Plasma Consult

13.56 MHz Hollow Cathode Plasma Source HCD-L 300 System

Hollow Cathode Discharge - module for plasma aided materials processing and synthesis

The HCD-L 300 is a very efficient but comparatively simple device for producing remote plasmas with high densities. The HCD-L 300 in its linear form consists of two coaxial tubes of 30 cm length. The inner tube is the hollow cathode and the outer grounded tube forms the anode.
Both cathode and anode are supplied with two rows of coaxial holes aligned to each other resulting in 30 plasma jets. The source is all-aluminum manufactured to avoid contamination problems. HCDs can either be mounted inside a vacuum chamber or can be attached to the chamber´s wall.

A primary working gas is fed into the cathode from both ends in order to maintain a constant gas pressure over the entire cathode length. RF-power at 13.56 MHz is applied to the cathode and an intense primary plasma is generated, approaching plasma densities of 10^{11} cm^{-3}. The coaxial holes in the cathode allow plasma jets to form and create a remote plasma in the process chamber. The overlap of plasma jets results in a very homogeneous plasma density distribution.

The HCD can be cleaned easily since no quartz parts are used.

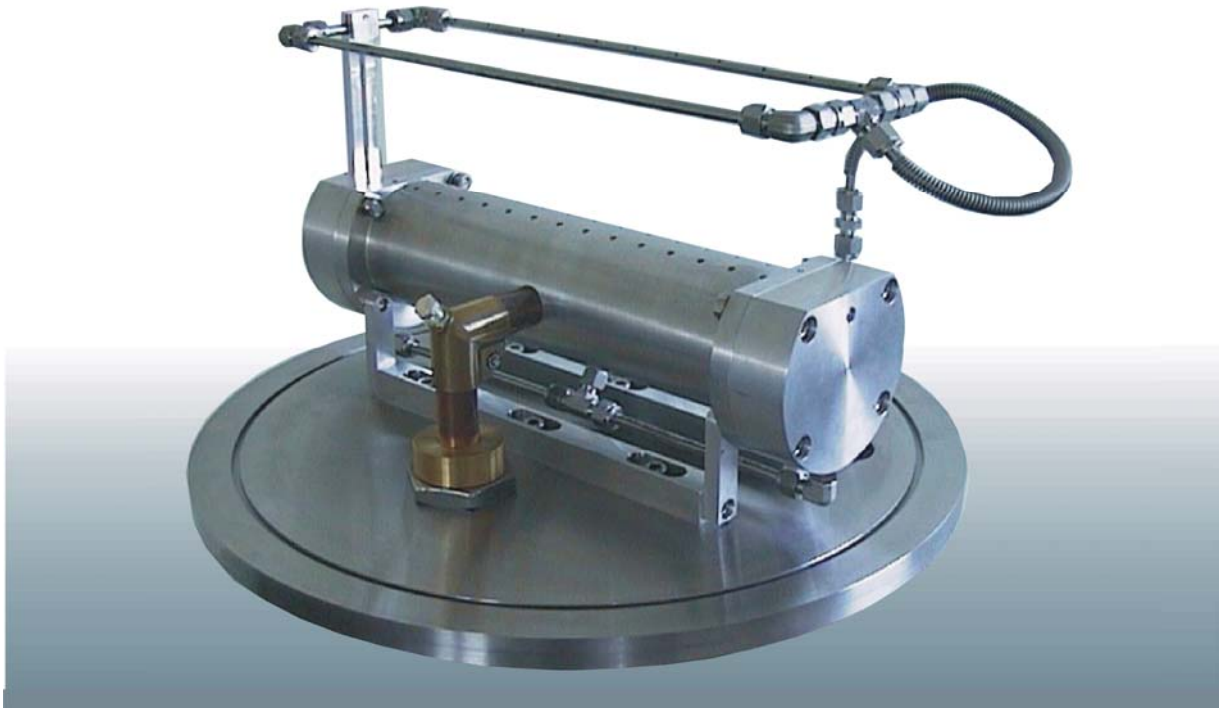
Treatment of large area planar substrates
By subsequently adding HCD-modules the total source width can be extended in steps of 30 cm each. Alternatively, HCD-modules may be arranged in parallel, increasing the deposition rate for a given plasma parameter setting.

Good film quality
The homogeneous plasma results in a small thickness variation. To name an example, HMDSO-derived SiO_x thin films on a substrate showed typical thickness variation of only about +-3%. Applications for SiO_x films include scratch resistant, anti-corrosion and barrier layers.

High deposition rates
The high rates allow a fast treatment of the substrate resulting in a high productivity of the system.

Continuous plasma treatment and deposition
Single and double side deposition or modification of thin foils in a continuous process is possible.

Low temperature treatment of thermally sensitive substrates
Possible are treatment of foils, papers and textiles. Since the thermal load of the substrates during remote processing is very low (can be kept lower than 40^0 C) the process can be applied to thermally sensitive substrates.



TECHNICAL NOTE

HCD-L 300 System

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Technical Data

Module dimension:

Length	300 mm
Outer diameter	110 mm (tubes plus end connector)
Weight:	3 kg

Process parameters:

rf-power rating	13.56 MHz, 100 - 300 W, single module
Pressure range	0.05 mbar – 10 mbar, gas dependent
Mass flow rate	5 - 300 sccm per module, primary gas

Typical process data:
Deposition rate
for HMDSO/O_2
(25/300 sccm, 0.3 mbar, 200 W):
substrate position 40 mm downstream:
~ 50 nm/min, > 1,5 µm/min possible
for C_4F_8
(8 sccm, 0.15 mbar, 10 W):
substrate position 40 mm downstream:
~ 50 nm/min, > 150 nm/min possible

Thickness homogeneity along source axis:
better than ± 3%

Applications

The HCD-L 300 can be used for plasma aided deposition, plasma cleaning and modification of surfaces. For plasma deposition a monomer or other chemically reactive molecular gases are introduced into the remote plasma region.

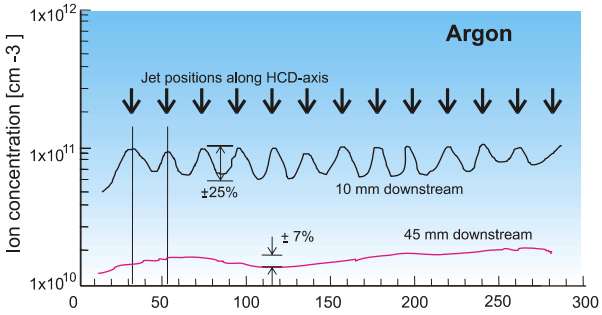

Fig. 1: Ion density distribution along the HCD-axis. Only one row of plasma jets is operating, the one is blocked. Argon chamber pressure 0,4 mbar, flow rate 550 sccm, rf-power 200 W. Data is taken 10 and 45 mm downstream along 13 plasma jet holes. At the shown downstream positions the ion concentration varies about ± 7% along source axis. Since remote processing is usually done at least 45 mm downstream this excellent uniformity leads to excellent film homogeneities.

Schematic drawing

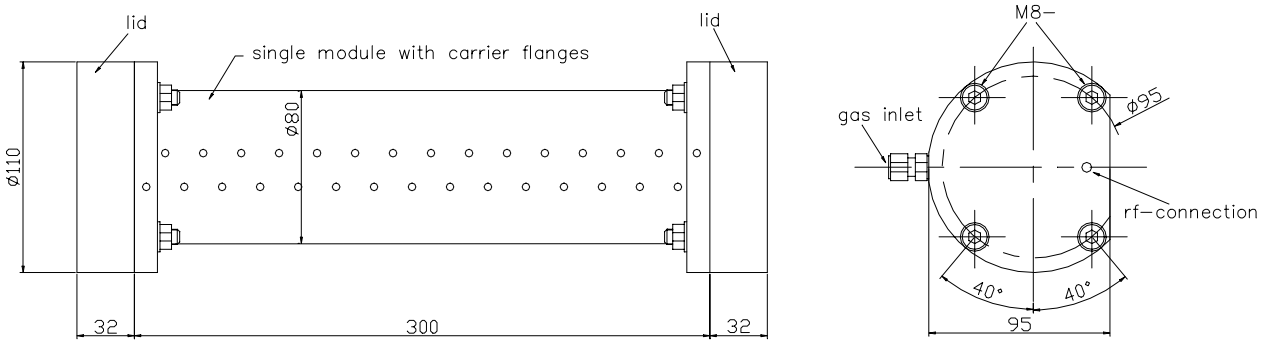

Fig. 2: Dimensions of the HCD. Several modules can be connected via the flanges at either end. Each complete row of modules forms a single large linear source. The primary gas is connected through the end caps sealing both ends of the complete row.

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