MAGPULS

MP 2 Series

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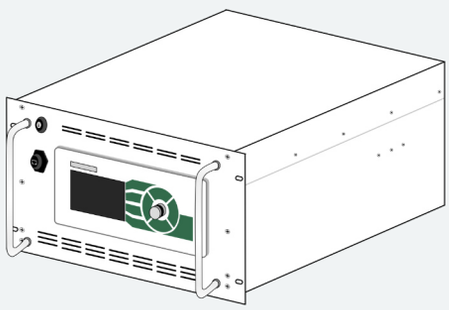
MAGPULS

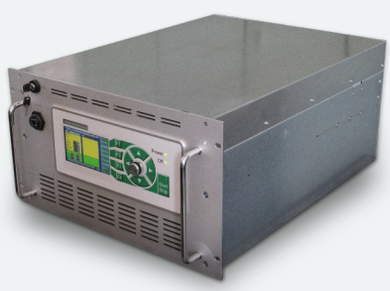
MP 2 - Series

BIPOLAR Pulse Power Supply



MAGPULS Bipolar Pulse Power Supplies are the first choice for PVD, ARC-PVD, dual Cathode sputtering and HIPIMS processes, where high film quality, low thermal stress and high performance is required.

- Semiconductor manufacturing
- Decorative Coating
- Solar cell production
- Architecture glass coating
- High quality hard coating
- High power Pulsed Plasma Nitriding
- Plasma Electrolytic Oxydation
- Plasma Cleaning
- Plasma Etching



1. Highest frequency and pulse form flexibility

- Up to 8 different pulse mode selectable. Uinipolar, DC, Bipolar and pulse Train mode
- Frequency range from 0.005 Hz up to 100 kHz in 100 ns adjustable

Benefits:

- ▶ High deposition rate
- ▶ Reducing temperature stress
- ▶ Reducing Arcing probability
- ▶ High quality coatings as different duty cycle or frequency settings
- ▶ Controlling of different material alloys at Dual Cathode Sputtering via flexible and separate setting of the Pulse ON- and OFF-time for the positive and negative Pulse polarity.
- ▶ High process yield

2. Flexible ARC handling:

- Low ARC energies (depending of the ARC parameter settings > 0,2mJ)
- Flexible settings of the arc parameters
- Pulse reverse voltage for reducing Arcing probability

Benefits:

- ▶ Short process time
- ▶ High layer quality
- ▶ High process yield
- ▶ Less particle contamination
- ▶ Lower target wear

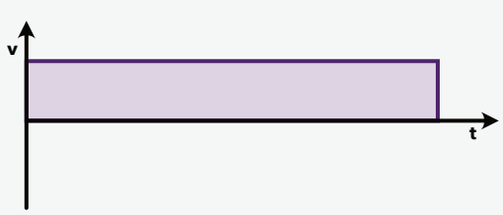
3. Energy efficiency:

- Up to 30% energy saving due energy feed back into the DC link capacitors during the pulse OFF time

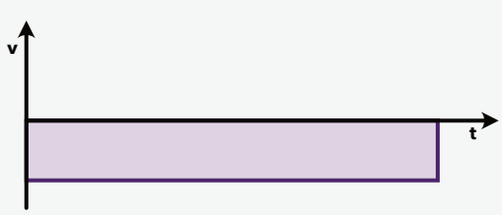
Benefits:

- ▶ Low cost of ownership
- ▶ Lower production cost

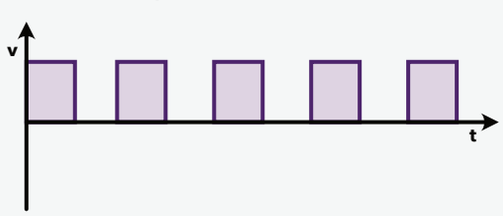
DC+ Output



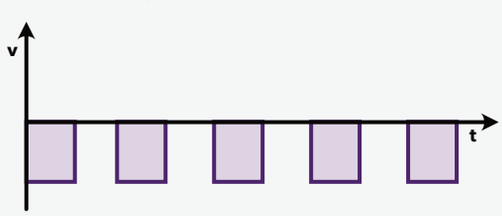
DC- Output



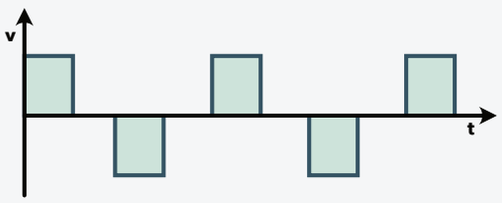
UP+ Pulse Output



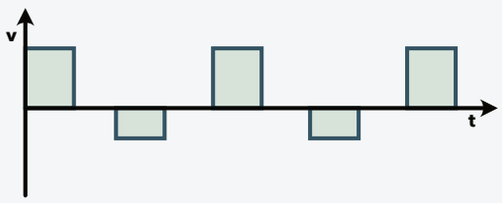
UP- Pulse Output



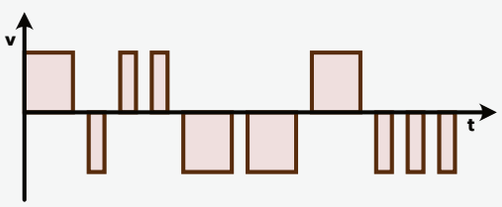
BP Symmetric Output



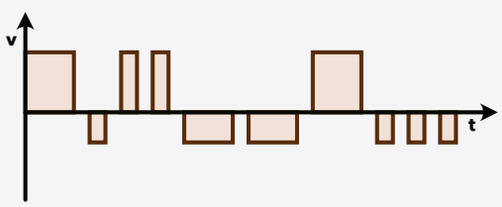
BP Asymmetric Output

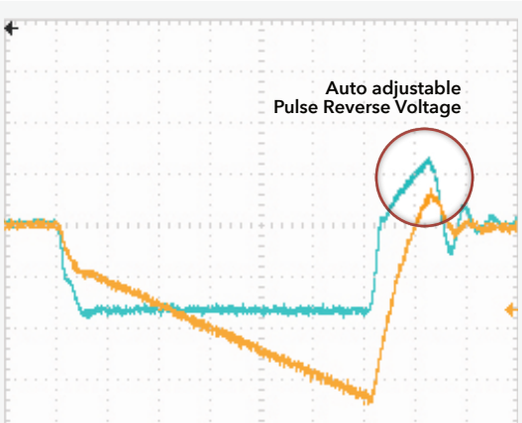


BP Symmetric Pulse Train Output



BP Asymmetric Pulse Train Output

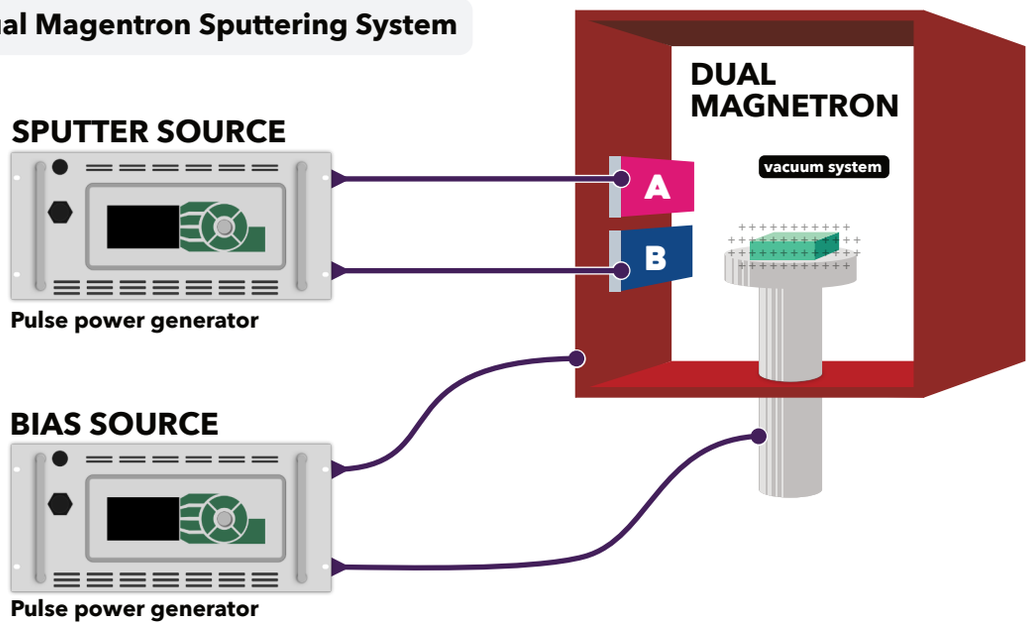




The auto adjustable pulse reverse voltage provides better process stability by reducing the ARCing behavior

MP2-Series Applications

PVD Dual Magentron Sputtering System



The magnetron sputtering process is a physical vapor deposition (PVD) technique that uses ions from a plasma, confined by a magnetic field, to eject atoms from a target material, which then deposit as a thin film onto a substrate in a vacuum chamber. This process is used to create high-quality, uniform thin films for various applications by accelerating gas ions to bombard the target, dislodging its atoms, which are subsequently transported and deposited onto a target surface. With the Bias power supply the Ions will be accelerated into the direction of the substrate to improve the hardness, adhesion strength, layer thickness and deposition rate.

Advantages

High Deposition Rates: The magnetic field confines the plasma, leading to more ionization and higher deposition rates.

Uniform Coatings: The process ensures excellent coating uniformity across the substrate, which is crucial for various applications.

High-Quality Films: It produces thin films with high density and adhesion, resulting in superior coating quality.

Versatility: Magnetron sputtering can be used to deposit a wide range of materials, including metals and alloys.

Applications

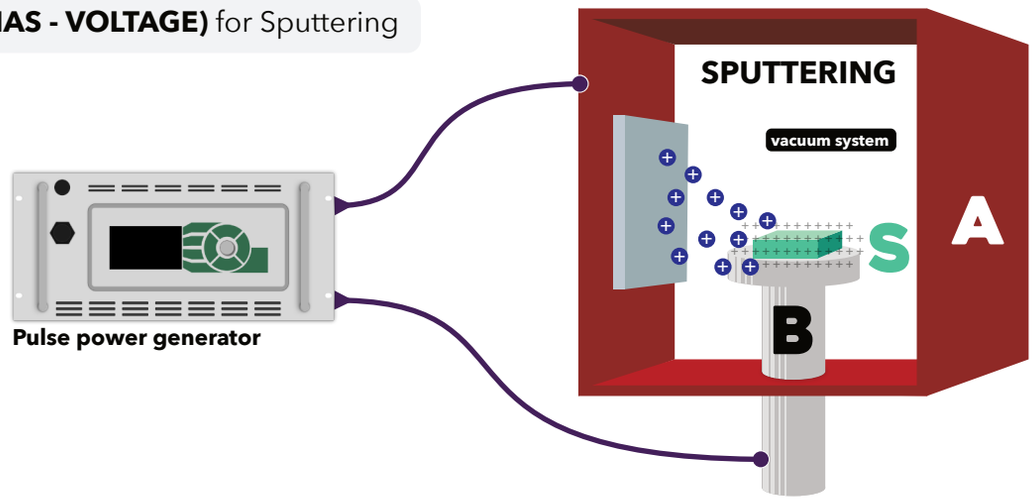
Magnetron sputtering is used in various fields for creating diverse thin-film coatings. Examples include:

Optical Coatings: For consistent optical properties in displays and lenses.

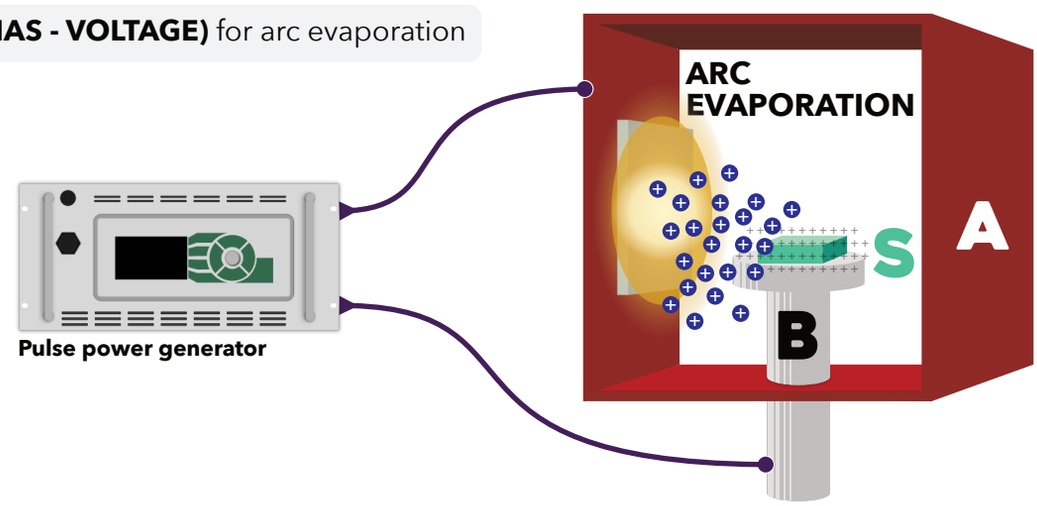
Conductive Coatings: For use in electronic devices.

Corrosion-Resistant Coatings: To protect surfaces from wear and tear.

PVD (BIAS - VOLTAGE) for Sputtering

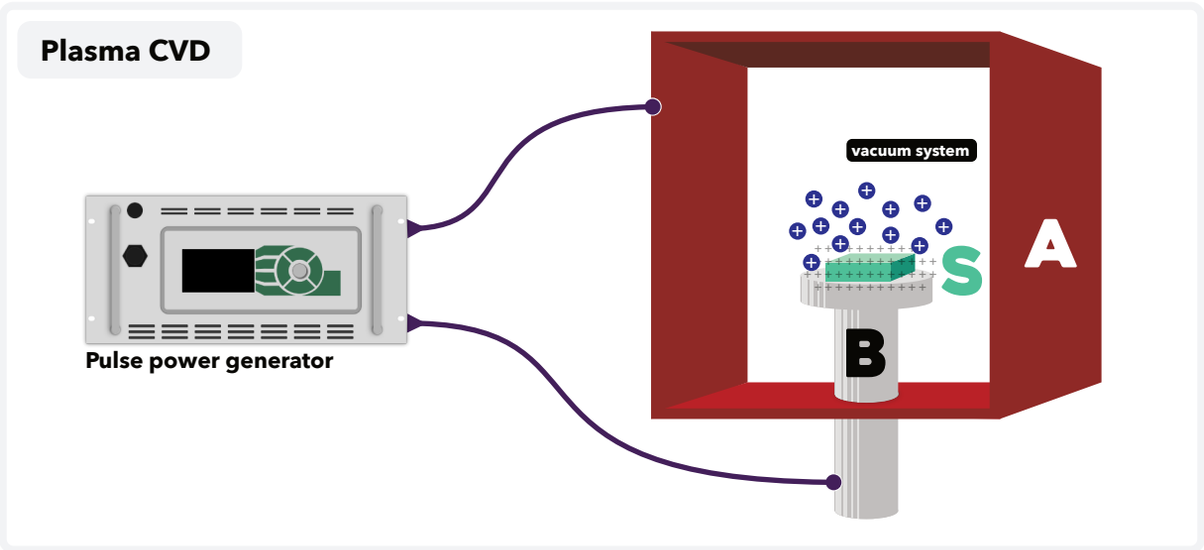


PVD (BIAS - VOLTAGE) for arc evaporation



Pulsed Bias Power supply for ARC PVD process

With the pulsed Bias voltage the Ions will be accelerated into direction of the substrate to improve the coating quality.



A Plasma CVD (or PECVD/PACVD) process uses an energized plasma to break down precursor gases into reactive species, allowing them to deposit thin films onto a substrate at lower temperatures than traditional Chemical Vapor Deposition (CVD). This plasma, generated by applying an electric field to the process gases, creates ions and radicals that form coatings with high precision and excellent adhesion on a variety of materials, including temperature-sensitive ones like plastics.

Key Characteristics

Low Temperature Process: Significantly lowers the deposition temperature compared to conventional CVD, making it suitable for delicate substrates.

Enhanced Reactivity: The plasma provides the energy to dissociate precursors, making the reaction more efficient and controllable.

Versatile Coatings: Can deposit various materials, including dielectrics, metals, and semiconductors, by adjusting precursor gas mixtures.

High Precision: Offers high precision in film deposition, allowing for the creation of precise coatings for various applications.

Common Applications

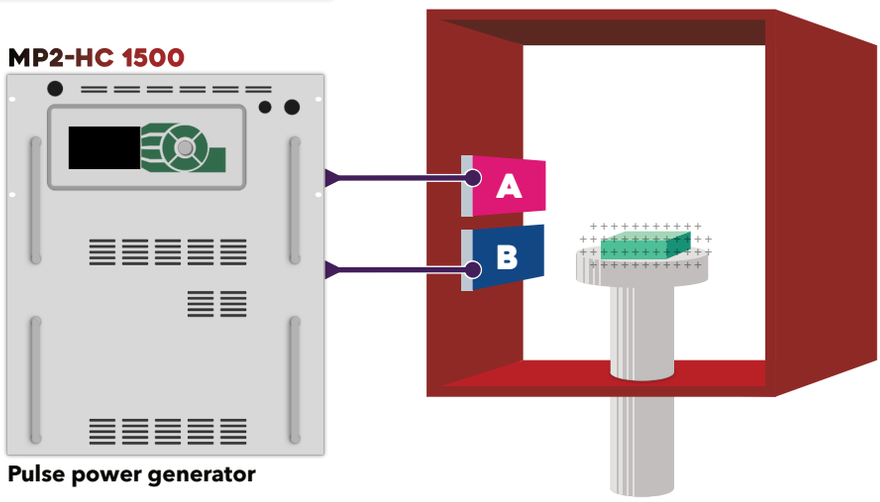
Semiconductor Devices: Deposition of thin films for electronic components.

Solar Cells: Used in the production of solar cells and other optically active devices.

Flexible Electronics: Ideal for processing flexible and printable electronic devices on polymer substrates.

Protective Coatings: Creating thin films that provide excellent barrier properties against moisture and harsh chemicals.

High Impuls sputtering (HIPIMS)



The High Power Impulse Magnetron Sputtering (HiPIMS) process is an advanced physical vapor deposition (PVD) technique that uses short, high-power pulses of voltage instead of a continuous one, generating a dense plasma with a high fraction of ionized material. This results in a much higher flux of energetic ions impacting the substrate, leading to superior thin-film coatings with better density, hardness, and adhesion compared to conventional magnetron sputtering. While HiPIMS offers improved film quality, a key drawback is a lower deposition rate, which can sometimes be compensated for by integrating HiPIMS with DC or medium-frequency (MF) sputtering.

How the HiPIMS Process Works

1. **Pulse Application:** Instead of a continuous voltage, HiPIMS applies short, high-power pulses to the target, which is a piece of metal being used to deposit a coating.
2. **Dense Plasma Formation:** These high-power pulses create a dense, transient plasma with a significantly higher percentage of ionized species compared to traditional sputtering methods.
3. **Energetic Ions:** The high-power pulses lead to a high peak power density, generating a large flux of energetic ions from the sputtered material.
4. **Film Deposition:** These ionized and energetic particles are directed to the substrate, where they arrive with high kinetic energy.
5. **Enhanced Coating Properties:** The energetic bombardment leads to a highly dense, smooth, and well-adhered thin film with enhanced mechanical, electrical, and optical properties.

Advantages of HiPIMS

Superior Film Quality: Produces films with higher density, improved hardness, and excellent adhesion.

High Ion Fraction: A significant portion of the sputtered material is ionized, providing control over film structure and properties.

Enhanced Control: Allows for greater control over microstructure, phase formation, and chemical composition of the deposited films.

Challenges

Lower Deposition Rates: The pulsed nature and high ionization lead to lower deposition rates compared to continuous DC sputtering, especially for certain materials.

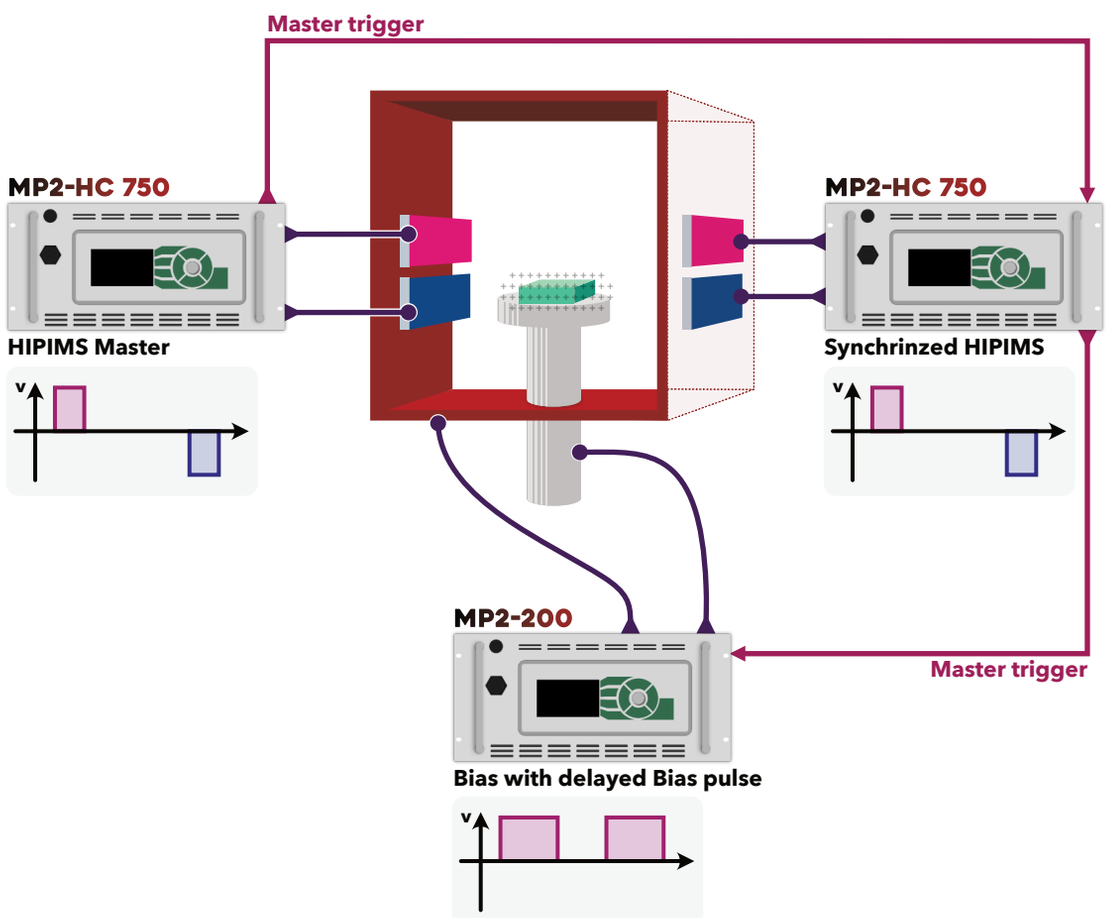
Applications

Electronics: For creating specialized electronic components.

Optics: In the production of optical coatings.

Protective Coatings: To deposit high-performance protective layers for various industrial applications.

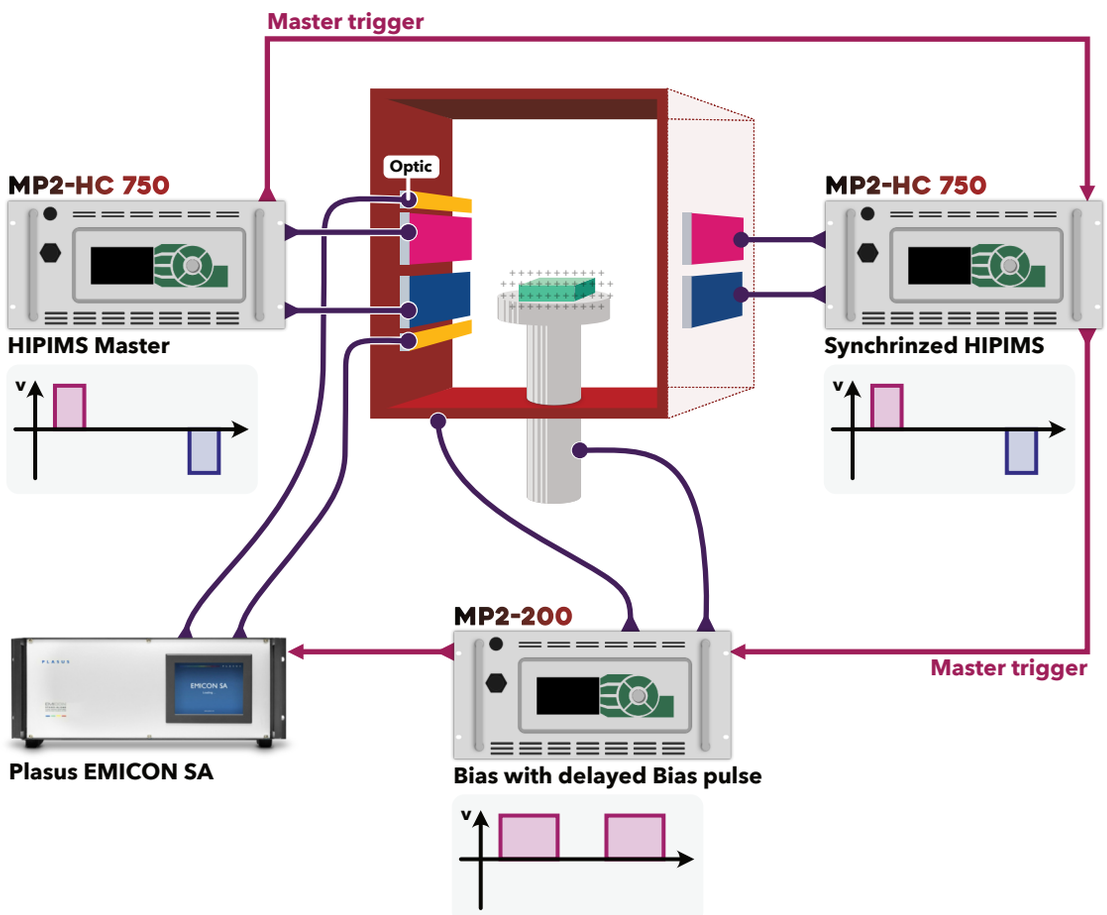
HIPIMS systems synchronized Sputtering



High sophisticated HIPIMS Magnetron sputtering process with synchronized HIPIMS power supplies and a Bias power supply with delayed pulsing for collecting special Ion concentration into the direction of the substrate. One HIPIMS power supply operates as master and synchronize the additional HIPIMS power supplies which operates as Slave. The synchronized signal form the Master will be lead to the Bias power supply which apply a Bias voltage with e predefined delay time and Pulse time to the substrate holder.

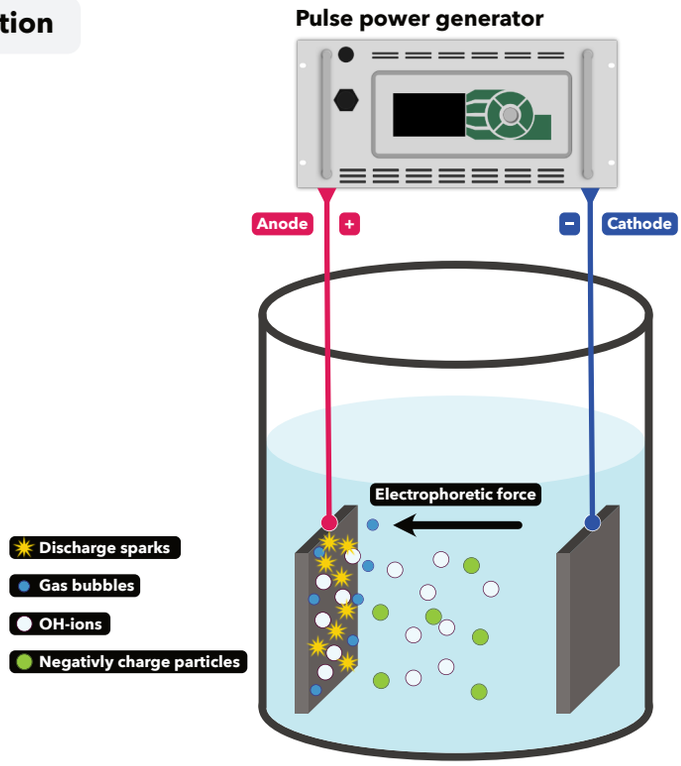
Advantage in comparison to the standards HIPIMS process: Enhanced coating quality.

HIPIMS systems synchronized Sputtering



Improvement of the HIPIMS sputtering application with synchronized HIPIMS power supplies and Bias and an additional synchronized optical plasma spectrometer for identifying the Ionization concentration during the HIPIMS pulse.

Plasma electrolytic oxydation



Plasma electrolytic oxidation (PEO), also known as micro-arc oxidation (MAO), is an electrochemical surface treatment process that converts light metals like aluminum, titanium, and magnesium into a hard, ceramic-like oxide-ceramic coating through high-voltage discharges in an electrolyte bath. This process improves the metal's wear resistance, corrosion protection, and thermal properties by forming a dense, ductile layer with enhanced mechanical and dielectric properties.

How the Process Works

1. **Immersion:** The metal component is immersed in a dilute alkaline electrolyte solution and acts as the anode in an electrochemical cell.
2. **High-Voltage Discharge:** A high AC or DC voltage is applied, causing the formation of micro-discharges on the metal's surface.
3. **Plasma State:** These micro-discharges create a plasma state with extremely high local temperatures, leading to the rapid oxidation and conversion of the metal's surface.
4. **Coating Formation:** The substrate material, along with its alloying elements, reacts with oxygen from the electrolyte and forms a hard, ceramic oxide layer.

Key Features and Benefits

Ceramic-Like Coating: The PEO process creates a dense, wear-resistant, and corrosion-resistant ceramic layer.

Versatility: It is effective on valve metals such as aluminum, magnesium, and titanium.

Improved Properties: The resulting coating enhances mechanical strength, wear resistance, thermal stability, and dielectric properties.

Multi-Functional Capabilities: Advanced PEO methods involve incorporating micro- and nano-particles into the coating to add functionalities like self-healing, bioactivity, or catalytic performance.

Applications

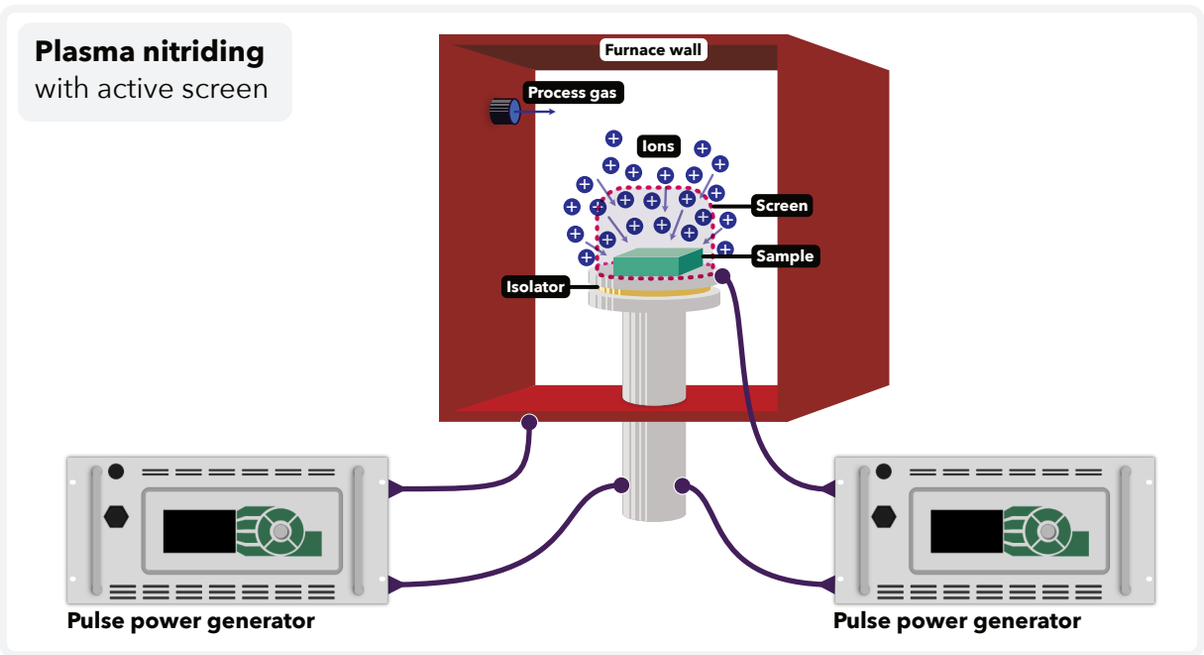
PEO is crucial for various industries:

Biomedical: For implants that require bioactivity and biocompatibility.

Aerospace: To protect lightweight alloys from harsh conditions.

Automotive: To enhance the durability and corrosion resistance of engine components and other parts.

General Engineering: To extend the service life and improve the performance of light alloys susceptible to wear and corrosion.



Plasma nitriding application with active screen (ASPN) Active Screen Plasma Nitriding.

The glow discharge will be moved into the direction of the metal screen which produce a highly reactive process gas to promote the enragement of nitrogen at the surface of the workpiece, resulting in increase hardness and improved corrosion resistance. With the synchronization of the pulse power generator, which is connected with the active screen, the plasma nitriding results can be improved.

Advantages of the ASPN method:

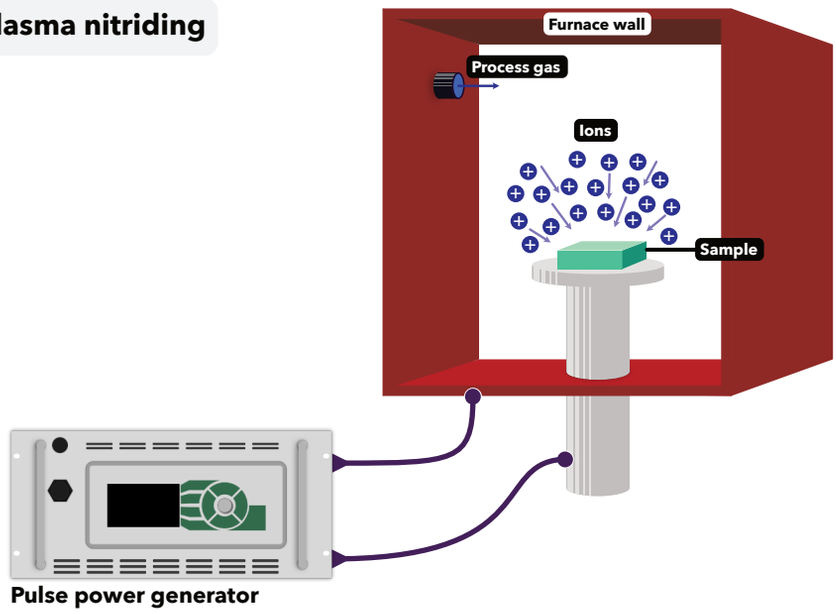
The ASPN process combines the advantages of plasma nitriding, such as minimal distortion and the ability to treat fully machined components.
Improved controlling of the process gas and homogeneous glow discharge.

High ductility: The compound layers produced by this process are highly ductile.

Fields of application:

It is suitable for components that require high wear resistance and enhanced corrosion resistance.

Plasma nitriding



Plasma nitriding is a thermochemical surface treatment process used for hardening metal surfaces. By enriching the surface with nitrogen in a plasma environment, a hard, wear-resistant, and corrosion-resistant protective layer is formed. This process is characterized by low treatment temperatures, minimal distortion, high dimensional accuracy, and the avoidance of toxic gases such as ammonia. It is used for engineering components subjected to high stresses, in order to improve their service life and reliability.

Advantages of plasma nitriding:

Minimal distortion: Since it is performed at low temperatures, components experience virtually no deformation.

Improved properties: Wear and corrosion resistance, as well as fatigue strength, are significantly enhanced.

Environmentally friendly: No toxic gases, such as ammonia, are used, making the process more environmentally friendly.

Dimensional accuracy: Particularly well-suited for precision-machined parts.

Selective treatment possible: Only specific areas of a component can be treated.

Fields of application:
It is suitable for components that require high wear resistance and enhanced corrosion resistance.

Option: Trigger/Synchronization card for all MAGULS Pulse Power Supplies available.

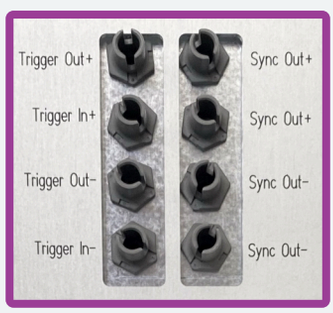
With this Trigger/Synchronization card all Pulse Power Sullies series MP1 and MP2 can triggered and synchronized. No separate synchronization generator or special Software is necessary.

Features:

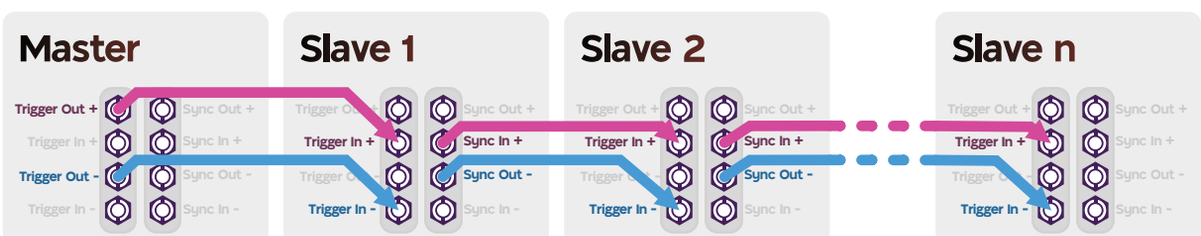
- Synchronization of pulsed power supplies in a sputtering system at different Cathodes and synchronization an additional MAGPULS Bias power supply
- Parallel connecting of MAGPULS power supplies with the same technical data for increasing the pulse power.
- Trigger / Delay mode for individual timing with preset pulse ON-times and time shift in 10 ns steps for sequency sputtering of several Sputter cathodes in a system.
- Easy programming of the trigger delay time (phase shift) and Pulse On time of each connected Pulse Power supply.
- No limit of the total quantity of the synchronized Power supplies in the system
- Fiber optic singling guaranties highest reliability in HIPIMS processes.

Rear side of the Pulse Power Supply with Trigger/Synchronization option

Fiber optic Input and Output Interface

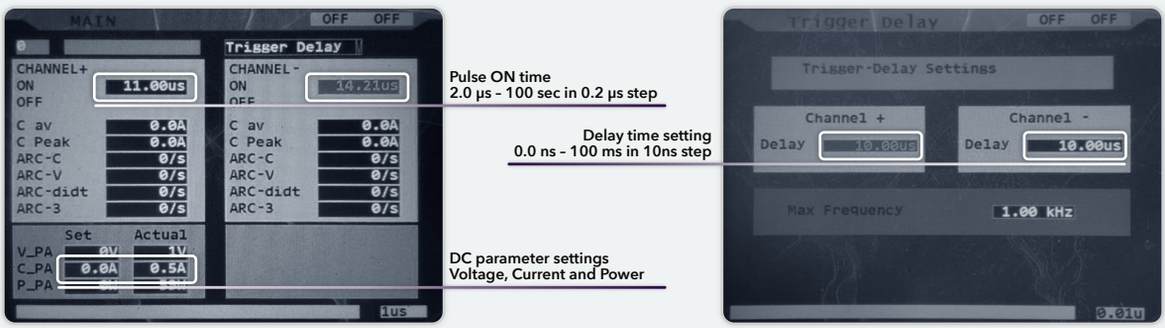


Example for the principal configuration for synchronization and Trigger/Delay operation.



One pulse unit will be defined as Master and send the Trigger signals to the next Slave. The Master Trigger Output Signal is lead to the Slave Sync. Input. Wit this Input signal the Slave can be run in synchronization mode with the same Pulse times as the Master as well as the Slave can be operated in Trigger/Delay mode with preset Pulse ON time and time shift from the Trigger Input signal. At the same time the Master input trigger signal will be rectified and linked to the Sync. Output signal for synchronization or Trigger/Delay operation of the next Slave in this configuration, and so on.

Trigger Dealy setting at the front panel of each Slave pulse power supplies



Timing diagram of the pulse output of each pulse power supplies