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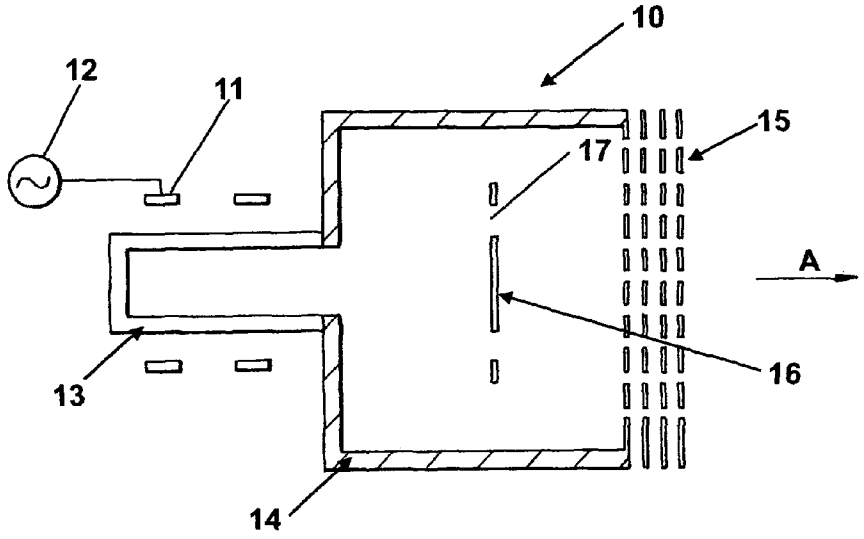
(54) Title: PLASMA SOURCES



(57) Abstract: This invention relates to a plasma source in the form of plasma generator (13) which utilises an antenna (11) and an RF source (12). The generated plasma flows into a chamber (14) and ions are accelerated out of the chamber (14) by grid (15). A body 16 is located in the volume for creating local losses and thereby reducing local plasma density.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Plasma Sources

This invention relates to plasma sources.

Plasma sources are used in many different arrangements including ion beam sources and a variety of etch and deposition tools. Such sources typically include a chamber for containing the plasma and it is well known that the plasma density is reduced adjacent the walls of the chamber due to interactions between the plasma and the chamber wall. This lack of uniformity can result in processed non-uniformity on the work pieces which are processed by processes involving the plasma.

The almost universal solution to date has been to surround the chamber with magnets or electro-magnets to create a field, which tends to reduce the rate at which electrons can reach the chamber wall. This in turn reduces the rate of ion loss to the wall and improves overall uniformity at the process plane by virtue of increased plasma density at the edge. This solution is often only partially successful and the longitudinal magnetic field passing through the chamber can produce other effects, which may not always be desirable.

However, uniformity of process is highly desirable, because the manufacturers of semi conductors devices and the like demand that every device formed on a work piece has the same characteristics.

From one aspect the invention consists in a plasma source including a plasma generator, a chamber having a volume for the plasma and a body located in the volume for creating local losses and thereby reducing local plasma density to determine the gradient of the plasma density across the volume.

In a preferred arrangement the plasma density is made more uniform across the chamber.

The Applicants have realised that there is, surprisingly, a completely different approach to the problem of plasma uniformity or achieving a preferred plasma gradient, which is to reduce the higher plasma density, which typically occurs towards the centre of the plasma, so that the density across the whole plasma is significantly more uniform or graduated as required. This can be used

in combination with the traditional magnetic approach or alternatively it can be used alone.

Conveniently the body is generally planar and may lie in a general lateral plane in the chamber. The body may have one or more cut-outs or openings and indeed there may be more than one body. The bodies may be co-planar or alternatively they may be spaced and generally parallel.

In an alternative arrangement the body may be arranged generally axially within the chamber and there may be a number of spaced parallel bodies.

Where the body is located in an RF field it should be formed from an insulator. Otherwise the body may be a conductor. The body may be any suitable shape, but for manufacturing reasons a regular geometrical shape such as triangular, circular, diamond shaped, square or rectangular bodies are particularly suitable. Three dimensional and/or irregular shapes may be used.

The plasma source may be part of an ion source. Equally it may be substituted for antennae configurations or other plasma sources. Any appropriate mode of generating plasma may be used.

From a further aspect the invention consists in an ion source for creating a low power ion beam of 100V or less including a plasma generator having an input power of above about 100W, a plasma chamber and at least a body located in the plasma chamber for absorbing power from a plasma contained in the chamber.

In this arrangement, the problems associated with running ion sources with very low input powers to created lower power beams can be overcome by running the source at higher powers and then using the body to absorb sufficient power to reduce the ion beam to the desired level.

Although the invention has been defined above it is to be understood that it includes any inventive combination of the features set out above or in the following description.

The invention may be performed in various ways and specific embodiments will now be described, by way of example, with reference to the accompanying drawings in which:

Figure 1 is a schematic cross-section through a first embodiment of an ion source; and

Figure 2 is a corresponding view through an alternative construction.

An ion source generally indicated at 10 includes an antenna 11 powered by an RF source 12 and surrounding a plasma generation chamber 13, plasma source or containment chamber 14 and an accelerator grid 15. Such an arrangement is more specifically described in the co-pending application entitled Ion Deposition Apparatus filed on the same day. Broadly a plasma is struck in the plasma generator 13 using the antenna 11 and RF source 12. The plasma flows into the chamber 14 and ions are accelerated out of the chamber 14 by grid 15 to form a stream of ions indicated by the arrow A.

The Applicants have inserted a body 16 to extend laterally across a general central portion of the chamber 15. The size, shape and location of the body 16 are selected to absorb the sufficient power from the plasma struck in the chamber so as to reduce locally the plasma density in such a way that the density of the plasma, as seen by the grid 15 is essentially uniform across the width of the chamber 14 or to achieve some desired profile of non-uniformity.

The size, shape and location can be determined empirically. The body 16 may be provided with openings or perforations 17 to allow for local fine tuning.

When a lateral body of this type is used, it will also affect the flow of ions through the chamber, as well the presence or absence of opening 17. This can be used to displace ion flow towards the chamber walls again enhancing uniformity. More than one body can be used and the addition of further bodies 16 will often persist in fine tuning.

As has already been mentioned, the ion source is only one example of a plasma generation device and the principals discussed above can equally well be applied to other plasma generation devices.

As well as being used to alter the level of non-uniformity within the plasma, a body or bodies 16 can be used to absorb power from the ion beam. This can be particularly effective for applications where low energy process beams are required (eg 100V or less). Typically applications requiring low energy process beams demand a plasma density in the region of $0.2mAcm^{-2}$,

with good uniformity. However this means that they tend to be operated at input powers in the region of 20W where it is extremely difficult to control the device. In contrast, the Applicants have appreciated, that by utilising the arrangement shown in Figure 1, the ion source can be operated in a well controlled region e.g. an input power of 150W. The body or bodies 16 are then designed to absorb sufficient power and provide the appropriate uniformity.

If power absorption or control of plasma density is the sole requirement, then the body or bodies 16 may be aligned longitudinally with in the chamber 14 as illustrated in Figure 2. Arrangement lying between the orientations of Figures 1 and 2 may also be utilised.

The positioning requirements vary depending on the geometry of the apparatus, but in general the insert should not be place too close to the antenna region of primary plasma generation such that it affects the flow of plasma into the chamber 14. Equally if the body 16 is too close to the grid 15 or process plane, it may effectively block the grid 15. Within these limits the longitudinal position of the body may be selected in accordance with the effect that is desired. There is some suggestion from experiment, that the diffusion length of the expansion box is sensitive to changes of the insert axial location of the order of 5mm. A diffusion length of half the radius of the insert, measured across the short axis of the chamber 14, has proved to be acceptable. In general it has been found that it is useful to have an insert which follows the symmetry of the chamber 14.

Claims

1. A plasma source including a plasma generator, including a chamber having a volume for the plasma and a body located in the volume for creating local losses and thereby reducing local plasma density to determine the gradient of the plasma density across the volume.

2. A plasma source as claimed in claim 1 wherein the body is generally planar.

3. A plasma source as claimed in claim 2 wherein the body lies in a generally lateral plane in the chamber.

4. A plasma source as claimed in any one of the preceding claims wherein the body has cut-outs or openings.

5. A plasma source as claimed in any one of the preceding claims wherein the body is located generally centrally in the lateral plane of the chamber.

6. A plasma source as claimed in any one of the preceding claims wherein the body is an insulator.

7. A plasma source as claimed in any one of claims 1 to 5 wherein the body is a conductor.

8. A plasma source as claimed in any one of the preceding claims wherein, in use, the plasma generator generates a non-uniform plasma in the chamber and the body is located in the region in which the highest plasma density would be generated absent the body.

9. A plasma source as claimed in any one of the preceding claims wherein the body is generally triangular, circular, diamond shaped, square or rectangular.

10. A plasma source as claimed in any one of the preceding claims wherein there is more than one body.

11. A plasma source as claimed in claim 5 wherein the bodies are spaced and generally parallel.

12. A plasma source as claimed in any one of the preceding claims wherein the source wherein the source is part of an ion source.

13. An ion source for creating a low power ion beam of 100V or less including a plasma generator having an input power of above about 100W, a plasma chamber and at least a body located in the plasma chamber for absorbing power from a plasma contained in the chamber.

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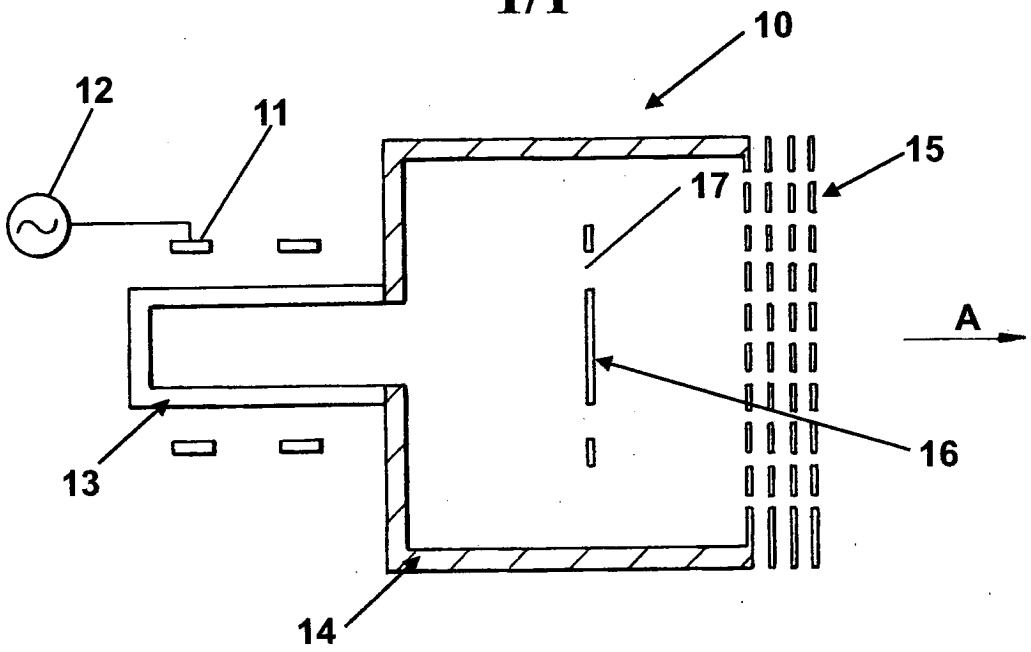

Fig. 1

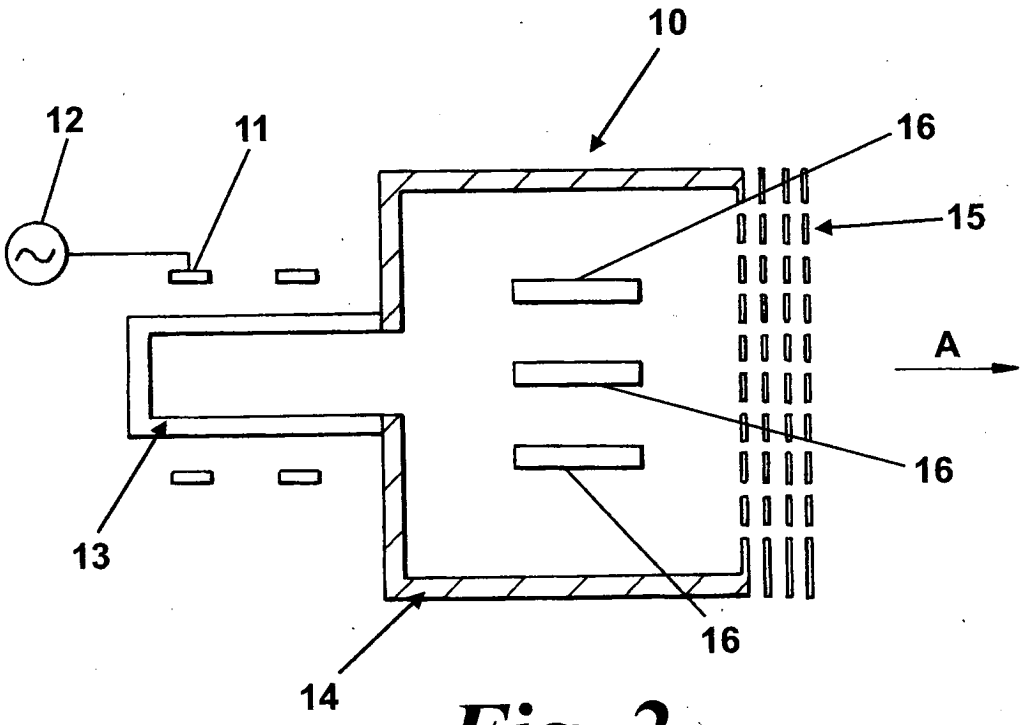

Fig. 2

ATIONAL SEARCH REPORT

International application No
PCT/GB2007/002550

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01J37/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 2002/185226 A1 (LEA LESLIE MICHAEL [GB] ET AL) 12 December 2002 (2002-12-12) figures 6-8,16A,16B,17A-C paragraphs [0004], [0013], [0032], [0033], [0117], [0125] - [0128], [0136], [0160], [0168]	1-12
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X	WO 00/36631 A (SURFACE TECH SYS LTD [GB]; BHARDWAJ JYOTI KIRON [GB]; LEA LESLIE MICHA) 22 June 2000 (2000-06-22) the whole document	1-12
Y		13

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2 October 2007	12/10/2007

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Crescenti, Massimo

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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