GRS-C Cantilever Mount

Sputtering Solutions for Vacuum Web Coating

• Components or Process Ready Modules with Process Tuning Available
GRS-C Cantilever Mount
GENCOA ROTATABLE SYSTEM

• A range of components for vacuum web coating with rotatable magnetrons

• GRSC rotatable end-blocks
• Standard, High Strength and Assymetric Magnetic Arrays
• Active Anodes for low temp coating and low R ITO
• Multi-zone gas delivery bars
• OPTIX web, chamber & process monitoring
• SPEEDFLO reactive gas feedback control for high rates
• Linear ion sources
• AC dual electrode pre-treat
• Pulsed electrode pre-treat / etcher
• Cantilever supports or design service for self-manufacture
23 Years of Products and Technology from Gencoa

- Rotatable & Planar Magnetron Sputter Cathodes
- Retrofit magnetic packs
- Plasma Treaters
- Speedflo Reactive Gas Controllers
- IM Ion Sources & power supplies
- Arc MAX sources & power supplies
- Active Anodes and Gas Delivery Bars
- OPTIX Gas and Chemical Sensing
- S and Se Sensor
- PEC Pulsed Effusion Cell
- V’DLC - Transparent DLC
- IC Nano antimicrobial layer technology
- Process implementation & tuning
## Gencoa Rotatable System GRS end-blocks

<table>
<thead>
<tr>
<th>End Block</th>
<th>Target Diameter</th>
<th>Target Length</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gencoa GRS-S Ultra compact drop-in flange plate mounted</td>
<td>75, 90, 100/105mm</td>
<td>0.15 to 1.2m – target weight and orientation dependant</td>
<td>40 kW</td>
</tr>
<tr>
<td>Gencoa GRS-C Side mounted - cantilever</td>
<td>75, 90, 105, 152-165mm</td>
<td>0.15 to 1.2 m pure cantilever Upto 2.4m with outer end support</td>
<td>&gt;100 kW</td>
</tr>
<tr>
<td>Gencoa GRS-M Drop-in flange plate mounted</td>
<td>75, 90, 105, 152-165mm</td>
<td>≤ 1.8 m vertical (up) ≤ 2.5 m horizontal with end support</td>
<td>&lt;100 kW</td>
</tr>
<tr>
<td>Gencoa GRS-V Top mounted hanging down</td>
<td>75, 100/105, 152-165mm</td>
<td>≤ 2.5 m vertical</td>
<td>&gt;100 kW</td>
</tr>
</tbody>
</table>
Gencoa Rotatable System GRS C end-blocks

GRSC stand-alone or fully integrated solutions

Gencoa GRSC cantilever end-block is a high capacity product for web coating

- Up to 180Amps of current ~ 100 kW of power, DC/AC
- Targets up to 2.5m long with out-bound support
- Fully EMC shielded and no debris or water ingress from atmosphere side
- Manual magnetic bar angle adjustment from atmos. side
- 152mm target OD, plus 100/105mm option
- Rotation encoder
- Helium leak rates in the <5 x 10^{-8} mbar l/s
- 550, 750, 1000 Gauss field options
- Active Anode for low temp dep
- Cantilever supports optional
- Complete process packages
Gencoa GRS-C cantilever mounted rotatable for insertion from the chamber side typically for web coating systems for target sizes of 75, 100 & 150+mm

Gencoa’s GRS-C represents high performance in a small package. The GRS-C cooling and power capacity matches the largest cantilever style rotatable magnetrons on the market.

- ¾” ID water connections (60-100l/min)
- 250A current capacity (patent pending power delivery)
- LS, DLIM, SSF, HS, PP, CVD magnet packs
- Target size can be adapted up or down – 75 – 160mm
- Target length depends upon weight – typically upto 0.6m cantilever loaded or 2.4m with outer end support
Gencoa currently supply a full package of products for the coating of flexible substrates:
• Single, Dual and Triple GRSC cathodes
• 250 to 2400mm long magnetic arrays
• Combination Active Anode and Gas bar
• Segmented gas bar
• Cantilever assembly, flange plate out-board support, electrical enclosure (optional)
• OPTIX for Vacuum Process Monitoring
• Speedflo CCD for reactive gas control
Benefits of using Gencoa supplied parts for flexible web coating.

**GRSC cathodes** – high power and load capacity with <10-8 mbar l/sec leak rate  
Variable target OD and length of magnetic arrays – high target use – low substrate heating  
Active Anode – stable uniformity – better coating – lower substrate heating – gas activation

- Cantilever assembly – low deflection and contains anode and gas connections in atmosphere – can be manufactured by the OEM to Gencoa drawings. Segmented gas bars – 3 or 5 zone control of uniformity

- OPTIX for Vacuum Process Monitoring – detects process and system faults – raises alarms – can link to Speedflo
- Speedflo for reactive gas control – controls gases for high rates & long term stability
Easy angle adjustment of the magnetic pack or stepper motor driven dynamic magnetic pack rotation / positioning
Gencoa GRS-C, GRS-M, GRS-V standard target design double screw clamping

Double screw fixing for better load bearing

Wide target clamp to prevent deformation and for better load bearing

Double retaining rings for better load bearing

Double seals of target tube – first seal prevents water pressure from acting on the main vacuum seal – more robust sealing and better load bearing
Genco GRS, GRS-C, GRS-M, GRS-V
MONOBLOCK style solid target
material clamping option

Double screw fixing for better load bearing

Large clamping area for lower stress on the target to clamp contact point

Larger amount of target material under the clamp to reduce the chance of cracking fragile targets

Double seals of target tube – first seal prevents water pressure from acting on the main vacuum seal – more robust sealing and better load bearing

Wide target clamp to prevent deformation and for better load bearing
Gencoa GRS, GRS-C, GRS-M, GRS-V
Double Sealing of air to vacuum
dynamic seal

The GRS-C main dynamic air to vacuum sealing is unique and has very low leak rates.

- The sealing provides Helium leak rates in the $<5 \times 10^{-8}$ mbar l/s range under rotation and high loading
- The sealing system can be individually leak checked via a pumping port on the mounting block
- By using the leak check port to differentially pump the double seal improves leak tightness to the $10^{-10}$ range and does not affect seal life (available with GRS C&V only)
- $1-5 \times 10^{-7}$ mbar ultimate chamber pressure range for the whole assembly
Gencoa GRS-C has excellent load bearing capacity

The bearing support and high mounting tube stiffness minimizes the deflection of the target. Typically 0.8m unsupported targets or 2.4m long with outboard support.
Complete sub-assemblies can be supplied including cantilever support, active anodes & gas bars.

All elements tested and leak checked.

Cantilever, flange plates, power enclosure can be manufactured by the customer to Gencoau drawings.
Electromagnetically Compatible (EMC) power enclosures to avoid stray radiation affecting system instrumentation.
Plasma emission monitoring, gas delivery and plasma control via active anode and multi-segment gas bars for high quality layers and excellent uniformity
Thickness uniformity with DLIM cathodes and gas bar tuning only (no magnetic array adjustment) for <±0.5-1.5% uniformity

Uniformity along width of substrate

- **Metal ± 1%**
- **40kW Reactive ± 0.5%**
- **20kW Reactive ± 1.5%**
Process and endurance testing of GRSC at Gencoa

Monitoring window

Power supply Control

Optix Monitoring

Optix & Penning

Motor controllers. Torque was monitored

Water Cooling temperature monitoring

Power Supplies
Testing of a dual assembly with active anode, heavy targets - monoblock molybdenum at 80 kW

- Unit removed from vacuum system
Active Anodes for magnetron plasmas

• A plasma is effectively an electric circuit with the target a negatively biased cathode and the chamber or separate mean providing the anode for the circuit return.

• Anodes are commonly earthed, although a positive charge is also possible.
• Whilst the plasma confinement in the near target area is governed by the magnetic field, the plasma spread away from the target is primarily an anode interaction effect.
Absence of anode can be seen in a plasma spread away from the target area.

- A stable anode will prevent parasitic plasma’s, process drifts / fluctuations, poor uniformity and instability.
- Anodes are most effective close to the target and intersecting with the magnetic field lines of the plasma trap (like a planar magnetron).
- Rotatables work better if no extra components are close to the target as they will become coated and products flakes and defects – this present a problem of where best to locate an anode.
Gencoa have developed and patented a method to provide an effective anode away from the coating flux that can collect all electrons escaping the plasma.

The method effectively combines magnetic trapping with electrostatic attraction of electrons:

- The magnetic field from a single or double magnetron (shown) combined with the magnetic field of the anode to form a closed trap for the electrons to guide them to the anode – electrons do not possess sufficient energy pass the field lines and escape the trap.
- The anode can be at varying potentials but the most convenient and cost effective method is to have the anode at earth potential.
- For example, when used with AC power between two targets, the active anode improves process stability.
Gencoa Active Anodes guide electrons for process stability and uniformity

*Also ionizes the gas passing through the anode*

– covered by Gencoa’s DLIM patent.
Improves coating density and lowers coating stress.
Substrate temperature reduction for DC-Pulsed configurations

Grounded anode

- Positive output to anode
- Power on (6kW)
- 100 kHz pulse frequency
- Power split to 2 targets
- Total time: 60 mins

Floating anode

- Power on (6kW)
- 100 kHz pulse frequency
- Power split to 2 targets
- Total time: 60 mins

2x rotatable Ti targets (152mm OD)
Al block (256 g)
Reduced substrate temperatures with the Active Anode and DC power modes

With single power modes when the patented Gencoa magnetic guidance into the Active Anode is used, 100% of the plasma electrons return to the Active Anode.
- Single cathode power modes are DC, Pulsed DC & HiPIMS.
- The electron heating is directed into the active anode and the substrate avoids any additional heating.
- This reduces by 50% the heating of the substrate.
- This prevents substrate damage and also enables much higher deposition rates and hence lower cost production.
- Two DC powered magnetrons can be connected to one central Active Anode.

Temperature indicator strips on the rear of substrates coated with 1 micron Aluminum with and without the active anode
**Gencoa Active Anodes** available in two forms for switching AC type power or DC type power modes

For DC type power modes the anode is electrically floating and connected to the positive of the power supply to collect 100% of the plasma electrons.

For switching double cathode AC power the anode is electrically earthed.

High water flow to the anode structure ensures efficient heat removal and high power capability.
**Gencoa Active Anodes** reactive oxides with pulsed DC, a unique option compatible with AC and DC power modes

Gencoa’s active anodes provides a long-term stable anode for rotatable magnetron operation which improves DC and pulsed DC processes from single or dual cathodes.

Highly insulating dielectric films can be deposited such as Al2O3 and SiO2 with a single pulsed DC cathode and an active anode. This gives an alternative for dual cathodes with AC type power.

Active Anodes dramatically improves ITO layer properties from rotatable magnetrons, $2.3 \times 10^{-4}$ resistivity at 100 C.
Creation of extra energy via the use of switching power modes between 2 targets and the use of a magnetically guided earthed active anode

- By switching electrons between targets extra ionisation is created
- Active Anodes AA creates positive and negative energy bursts on the substrate (ideal for glass or plastic substrates without external bias)
- Introduction of a delay in the power switching

<table>
<thead>
<tr>
<th>Earth potential</th>
<th>10 eV</th>
<th>46 eV</th>
</tr>
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</table>

- Standard square wave switching with Active Anode
- Standard AC power with Active Anode
- Square wave switching with 1μsec delay and Active Anode
Creation of extra energy via power mode and Active Anode – comparison of coating structures

10 micron thick AlOx deposited onto glass (floating potential – no external bias) from a dual rotatable magnetron and with active anode

- Pulsed DC power applied to the targets – NON SWITCHING – With Active Anode
- Standard AC power SWICHING but without Active Anode
- Standard AC SWITCHING power with Active Anode

Increasing Energy Levels

Columnar structures are recurrent when DC-Pulsed is used
AC switching power mode has improved structure compared to pulsed DC
AC with active anode Produces highly dense structure
Gencoa magnet bars with pre-tuned and scanned magnetics fit all types of end-block mounted on standard or ‘free-span’ HU support tubes

- Variable magnetic bar designs – 550, 750, 1000 Gauss. Unbalanced designs. Mag bars for 152 & 75 to 105mm OD
- Pre-checked magnets, precise alignment, no water contact – welded enclosure
- Final scan for quality control and uniformity checking
- Low deflection water tube support – no bowing – good field uniformity
- Different companies end-block connection types
GRS different processes by switching the magnetic pack – DC, AC, RF/DC, PECVD available in target diameter from 75 to 160mm.
Different magnetic and anode designs for rotatable magnetrons based upon needs

One solution does not fit all for optimum production!
Plot of magnetic field strength relative to distance from the target backing tube

Target thickness / strength plot - parallel field component in the centre of the race-track

- Red: Target Surface (Ø152)
- Cyan: LS single rotatable
- Blue: Single rotatable
- Pink: DLIM - double rotatable
- Purple: 700G Single Rotatable
- Orange: 850G Single Rotatable
- Green: 1000G Single Rotatable

Strength (Gauss) vs Distance from OD of target backing tube (mm)
Unbalanced (PP type) and linked magnetics are also available for substrate plasma bombardment effects.

Varying the angle changes the substrate plasma bombardment.
Plasma control by Double Low Impedance Magnetics – DLIM no Active Anode

DLIM uses the Assymetric linked magnetic designs with an tilt angle to control electron exchange and plasma escape, product code - SAR – standard strength assymetric

SAR – standard strength linked is the DLIM design without Anode

SSR – standard strength unlinked is the conventional design
Gencoa magnet bars with pre-tuned and scanned magnetics fit all types of end-block

Mounted on ‘free-span’ HU high rigidity support tubes

Typical Magnetic Array Process Recommendations

<table>
<thead>
<tr>
<th>Process Type</th>
<th>Magnetic Array</th>
<th>Active Anode</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC high rate metallizing</td>
<td>SSR 550 Gauss</td>
<td>Connected to DC +ve</td>
</tr>
<tr>
<td>DC ceramic ITO</td>
<td>SSR 550 or HSR 1000</td>
<td>Connected to DC +ve</td>
</tr>
<tr>
<td>Reactive oxides dual AC or square wave switching</td>
<td>SSR 550 or SAR 550</td>
<td>1 and per single or dual connected to earth</td>
</tr>
<tr>
<td>Reactive oxides / nitrides single or Duals DC pulse</td>
<td>SSR 550 or SAR 550</td>
<td>1 and per single or dual connected to DC +ve</td>
</tr>
<tr>
<td>Magnetic Materials</td>
<td>HSR 1000 or HAR 1000</td>
<td>Connected to DC +ve</td>
</tr>
</tbody>
</table>

**Codes**

<table>
<thead>
<tr>
<th>Balanced 150</th>
<th>SSR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balanced Asymmetric 150</td>
<td>SAR</td>
</tr>
<tr>
<td>Unbalanced 150</td>
<td>PSR</td>
</tr>
<tr>
<td>Unbalanced Asymmetric 150</td>
<td>PAR</td>
</tr>
<tr>
<td>High Strength 150</td>
<td>HSR</td>
</tr>
<tr>
<td>High Strength Asymmetric 150</td>
<td>HAR</td>
</tr>
<tr>
<td>Balanced 75, 90, 100</td>
<td>GSW</td>
</tr>
<tr>
<td>Unbalanced 75, 90, 101</td>
<td>GPP</td>
</tr>
<tr>
<td>High Strength 75, 90, 102</td>
<td>GSH</td>
</tr>
</tbody>
</table>
Gencoa Process Support provide complete sub-systems and process set-up support worldwide, process staff in the US, China and Taiwan.
**Gencoa** is actively combining technologies and developing ways to enhance thin film devices.

Thank You for your attention.

Visit [www.gencoa.com](http://www.gencoa.com) for more information or speak with your local sales representative.