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JENION

Material Technology by New Plasma- and Ion Beam Techniques

Inline substrate holders for linear plasma- and ion beam processing

1 Application

Historical development of plasma- and ion beam processes was carried out for semiconductor industry processing silicon wafers with typical diameters between 4 and 8". Therefore most plasma- or ion sources developed for silicon wafer technology have a circular plasma- or ion beam output processing a fixed substrate. The realization of the high demands on process homogeneity over the wafer diameter is often a big problem for plasma- and ion beam source developers and only can be realized at small process parameter fields.

The best solution in regard to the above mentioned homogeneity problem is in principle the combination of a linear plasma- or ion source together with a mechanism transporting the substrates with a constant velocity under the linear processing source. Because of the constant substrate motion in one dimension the demands on the process source to achieve excellent homogeneity are reduced to time stability and plasma- or ion beam homogeneity over the linear axis of the source. Excellent process homogeneity over the total process parameter field can be realized.

In most cases substrate holders or transport mechanisms are produced together with the complete processing equipment by a customer specified solution. The substrate holders presented here are more designated to upgrade existing vacuum equipments with linear processing technique and therefore also with inline mountable substrate transport mechanisms.

2 Linear inline substrate holders

Substrate holders with linear substrate transport are used in combination with linear thin film deposition techniques such as linear magnetron sputtering or linear plasma- or ion sources for thin film deposition or etching. Big advantages of these arrangements are:

- Very good homogeneity over the substrate dimensions can be reached because of the fact that in both axis directions of the substrate area linear and homogeneous principles are applied;
- High throughput like necessary for industrial use can be realized by this principle;
- If in-situ control of the deposition process is realized a closed loop control can be installed to secure constant deposition parameters over long times.

Inline mounted substrate holders and processing sources are coupled to medium feedthroughs by internal cables and cooling water and gas tubes. By this way they easy can be adapted to a variety of vacuum chambers by a customer specified solution.

2.1 Principle

Fig.1. shows the principal arrangement of a linear plasma- or ion source together with an inline substrate transport.

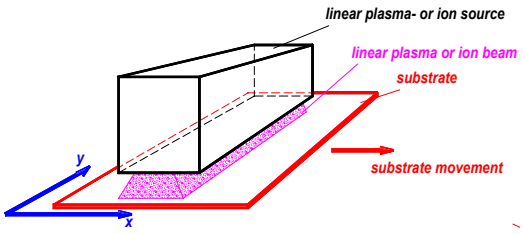

Fig.1: Principle of processing with linear plasma- or ion beam sources

Fig.2 shows a typical deposition or etch rate profile of a linear source. In x-axis direction the sources deliver mostly a nearly gaussian shaped profile. The shape of this profile is not so of interest only a mean width labelled by “b” will further be used.
In contrary to this the processing profile in the y-axis direction should be very homogeneous over the processing width, like shown at fig.2.

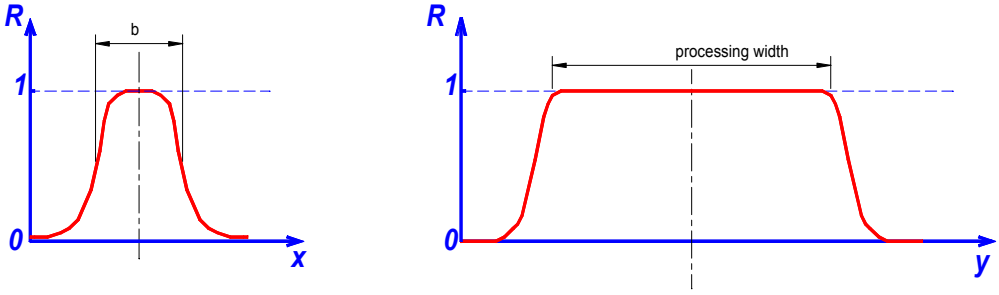

Fig.2: Typical plasma or beam profiles of linear plasma or ion beam sources (normalized deposition or etch rate R)

Mostly the thin film deposition or etch rate R of a certain process is given for the situation of a substrate fixed under the source. In case of a linear substrate transport with the substrate velocity v_{sub} the corresponding thin film thickness change after passing the source is:

$$d = R * \frac{b}{v_{sub}} \quad (1)$$

with:

d - layer thickness,
R - deposition rate (at a fixed substrate),
b - process width according to fig.2,
v_{sub} - transport velocity of the substrates.

Fig.3 shows the typical dependence of the thin film thickness from the substrate velocity for a processing source width of 50 mm and processing rates from 30 to 300 nm/min.

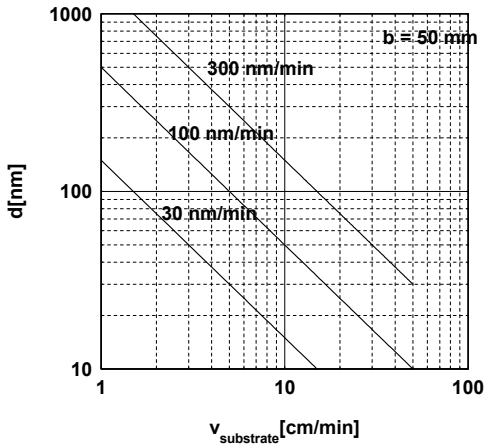

Fig.3: Processed thin film thickness in dependence from the substrate velocity and the thin film deposition rate of the plasma- or ion beam source with the process width of b= 50 mm (calculated after (1)).

2.2 Technical Data

Tab.1 gives an overview about the linear substrate transport mechanisms for substrates with max. 100 or 200 mm dimensions.

	LSH-100	**LSH-200**
Max. processable substrate width	100 mm	200 mm
max. substrate dimensions	4 “ diameter or 100 x 100 mm	8 “ diameter or 200 x 200 mm
substrate carrier material	graphite, stainless steel, aluminium (aluminium oxide parts)	graphite, stainless steel, aluminium (aluminium oxide parts)
Max. transport length	300 mm	600 mm
Outer dimensions	approx. 150 x 400 x 100	approx. 250 x 750 x 100
Velocity range	0.1 to 50 cm/min	0.1 to 50 cm/min
Temperature range	0 to 500 C (800 C) (with optional heater [3])	0 to 500 C (800 C) with optional heater [3])
Required electrical feedthrough	CF 40 or KF 40	CF 40 or KF 40

Tab.1: Technical data of the linear substrate holders

The substrate transport mechanism contains a stepper motor inside the vacuum. No mechanical feedthroughs are required.
The stepper motor electronic is mounted inside a 19” rack, which can be controlled by a separate software for substrate motion from a PC or can be controlled by the software of the Linear JENION Plasma- or Ion Beam Sources [2,4].

3 Options and Modifications

Substrate holders are a wide field of possible solutions. A lot of options and modifications can be done. Fig.4 and Fig.5 show some solutions for rotational substrate holders.

Fig.4: Customer specified flange mounted inside heated substrate holder for max. 100 mm diameter with substrate rotation and angle movement by two integrated stepper motors

Fig.5: Customer specified high voltage substrate holder for max. 20 kV Substrate bias with two integrated stepper motors for independent substrate rotation

For linear transport substrate holders the following options are possible:

- Additional a halogen lamp heater [3] from one or both substrate sides can be mounted,
- Linear transport substrate holders with other (customer specified) dimensions,
- Linear transport from roll to roll for flexible substrates like kapton - or metal foils,
- Two dimensional substrate movement for controlled local plasma- or ion beam interaction like programmed RIBE with a 40 mm ion source [1].

4 References

[1] “Alternating Cold Cathode Ion source JENION ACC-40 IS”, product information , JENION 2003.

[2] "Broad Beam Ion Implantation with linear ACC ion sources JENION ACC-30x150 IMP, ACC-40 x300 IMP and ACC-40x600 IMP " product information, JENION 2003.

[3] “Heaters for ion beam- and plasma processing”, product information JENION 2003.

[4] “Linear ACC-ion sources ACC-30x150 IS, ACC-40 x 300 IS and ACC-40 x 600 IS”, product information , JENION 2003.