Impedans
PLASMA MEASUREMENT

Semion™ Pulsed DC

Retarding Field Energy Analyser (RFEA)

Time-Resolved IEDF Measurement System

For high-resolution (44 ns) IEDF measurement in Pulsed DC plasmas

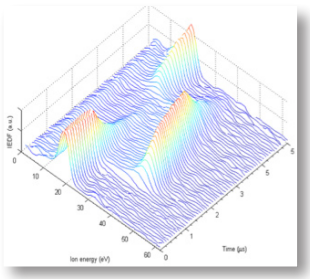
The Semion Pulsed DC system is a precision plasma measurement instrument used to measure the time dependence of the ion energy distribution arriving at any surface in a plasma chamber. The Semion Pulsed DC system is the key instrument used to measure the temporal evolution of the ion energy and flux at different times through the pulse period of a pulsed DC plasma process. It is the only commercial RFEA technology on the market with sub-microsecond time resolution. A variety of replaceable sensing elements with different signal sensitivities are available to probe a wide range of plasma ion current densities. The Semion Pulsed DC system is an essential plasma process diagnostic for establishing the correlation between the plasma inputs and the plasma state which, in-turn, determines the effectiveness of the surface treatment.

Key Features

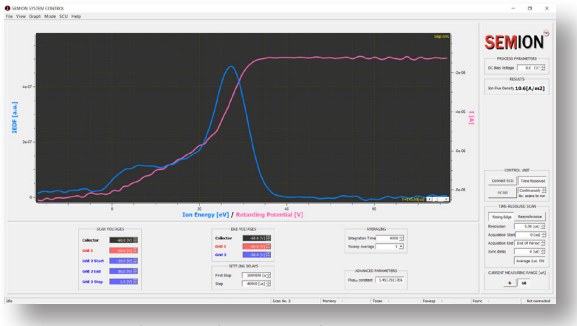
- Energy range up to 2000 eV (process dependant) and operating frequency range from DC to 350 kHz.
- Suitable for grounded, floating and Pulsed DC biased conditions.
- Time averaged and time resolved measurements with up to 44 ns time resolution (sensor cable length dependant).
- Fully automated software analysis including IEDF adjustment for sensor DC bias potential.
- Replaceable sensor elements with different sensitivities ranging from 0.001 Am^{-2} to 700 Am^{-2}.
- Sensor elements and holder available in anodised aluminium, bare aluminium, stainless steel options.
- Can be mounted on a Pulsed DC biased electrode with up to 400 V peak-to-peak applied.

Key Benefits & Applications

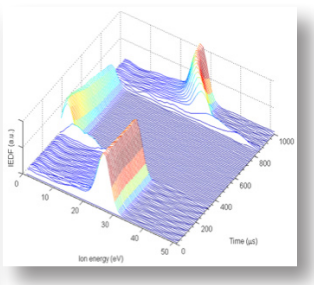
- Portable system allowing analysis in multiple chambers using a single system.
- Provides in-situ measurement of Ion Energy Distribution (IED) under plasma processing conditions.
- Ideal for characterising Pulsed DC plasma processes (magnetron sputtering, HiPIMS, PLD).
- High pressure Button Probes™ extend the pressure ranging to 1.5 Torr (limited to 150 eV energy range).
- Provides insight for fundamental research and for plasma model validation.
- Generate process data for customer escalations or product marketing.
- Correlate process performance with the key plasma process drivers (ion energy and ion flux).



IEDF vs time through a 200 kHz pulse cycle



IEDF at a single time during a pulse



IEDF vs time through a 1 kHz pulse cycle

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Electronic Control Unit Specifications

# Voltage channels	3
Voltage range	-2000 V to +2000 V
Current range	10 nA to 60 µA
Connectivity	USB 2.0
Synchronization	TTL Input

RFEA Probe Specifications

Probe configuration	x3 active grids & x1 collector
Button Probe diameter (sensing element)	33 mm
Holder diameter	50 – 300 mm diameter options (custom available)
Holder thickness	5 mm
Max. operating temperature	150° C
Button Probe material	Aluminium, anodised aluminium, stainless steel
Holder material	Aluminium, anodised aluminium, stainless steel
RFEA Probe cable length	350 mm (custom available)
Flange Type	CF40 as standard, KF40 or custom
Feedthrough Plug	x2 HV BNC connectors

Semion Pulsed DC - System Specifications

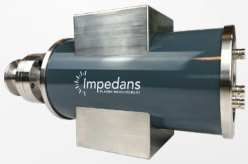
Ion Energy Range	0 to 800 eV (standard Button Probe) 0 to 150 eV (high pressure Button Probe)
Ion Flux	0.001 to 3 Am^{-2} (low density Button Probe) 0.01 to 50 Am^{-2} (standard Button Probe) 0.1 to 700 Am^{-2} (high density Button Probe)
Pressure range	≤ 300 mTorr (standard Button Probe) ≤ 1.5 Torr (high pressure Button Probe)
IEDF Resolution	±1 eV nominal
Ion Density Range	10^{12} to 10^{20} m^{-3} (Button Probe dependant)
Max. bias voltage (applied to probe)	400 V (peak to peak)
Time resolved method	Boxcar integration
Time resolution	44 ns per 350 mm of cable

Product Operating Parameter

	Pressure (Pascal)	Pressure (Torr)	Gas Temp.	Density	Gas Reactivity	Bias Frequency	Ion Energy
High	> 10^5 Pa	> 760 Torr	> 5000°	> 10^{14} cm^{-3}	SiH_4	Microwave (3 GHz - 20 GHz)	> 100 KeV
	1000 Pa - 105 Pa	10 - 760 Torr	5000°	10^{12} - 10^{14} cm^{-3}	$C4F_8$, SF_6	Microwave (1GHz - 3 GHz)	10 - 100 KeV
	100 Pa - 1000 Pa	1 - 10 Torr	1000°	10^{10} - 10^{12} cm^{-3}	CHF_3	UHF (100 MHz - 1 GHz)	2,000 - 10,000 eV
Medium	10 Pa - 100 Pa	0.1 - 1 Torr	500°	10^8 - 10^{10} cm^{-3}	Cl	RF (1 MHz - 100 MHz)	800 - 2,000 eV
	1 Pa - 10 Pa	10 - 100 mTorr	200°	10^6 - 10^8 cm^{-3}	O_2	MF (0 - 1 MHz)	400 - 800 eV
	0.1 Pa - 1 Pa	1-10 mTorr	100°	10^4 -10^6 cm^{-3}	N_2	pDC (0 - 350 kHz)	100 - 400 eV
Low	< 0.1 Pa	< 1 mTorr	20°	< 10^4 cm^{-3}	Ar, He	DC (0 kHz)	0 - 100 eV

System Operating Parameters Beyond Operating Parameters

Publication list available at: impedans.com/semion-publications

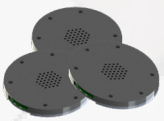


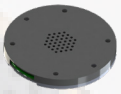
Feedthrough

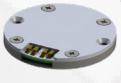
Electronic box


Flange with x2 HV BNC connectors


Sensor with ceramic cable with colour coded connectors


Button Probes


Button Probe - front side


Button Probe - back side