SEMION APPLICATIONS LIST - [SE14]

SEMION SYSTEM - Retarding Field Energy Analyser

The Semion RFEA is in use worldwide for substrate-level measurements in many different types of plasma conditions. Below is a list of publications with their plasma sources, process gases, pressures and applications.

Plasma Source	Frequency	Gases	Pressure	Published Paper
Cascaded Arc	100 kHz	$Ar/H_2/SiH_4$	100 mTorr	Hydrogenated amorphous silicon deposited under accurately controlled ion bombardment using pulse-shaped substrate biasing
Cascading Arc	195 kHz	Ar/H_2	130 mTorr	Accurate control of ion bombardment in remote plasmas using pulse-shaped biasing
Cathodic Arc Thruster	30 Hz DC	Titanium	0.15 mTorr	Life Time Characterization of the Inline-Screw-Feeding Vacuum-Arc-Thruster
Cathodic Arc Thruster	30 Hz DC	Titanium	0.15 mTorr	Experimental Characterization of the Inline-Screw-Feeding Vacuum-Arc-Thruster Operation
CCP	13.56 MHz and 250kHz Pulsed-DC	CH_2	7 to 70 mTorr	Ion energy distributions in bipolar pulsed-dc discharges of methane measured at the biased cathode
CCP	15 MHz, 30 MHz and 60 MHz	$Ar + CF_4 + O_2$	5 to 40 mTorr	Control of ion energy distributions using phase shifting in multi-frequency capacitively coupled plasmas
CCP	13.56 MHz	Ar	20 mTorr	A spatially resolved retarding field energy analyzer design suitable for uniformity analysis across the surface of a semiconductor wafer
CCP	13.56 MHz 27.12 MHz	Ar	30 mTorr	The electrical asymmetry effect in geometrically asymmetric capacitive radio frequency plasmas
CCP	13.56 MHz 27.12 MHz	Ar	20 mTorr	Ion Energy Distribution Skew Control Using Phase-Locked Harmonic RF Bias Drive
CCP	400 kHz 100 MHz	Ar	20 mTorr	Monitoring Ion Energy Distribution in Capacitively Coupled Plasmas Using Non-invasive Radio-Frequency Voltage Measurements
CCP	13.56 MHz	CO_2/C_2H_4	75 mTorr	Deposition of Functional Plasma Polymers Influenced by Reactor Geometry in Capacitively Coupled Discharges
CCP	13.56 MHz	H_2	200 to 300 mTorr	Direct ion flux measurements at high-pressure-depletion conditions for microcrystalline silicon deposition
CCP	13.56 MHz	H_2	10 mTorr	Nouvelle technologie utilisant les plasmas H2 et He pour contrôler la gravure de couches ultraminces à l'échelle nanométrique
CCP	13.56 MHz 27.12 MHz	Ar/N_2	4 mTorr	Ion energy control via the electrical asymmetry effect to tune coating properties in reactive radio frequency sputtering
CCP	30 MHz to 60 MHz	He/Ne	37 to 150 mTorr	UWAVS first mirror plasma cleaning technology using 30–60 MHz RF discharges
CCP	13.56 MHz	CO_2/C_2H_4	75 mTorr	Stable, nanometer-thick oxygen-containing plasma polymer films suited for enhanced biosensing
CCP	13.56 MHz	NH_3	50 mTorr	Amino functionalization of carbon nanotube surfaces with NH3 plasma treatment
CCP	13.56 MHz	Ar	1 Pa	Experimental and numerical characterisation of a radio frequency plasma source with a DC grounded electrode using a
CCP	13.56 MHz	Ar/O_2	7.5 mTorr	The Magnetic asymmetry effect in geometrically asymmetric capacitively coupled raio frequency discharges operated in
CCP	45, 51, 54, 57 and 60 MHz	H_2	37.5 mTorr	ITER visible spectroscopy reference system first mirror plasma cleaning in radio-frequency gas discharge - circuit design and

Plasma Source	Frequency	Gases	Pressure	Published Paper
CCP Magnetron Sputtering	13.56 MHz 350kHz Pulsed-DC	Ar, Titanium	2 mTorr	Ion energy distribution measurements in rf and pulsed dc plasma discharges
CCP (200 mm TEL DRM)	13.56 MHz 60 MHz	$Ar/O_2/CF_4$	5 to 40 mTorr	High Voltage RFEA Design, Optimization, and Operation in the Cathode of a Dual Frequency Capacitively Coupled Plasma
CCP (GEC Reference Cell)	13.56 MHz 27.12 MHz 40.68 MHz	Ar	40 mTorr	Power supply and impedance matching to drive technological radio-frequency plasmas with customized voltage waveforms
CCP (GEC Reference Cell)	13.56 MHz 27.12 MHz 40.48 MHz	Ar/Ne	20 mTorr	Experimental investigations of electron heating dynamics and ion energy distributions in capacitive discharges driven by customized voltage waveforms
CCP (GEC Reference Cell)	13.56 MHz 27.12 MHz 40.48 MHz	Ar	40 mTorr	A Simple Model for Ion Flux Energy Distribution Functions in Capacitively Coupled Radio Frequency Plasmas Driven by Arbitrary Voltage Waveforms
CCP (GEC Reference Cell)	13.56 MHz 67.8 MHz	Ar	26 mTorr	Plasma Sources Science and Technology Dual frequency capacitive plasmas in Fe and Ni sputter applications: correlation of discharge properties on thin film
CCP and ICP	13.56 MHz	Ar/O_2	20 mTorr	Generation of carbon nanowhiskers, nanotips, and nanodots by controlling plasma environment: Ion energy and radical effects
CCP for PECVD	13.56 MHz	C2H4/CO2	75 mTorr	Studium mechanism plazmové polymerace
CCP for PECVD	13.56 MHz	H_2, SiH_4	450 mTorr	Plasma–surface interaction during low pressure microcrystalline silicon thin film growth
ECR Ion Gun	Microwave	Ar	0.4 mTorr	Particle beam experiments for the investigation of plasma-surface interactions: application to magnetron sputtering and polymer treatment
ECWR -HiPIMS	13.56 MHz and 100 Hz Pulsed-DC	Ar, Titanium	0.1 to 10 mTorr	Plasma diagnostics of low pressure high power impulse magnetron sputtering assisted by electron cyclotron wave resonance plasma
ECWR -HiPIMS	13.56 MHz and 100 Hz Pulsed-DC	Ar/O_2	0.6 to 70 mTorr	Deposition of rutile (TiO2) with preferred orientation by assisted high power impulse magnetron sputtering
EUV	500 Hz	Xe	0.75 to 75 mTorr	Ion fluxes towards surfaces exposed to EUV-induced plasmas
Hall Thruster	DC	Xe	0.2 mTorr	Experimental characterization of the narrow channel Hall thruster
Hall Thruster	DC	Xe	2 sccm	Far-Field Plume Characterisation of a 100-W Class Hall Thruster
Helicon	500 kHz 1 MHz	Ar/He	10 mTorr	Tailored ion energy distributions at an rf-biased plasma electrode
High Magnetic field Helicon eXperiment	13.56 MHz	Ar/N2	2.5-30 sccm	Sputter deposition of WNx thin films by helicon-wave-excited argon plasma with N2 seeding
Helicon Thruster	13.56 MHz and 27.12 MHz	Ar	15 mTorr	Ion ejection from a permanent-magnet mini-helicon thruster
Helicon Thruster	27.12 MHz	Ar	5 mTorr	A Compact Permanent-Magnet Helicon Thruster
HiPIMS	94 kHz + 100 Hz Pulsed DC	Ar, Titanium, Copper	2 to 20 mTorr	Ionized vapor deposition of antimicrobial Ti–Cu films with controlled copper release
HiPIMS	100 Hz to 500 Hz Pulsed-DC	Ar/N_2	4 to 15 mTorr	Entwicklung und Anwendung von kombinatorischen Methoden und Mikrosensoren zur Messung mechanischer Schichtspannungen und der Schichttemperatur bei reaktiven
HiPIMS	100 Hz Pulsed-DC	Ar	3 to 7 mTorr	A modified Katsumata probe—Ion sensitive probe for measurement in non-magnetized plasmas
HiPIMS	100 Hz, 200 Hz, 400 Hz Pulsed-DC	Al, Cr, Ar, N_2	4 to 15 mTorr	Effects of the Ion to Growth Flux Ratio on the Constitution and Mechanical Properties of Cr1–x-Alx-N Thin Films
HiPIMS	100 Hz	Ar, Cu	22 mTorr	Growth and properties of Ti-Cu films with respect to plasma parameters in dual-magnetron sputtering discharges
HiPIMS	13.56 MHz 27.12 MHz 60 MHz	Ar	37 mTorr	Effect of Frequency and Power of Bias Applied to Substrate on Plasma Property of Very-High-Frequency Magnetron Sputtering
HiPIMS	40.68 MHz	Ar	37 mTorr	Growth and structural properties of silicon on Ag films prepared by 40.68 MHz very-high-frequency magnetron sputtering
HiPIMS	2 MHz, 13.56 MHz, 2712 MHz, 40.68	Ar	37 mTorr	Control of growth and structure of Ag films by the driving frequency of magnetron sputtering

Plasma Source	Frequency	Gases	Pressure	Published Paper
HiPIMS	13.56 MHz, 27.12 MHz, 60 MHz	Ar	37 mTorr	Initial growth and microstructure feature of Ag films prepared by very-high-frequency magnetron sputtering
HiPIMS	2 MHz, 13.56 MHz, 27.12 MHz	Ar	37 mTorr	Structural properties and preparation of Si-rich thin films by radio-frequency magnetron sputtering
HiPIMS	13.56 MHz 27.12 MHz 60 MHz	Ar	37 mTorr	Effect of Driving Frequency on Growth and Structure of Silicon Films Deposited by Radio-Frequency and Very-High-Frequency Magnetron Sputtering
HiPIMS	13.56 MHz 60 MHz	Ar	37 mTorr	Preparation and structural properties of thin carbon films by very-high-frequency magnetron sputtering
HiPIMS	40.68 MHz 60 MHz	Ar	37 mTorr	Effect of driving frequency on the structure of silicon grown on Ag (111) films by very-high-frequency magnetron sputtering
HiPIMS + DC Magnetron Sputtering	500 Hz Pulsed-DC	Ar/N_2	3 mTorr	Space-resolved plasma diagnostics in a hybrid (Cr,Al)N process
HiPIMS + MF	350 kHz Pulsed-DC	$Ar + O_2 + N_2$, TiO_2 target	10 mTorr	Investigation of reactive HiPIMS + MF sputtering of TiO_2 crystalline thin films
HiPIMS + MF	94 kHz + 100 Hz Pulsed DC	Ar, Titanium, Copper	2 to 20 mTorr	Effect of mid-frequency discharge assistance on dual-high power impulse magnetron sputtering
HiPIMS and DC Cathode	500 Hz Pulsed-DC	Ar/Kr	4 mTorr	Analysis of ion energy distribution at the substrate during a HiPiMS (Cr,Al)N process using retarding field energy analyzer and energy resolved mass spectrometer
HiPIMS and DC Cathode	500 Hz Pulsed-DC	$Ar/Kr/N_2$	4 mTorr	Influence of HiPIMS pulse parameters on the reactive gas N_2 and on the properties of (Cr, Al)N coatings
HiPIMS and DC Magnetron Sputtering	500 Hz to 1000 Hz Pulsed-DC	Ar	4 mTorr	Influence of dcMS and HiPIMS in a dcMS/HiPIMS hybrid process on plasma and coating properties
ICP	13.56 MHz Pulsed RF	He, Ar, $Cl_2/SiCl_4$	10 mTorr	Ion flux and ion distribution function measurements in synchronously pulsed inductively coupled plasmas
ICP	13.56 MHz	Ar	20 mTorr	Experimental Study of SiO2 Sputter Etching Process in 13.56 MHz rf-Biased Inductively Coupled Plasma
ICP	3.39 MHz 13.56 MHz 27.12 MHz	Ar, O_2	10 to 30 mTorr	Ion energy and angular distributions in planar Ar/O_2 inductively coupled plasmas: hybrid simulation and experimental validation
ICP	13.56 MHz	Ar	20 mTorr	Surface structurization and control of CuS particle size by discharge mode of inductively coupled plasma and vapor-phase sulfurization
ICP	13.56 MHz	H_2	10 mTorr	Validation of an atomic hydrogen etching sensor for plasma diagnostics
ICP	13.56 MHz	Cl_2	10 mTorr	Study of a Radical Doping Method for Large-area Two-dimensional Materials
ICP	13.56 MHz CW/Pulsed	Ar/O_2	75 mTorr	Plasma dynamics at the surface interface in radio frequency discharges
ICP	13.56 MHz	He, Ar, O_2	2 to 10 mTorr	Generation and Characterization of Energetic Neutral Beams for Surface Modification
ICP	13.56 MHz Pulsed	$SF_6/C_4F_8/Ar$	7 mTorr	Etch Characteristics of Si and TiO2Nanostructures Using Pulse Biased Inductively Coupled Plasmas
ICP	13.56 MHz	Ar	7 to 40 mTorr	Enhanced metastable population through evaporation cooling and recombination in the argon afterglow
ICP	13.56 MHz	Ar, HBr	10 mTorr	Ion Energy Distribution Functions and Ion Flux in pulsed ICP plasmas
ICP	13.56 MHz Pulsed	Ar	7 mTorr	Recombination and enhanced metastable repopulation in the argon afterglow
ICP	13.56 MHz	Ar, Xe, Cl_2	5 to 20 mTorr	Towards a nanometric precision etching in reactive plasmas: molecular dynamics simulations of Si-Cl interactions
ICP (300 mm AMAT AdvantEdge)	13.56 MHz, CW and Pulsed	Cl_2	20 mTorr	Roughness generation during Si etching in Cl_2 pulsed plasma
ICP (300 mm AMAT AdvantEdge)	13.56 MHz	He	10 mTorr	Helium plasma modification of Si and Si_3N_4 thin films for advanced etch processes
ICP (300 mm AMAT AdvantEdge)	13.56 MHz, CW and Pulsed	HBr/O_2	10 mTorr	Silicon etching in a pulsed HBr/O_2 plasma. I. Ion flux and energy analysis
ICP (300 mm AMAT AdvantEdge)	13.56 MHz	Cl_2	20 mTorr	Etching mechanisms of thin SiO_2 exposed to Cl_2 plasma
ICP (300 mm AMAT AdvantEdge)	13.56 MHz	Cl_2	20 mTorr	Développement de procédés de gravure à base de plasmas réactifs pulsés Pulsed plasmas for etch applications
ICP (300 mm SEMES RIE)	13.56 MHz	HBr/O_2	5 mTorr	Characteristics of reactive ion etching lag in HBr/O_2 plasma etching of silicon trench for nanoscale device

Plasma Source	Frequency	Gases	Pressure	Published Paper
ICP (AMAT Centura 300 DPS)	13.56 MHz	$Ar/H_2/N_2$	20 to 40 mTorr	Development of innovating plasma etching processes for sub 14nm nodes by coupling conventional lithography with auto aligned approach based on block copolymer
ICP (Plasmalab 100 etcher)	13.56 MHz	CHF_3/Ar	10 to 40 mTorr	Balancing ion parameters and fluorocarbon chemical reactants for SiO_2 pattern transfer control using fluorocarbon-based atomic layer etching
ICP (Plasmalab 100 Etcher)	13.56 MHz	CF_3 + Ar	5 to 40 mTorr	Balancing ion parameters and fluorocarbon chemical reactants for SiO_2 pattern transfer control using fluorocarbon-based atomic layer etching
ICP (Plasmalab 100 etcher)	13.56 MHz	Ar	10 mTorr	Atomic layer etching of SiO_2 with Ar and CHF_3 plasmas: A self-limiting process for aspect ratio independent etching
ICP (PlasmaLab 80)	13.56 MHz CW and Pulsed	SF_6	7.5 to 30 mTorr	Extraction and neutralization of positive and negative ions from a pulsed electronegative inductively coupled plasma
ICP (SEMES Michelan)	13.56 MHz	Ar	10 to 100 mTorr	A Study on customized plasma dry etching suited to various application processes
ICP Array	13.56 MHz	Ar/Ne	7 mTorr	Inductively coupled array (INCA) discharge
ICP for ALD	13.56 MHz	O_2	7.5 mTorr	Substrate-biasing during plasma-assisted atomic layer deposition to tailor metal-oxide thin film growth
ICP for ALD	13.56 MHz	H_2/O_2, Ar, N_2	7.5 to 30 mTorr	Functional analysis of retarding field energy analyzers for ion energy distribution measurements in plasma enhanced atomic layer deposition
ICP for ALD (Oxford Instruments FlexAl)	13.56 MHz	Ar, H_2	6-30 mTorr	Plasma-Assisted ALD of Highly Conductive HfNx: On the Effect of Energetic Ions on Film Microstructure
ICP for ALD (Oxford Instruments FlexAl)	13.56 MHz	O_2	4 to 22 mTorr	The Influence of Ions and Photons during Plasma-Assisted ALD of Metal Oxides
ICP for ALE (PlasmaPro 100 ALE)	-	Ar/Cl_2	-	A route towards the fabrication of 2D heterostructures using atomic layer etching combined with selective conversion
ICP Ion Beam	13.56 MHz	Ar	0.5 to 50 mTorr	Retarding field energy analyser ion current calibration and transmission
Ion Beam	DC	Ar/O_2	1.6 mTorr	Ar and O_2 linear ion beam PET treatments using an anode layer ion source
Ion Beam (Boxer Pro)	DC	O_2	0.3 mTorr	Distribution of ion current density on a rotating spherical cap substrate during ion-assisted deposition
Ion Beam (DC Plasma)	DC	Kr	7.5 to 75 mTorr	Unbalanced Cylindrical Magnetron for Accelerating Cavities Coating
Ion Beam (Multiple Sources)	Grounded	Ar, O, N, N_2, O_2, H_2, CHxPolymers	0.1 mTorr	Particle beam experiments for the analysis of reactive sputtering processes in metals and polymer surfaces
ICP for Magnetron Sputtering	13.56 MHz 27.12 MHz, 60 MHz	Ar	40 mTorr	Plasma property of inductively coupled discharge and substrate bias co-assisted very-high-frequency magnetron sputtering
ICP for Magnetron Sputtering	13.56 MHz 27.12 MHz, 60 MHz	Ar	40 mTorr	Effect of driving frequency on plasma property in radio frequency and very high frequency magnetron sputtering discharges
ICP Magnetron Sputtering	13.56 MHz 60 MHz	Ar	7 to 37 mTorr	Ion property and electrical characteristics of 60 MHz very-high-frequency magnetron discharge at low pressure
ICP Thruster	4 MHz + DC	Ar	1 mTorr	Hysteresis effects in the formation of a neutralizing beam plasma at low ion energy
ICP Thruster	13.56 MHz	Ar, SF_6	1 to 12 mTorr	Response of an ion–ion plasma to dc biased electrodes
ICP Thruster	13.56 MHz	Ar, SF_6	1 to 12 mTorr	Extraction and Acceleration of Ions from an Ion Plasma
Magnetron Sputtering	2 MHz 13.56 MHz	Ar	7 to 40 mTorr	Effect of radio-frequency substrate bias on ion properties and sputtering behavior of 2 MHz magnetron sputtering
Magnetron Sputtering	DC	Ar, N_2	4 mTorr	Influence of the magnetic field configuration on the reactive sputter deposition of TiN
Magnetron Sputtering	Pulsed-DC	$Ar/O_2/CF_4$ Sn Sputter	4 mTorr	Transparent Conductive Oxides by Magnetron Sputtering for Solar Energy Applications
Magnetron Sputtering (Remote)	DC	Ar/N_2	1 mTorr	TiN Deposition and Process Diagnostics using Remote Plasma Sputtering
Plasma Jet	13.56 MHz	Ar/O_2, N_2	26 mTorr	The low temperature plasma jet sputtering systems applied for the deposition of thin films
RIE CCP (Nanomaster NRE 3500)	13.56 MHz	$Ar/O_2/SF_6$	30 to 300 mTorr	Excitation of Ar, O_2, and SF_6/O_2 plasma discharges using tailored voltage waveforms: control of surface ion bombardment energy and determination of the dominant

Plasma Source	Frequency	Gases	Pressure	Published Paper
RPS	60 MHz	Ar, H_2, N_2	300 mTorr	Downstream Plasma Delivery From a Remote VHF Source
ICP	13.56MHz Pulsed	Ar	20 mTorr	Factors influenching ion energy distributions in pulsed inductively coupled argon plamsas
ICP	13.56 MHz	C_5F_8,C_5F_8/Ar	5-15 mTorr	Study on plasma characteristics and gas analysis before and after recovery using liquid-fluorocarbon precursor
ICP for ALD (Oxford Instruments FlexAl)	13.56 MHz	Ar/H_2, H_2	6-30 mTorr	Plasma-Assisted ALD of Highly Conductive HfNx: On the Effect of energetic Ions on Film Microstructure
ICP Thruster		Xenon, Iodine	< 0.01 mTorr	Ion beam diagnostic for the assessment of miniaturized electric propulsion systems
Dual CCP	13.56MHz, 60 MHz	Ar/N_2	20mTorr	Focus ring geometry influence on wafer edge voltage distribution for plasma processes
ICP (Oxford Instruments FlexAL)	13.56 MHz	Ar	25 sccm	Precise ion energy control with tailored waveform biasing for atomic scale processing
Helicon	13.56 MHz	Ar/N_2	0-30 sccm	Sputter deposition of WNx thin films by helicon-wave-excited argon plasma with N2 seeding
Miniaturised ICP	135-175 MHz	H_2, Ar	3-17 Pa	Miniature Plasma Source for In-Situ Scanner Cleaning
CCP (Oxford Instruments Atomfab)	13.56 MHz	Ar, O_2	375 mTorr	Innovative remote plasma source for atomic layer deposition for GaN devices
Hydrogen radical generator (HRG), ICP	13.56 MHz	H_2	1-10Pa	An atomic hydrogen etching sensor for H2 plasma diagnostics
CCP	13.56 MHz	Ar	1-10 Pa	Multi-diagnostic experimental validation of 1d3v PIC/MCC simulations of low pressure capacitive RF plasmas operated in
CCP	60 MHz	He	1 Pa	Study of wall re-deposition on DC-grounded ITER-relevant mirrors with RF plasma in a first mirror unit
ICP	13.56 MHz	Ar	0.5 Pa	Lock-in technique for precise measurement of ion distribution functions
Dual CCP	13.56 MHz, 60 MHz	Ar		Focus ring geometry influence on wafer edge voltage distribution for plasma processes
ICP (Oxford Instruments	13.56 MHz	Ar, O_2	100 sccm O2	Impact of Ions on Film Conformality and Crystallinity during Plasma-
FlexAL ALD)	13.56 MHz	O2/Ar	flow, 50 sccm Ar flow, 50 mTorr	Assisted Atomic Layer Deposition of TiO2
ICP	13.56 MHz	Ar	2.66 Pa	Directly grown Te nanowire electrodes and soft plasma etching for high-performance MoTe2 field-effect transistors
Pulsed Laser-Produced Plasma (LPP)	50 kHz	H_2	5 Pa	EUV-induced Hydrogen Plasma: Pulsed Mode Operation and Confinement in Scanner
CCP	13.56 MHz	Ar	1 Pa	Experimental and numerical characterization of a radio-frequency plasma source with a DC-grounded electrode
CCP	20-80 MHz	Ar, H_2	0.1 - 10 Pa	Low-Energy Plasma Source for Clean Vacuum Environments: EUV Lithography and Optical Mirrors Cleaning
ICP	13.56MHz (Source), 12.56MHz (Bias)	Ar/C_4F_6	10 mTorr	Discharge physics and atomic layer etching in Ar/C4F6 inductively coupled plasmas with a radio frequency bias
Dual Frequency CCD	13.56 MHz, 27.12 MHz	Ar	0.5 Pa	Relative calibration of a retarding field energy analyzer sensor array for spatially resolved measurements of the ion flux and ion
High power pulsed magnet	1000Hz	Ar/N_2	500mPa	Pulse synchronized substrate bias for the High Power Pulsed Magnetron Sputtering deposition of CrAlN
Magnetron Sputtering	13.56 MHz, 27.12MHz, 60MHz	Ar	1 - 10 Pa	Effect of gas pressure on ion energy at substrate side of Ag target radio-frequency and very-high-frequency magnetron
ICP	13.56MHz	H_2	3-17 Pa	Miniature plasma source for in situ extreme ultraviolet lithographic scanner cleaning
CCP	13.56MHz	He	0.5-3 pa	Ion flux–energy distributions acrossgrounded grids in an RF plasma sourcewith DC-grounded electrodes
ICP	13.56MHz, 2-10 kHz pulse frequency	Ar	20-80mTorr	Time-resolved ion energy distribution in pulsedinductively coupled argon plasma with/withoutDC bias
Magnetron sputtering	13.56, 27.12, 60 MHz	Ar	1-10 Pa	Effect of gas pressure on ion energy at substrateside of Ag target radio-frequency and very-high-frequency magnetron sputtering
CCP	27.12 MHz, 25-400kHz	Ar	1 Pa	Control of ion flux-energy distributions by lowfrequency square-shaped tailored voltagewaveforms in capacitively coupled
Helicon Thruster	13.56 MHz	Xe	20 sccm	Magnetic Nozzle and RPA Simulations vs. Experiments for a Helicon Plasma Thruster Plume

Plasma Source	Frequency	Gases	Pressure	Published Paper
Hall Thruster	DC	Kr	0.8-1 mg/s	Experimental Optimization of Small Krypton Hall Thruster for Operation at High Voltage
ECR Thruster	5.8 GHz	Xe	2-4 sccm	Direct Thrust Measurements of a circular waveguide Electron Cyclotron Resonance Thruster
Oxford Instruments Plasma	13.56 MHz	O_2	50-200 mTorr	Use of plasma oxidation for conversion of metal salt infiltrated thin polymer films to metal oxide
CCP	13.56 MHz	$Ar+O_2$	2 Pa	Experimental investigations of plasma dynamics in the hysteresis regime of reactive RF sputter processes
HiPIMS	DC, 250-500 Hz	Ar	0.67-2 Pa	Time-resolved ion energy distribution functions during a HiPIMS discharge with cathode voltage reversal
EUV induce plasma in Ele	EUV	H_2	1-50 Pa	Measurements of ion fluxes in extreme ultraviolet-induced plasma of new EUVbeam-line 2 nanolithography research
Dual frequency CCP	60 MHz, 2 MHz	Ar/SF_6	NA	Investigation of ion-induced etch damages on trench surface of Ge2Sb2Te5 in high density Ar/SF6 plasma
HiPIMS	DC, 200-500Hz	Ar	5-15 mTorr	Time-resolved ion energy distribution functions during a HiPIMS discharge with cathode voltage reversal
ITER Edge Thomson scatte	40, 50 MHz	Ar, He	1-10 Pa	Radio-frequency plasma to clean ITER front-end diagnostic mirrors in geometry of Edge Thomson Scattering system
Oxford instrument The Fle	13.56 MHz	Ar	2.2 mTorr	Equivalent electric circuit model of accurate ion energy control with tailored waveform biasing
Gridded ion thruster	DC, 13.56 MHz	Ar	0.5-10 Pa	Experimental study of a neutralizer-free gridded ion thruster using radio-frequency self-bias effect
EH100 ion source, magnetron sputtering	DC, 5kHz	He	0.85 Pa	Enhanced formation of nanometric titanium cones by incorporation of titanium, tungsten and/or iron in a helium ion
ALE	13.56 MHz, 2 MHz	Ar, Cl_2	20 sccm	GaN damage-free cyclic etching by sequential exposure to Cl2 plasma and Ar plasma with low Ar+ -ion energy at substrate
EUV plasma, CCP	13.56 MHz	H_2	50-150 Pa	In-situ non-destructive removal of tin particles by low-energy plasma for imitation of EUV optical mirrors self-cleaning
ICP	13.56 MHz	Ar, N2, C4F8	2.7Pa	The role of nitrogen addition in C4F8/Ar plasma to modulate the plasma process from polymerization to etchin
PhD thesis				Power Electronics for Plasma Processing: Enabling Energy-Efficient and Accurate Ion Energy Control for Semiconductor
ICP, PECVD	13.56 MHz	Ar, H_2, CH_4	35-240 mTorr	Plasma low-energy ion flux induced vertical graphene synthesis
ICP/ALE	13.56 MHz	Cl_2, Ar	0.5 to 1.5 Pa	Measuring Ion Energy Distributions by Retarding Field Energy Analyzer and Using Low-Energy Ions for Si-ALE by Cl2
TOMAS device	13.56 MHz	H_2		First studies of local ion fluxes in radio frequency plasmas for ion cyclotron wall conditioning applications in the TOMAS
ICP	13.56 MHz, 12.56 MHz	Cl_2, Ar, CF_4, C_4F_8	5 mTorr	AsynchronouslyPulsedPlasmaforHighAspectRatioNanoscaleSiTrenchEtchProcess
ICP/ ALE (Alcatel A601-E)	13.56 MHz	SF_6,Ar	3 Pa	Atomic layer etching of gallium nitride using fluorine-based chemistry
Gridded Ion thuster (NPT 30-I2)	DC	Iodine	38-99 ug/s	Iodine Electric Propulsion System Thrust Validation: From Numerical Modeling to In-Space Testing
Helicon plasma thruster Thesis	13.56 MHz	Ar, Xe	5-50 sccm	Diagnostic Methods for the Characterization of a Helicon Plasma Thruster
Focused Ring CCP-Thesis	13.56, 60 MHz	Ar	10-50 mTorr	Effects of Focus Ring and External Circuit on Ion Energy and Sheath Dynamics in Electropositive Capacitively Coupled
CCP	27.12 MHz and 271.2 kHz	O_2	0.3-2.6 Pa	Numerical and experimental study of ion energy distribution function in a dual-frequency capacitively coupled oxygen discharge

*When making an order, please alert us if you will be using CO gas (Carbon Monoxide), since this gas requires non-standard grids in the RFEA probe.
*Click here to read more about Semion RFEA System
*Click to download the all the Semion Systems brochure here: Semion RFEA System , Semion Pulsed DC System and Semion 3 keV System.
*Click here to download the Semion RFEA System technical presentation

QUANTUM APPLICATIONS LIST - [SE14]

QUANTUM SYSTEM - Retarding Field Energy Analyser

The Quantum system is comprised of a RFEA with integrated quartz crystal microbalance (QCM), used to measure the ion energy distribution (IED) and the ion-neutral deposition ratio at a surface inside a plasma reactor. Below is a list of publications with their plasma sources, process gases, pressures and applications.

Plasma Source	Frequency	Gases	Pressure	Published Paper
HiPIMS		Ar, Cr-Al-C films	4 mTorr	Effects of HiPIMS discharges and annealing on Cr-Al-C thin films
HiPIMS		Ar, CuAgZr films	0.6 Pa	Influence of HiPIMS pulse widths on the deposition behaviour and properties of CuAgZr compositionally graded films
HiPIMS		Ar/ Cr plasma Cr-Al-C films	0.35-0.5 Pa	Effects of HiPIMS discharges and annealing on Cr-Al-C thin films - ScienceDirect
HiPIMS	300kHz, 200 Hz	O_2	5 mTorr	Impact of high-power impulse magnetron sputtering pulse width on the nucleation, crystallization, microstructure, and ferroelectric properties of hafnium oxide thin films
ICP (Ox. Insts. FlexAL ALD)	13.56 MHz	Ar/O_2, SiH_4/NO_2	50 mTorr	Evidence for low-energy ions influencing plasma-assisted atomic layer deposition of SiO2: Impact on the growth per cycle and wet etch rate
MA-HiPIMS		Ar/N_2 plasma, AlScN films	0.6 Pa	Deposition and characterisation of c-axis oriented AlScN thin films via microwave plasma-assisted reactive HiPIMS
Magnetron Sputtering	150 kHz pulsed-DC	Ar, Cu Sputtering	3 to 5 mTorr	Measurement of deposition rate and ion energy distribution in a pulsed dc magnetron sputtering system using a retarding field analyzer with embedded quartz crystal microbalance
Oxford Instruments FlexAL ALD reactor, equipped with a remote ICP	13.56 MHz	Ar/Cl_2	50 mTorr	Impact of Ions on Film Conformality and Crystallinity during PlasmaAssisted Atomic Layer Deposition of TiO2

*Click here to read more about Quantum RFEA System.

*Click here to download the brochure.

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