burner and the weir. This area may be fed with a trickle purge or air or nitrogen to avoid stagnancy. The burner or foraminous sleeve may have parallel walls. It may have tapered walls, preferably increasing in diameter from the inlet to the outlet. The taper half-angle is preferably between say 2 to 5 degrees, more preferably say 3 to 3.5 degrees. The burner may be constructed as an un-sintered accretion of metal and ceramic fibres cast against a perforated former. The extension of the burner lip into the weir section effectively obscures the burner-weir interface from any powder emanating from the combustor. This prevents the accumulation of solid at the interface and subsequent damage to the liner arising from water transport across the deposit. Some embodiments provide the feature that the gas/air plenum is enclosed at the bottom by the foraminous material, thus removing the necessity for a lower sealing surface. This some embodiments provide improvements to mean time between service and reduces the cost burden of burner liner replacement.

Some embodiments provide a surface burner or foraminous sleeve with substantially inward facing walls which has a section at the outlet of the burner to transition the burner surface from a radial to an axial flow direction. This improves performance at the outlet section of the burner by removing non-purged surfaces like gaskets and flanges. For multiple burner systems this allows for reliable cross ignition and improves packing density.

Some embodiments provide a cylindrical inward fired burner or foraminous sleeve. Fuel and air are introduced to an inlet where it propagates through cylindrical plenum area. This plenum is surrounded on the outside by a non-permeable burner wall and on the inside by a permeable burner material. Fuel

and air will travel through the burner wall and combust in combustion chamber area. The flow direction in this area will be radial. The burner top ensures that burner gases only exit downward. Further down the burner, the burner section transitions the burner material from a substantially radial, inward facing burner to an axial facing burner. One burner section is entirely axial facing. This causes flow fields in those combustion chamber areas to transition from a radial to an axial direction. It is possible to protect the outward facing burner surface with standoffs. These can be extensions of burner wall but do not have to be. The standoffs extend to the edge of burner material. This protects the material from accidental contact during handling and allows it to be placed on a flat surface. It is not necessary for standoffs to extend all around the perimeter of the burner. It is beneficial to have areas, which have no standoff. These areas can be covered by burner material, which is the edge of burner surface. This reduces the non-purged area in the combustion zone, which reduces solid deposition and burner corrosion.

In some embodiments a process gas can be introduced into an inlet. The process gas will travel downward, contacting the gases from the burner material. A transitional zone and an axial flow zone will ensure the process gases stay in the centre of the burner and prevent deposition of solid materials onto the burner surface.

In some embodiments, the same cylindrical burner, as stated above, is placed side by side with an identical burner for use in a multiple burner system. These burners share combustion space. Burner sections are directly next to each other allowing for immediate and reliable ignition from one burner to another. This helps to reduce the number of pilot burners required in a multiple burner system. The axial surface also optimizes the interface between the two burners by removing non-purged surfaces which would normally be required at this interface. This reduces the agglomeration of the solid particles, increasing burner life and efficacy.

Hence, it can be seen that some embodiments helps to improve performance at the outlet of the burner by removing non-purged surfaces like gaskets and flanges; allow for reliable ignition between different burner modules in a multiple burner system; improve packing density of burner modules in a multiple burner system by removing gaskets and flanges from the outlet of the burner; and provide an axial facing burner surface at the trailing edge of an inward fired burner.

It will be appreciated that the burner shape can vary; standoffs at the base of the burner can be included to prevent damage to the outward facing burner section; the burner transition section can vary in shape and scale; the ratio of radial facing burner surface to axial facing burner surface can vary.

Although illustrative embodiments of the invention have been disclosed in detail herein, with reference to the accompanying drawings, it is understood that the invention is not limited to the precise embodiment and that various changes and modifications can be effected therein by one skilled in the art without departing from the scope of the invention as defined by the appended claims and their equivalents.

REFERENCE SIGNS

Abatement apparatus 10
Combustion chamber module 30
Housing 40
Combustion reagent inlet 50
Inlet nozzle 60
Foraminous sleeve 90; 90a
Plenum 100; 1070
Combustion chamber 120
Upstream portion 120a
Downstream portion 120b
Inward-facing surface 1000
Axial surface 1010
Wetted wall 1020
Curved surface 1030
Outer jacket 1040
Outer sleeve 1050
Outer surface 1060
Purge gas outlet 1080
Protrusion 1090

CLAIMS

1. An abatement apparatus for abatement of an effluent stream from a semiconductor processing tool, comprising:

combustion chamber formed by

a foraminous sleeve defining an upstream portion of said combustion chamber for treating said effluent stream, said upstream portion of said combustion chamber having an inlet for receiving said effluent stream and

a wetted sleeve fluidly coupled with foraminous sleeve, said wetted sleeve defining a downstream portion of said combustion chamber , wherein said foraminous sleeve is configured to provide a foraminous axial surface facing downstream towards said downstream portion of said combustion chamber.

2. The abatement apparatus of claim 1, wherein said foraminous axial surface is orthogonal to said wetted sleeve.

3. The abatement apparatus of claim 1 or 2, wherein said foraminous sleeve has at least one inward-facing surface defining said upstream portion of said combustion chamber and said foraminous axial surface at least partially defines an upstream portion outlet.

4. The abatement apparatus of claim 3, wherein at least a portion of said foraminous axial surface is orthogonal to said inward-facing surface.

5. The abatement apparatus of claim 3 or 4, wherein said inward-facing surface is orientated to be generally parallel to a major direction of flow of said effluent stream in said combustion chamber and at least a portion of said foraminous axial surface is orientated to be generally orthogonal to said major direction of flow of said effluent stream.

6. The abatement apparatus of any preceding claim, wherein said foraminous axial surface is at least one of planar and curved.

7. The abatement apparatus of any preceding claim, wherein said combustion chamber is tubular.

8. The abatement apparatus of any preceding claim, wherein said combustion chamber is one of cylindrical and cuboid and said foraminous axial surface is one of annular and an annular quadrilateral.

9. The abatement apparatus of any preceding claim, wherein said foraminous sleeve is at least partially housed within a radially outer sleeve extending at least partially along an axial length of said foraminous sleeve to define a plenum for delivery of combustion materials to be conveyed through said foraminous sleeve for combustion thereon.

10. The abatement apparatus of claim 9, wherein said outer sleeve fails to extend to said foraminous axial surface to expose at least a radially outer edge of said foraminous axial surface to support combustion thereon.

11. The abatement apparatus of claims 9 or 10, wherein said outer sleeve fails to extend to said foraminous axial surface to expose a radially outer ring of said foraminous axial surface to support combustion thereon.

12. The abatement apparatus of any preceding claim, wherein said wetted sleeve is housed within a wetted sleeve housing and said foraminous axial surface is positioned at least flush with an upstream surface of said wetted sleeve housing.

13. The abatement apparatus of claim 12, wherein said upstream surface has a deflecting lip depending from said upstream surface and said foraminous axial surface is positioned at least flush with an edge of said deflecting lip.

14. The abatement apparatus of claims 12 or 13, wherein said foraminous sleeve is positioned to extend within said wetted sleeve to position said foraminous axial surface below said upstream surface.

15. The abatement apparatus of any preceding claim, comprising a purge conduit configured to deliver a purge gas to an exposed radial outer surface of said foraminous sleeve extending within said wetted sleeve.

16. The abatement apparatus of any preceding claim, comprising a plurality of upstands configured to extend to at least said foraminous axial surface.

17. A method comprising:

defining an upstream portion of a combustion chamber for treating an effluent stream with a foraminous sleeve;

defining a downstream portion of said combustion chamber with a wetted sleeve fluidly coupled with said foraminous sleeve; and

configuring said foraminous sleeve to provide a foraminous axial surface facing downstream towards said downstream portion of said combustion chamber.

Intellectual Property Office

Application No:	GB2110047.4	**Examiner:**	Contract Unit Examiner
Claims searched:	1-17	**Date of search:**	6 April 2022

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-7, 9, 12, 16, 17	EP2132485 A1 (EDWARDS LTD) paragraphs [0027] - [0029], [0031], [0032], figures 1, 2
X	1-9, 12, 16, 17	WO2010/054291 A2 (APPLIED MATERIALS INC; FOX ALLEN G) paragraph [0020], figure 2
X	1-6, 8, 9, 12, 16, 17	EP0694735 A1 (ALZETA CORP) column 5, line 56 - column 7, line 15, figures 2, 3

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

B01D; F23G; F23J

The following online and other databases have been used in the preparation of this search report

International Classification:

Subclass	Subgroup	Valid From
F23G	0007/06	01/01/2006
B01D	0053/70	01/01/2006
F23D	0014/16	01/01/2006
F23D	0014/58	01/01/2006