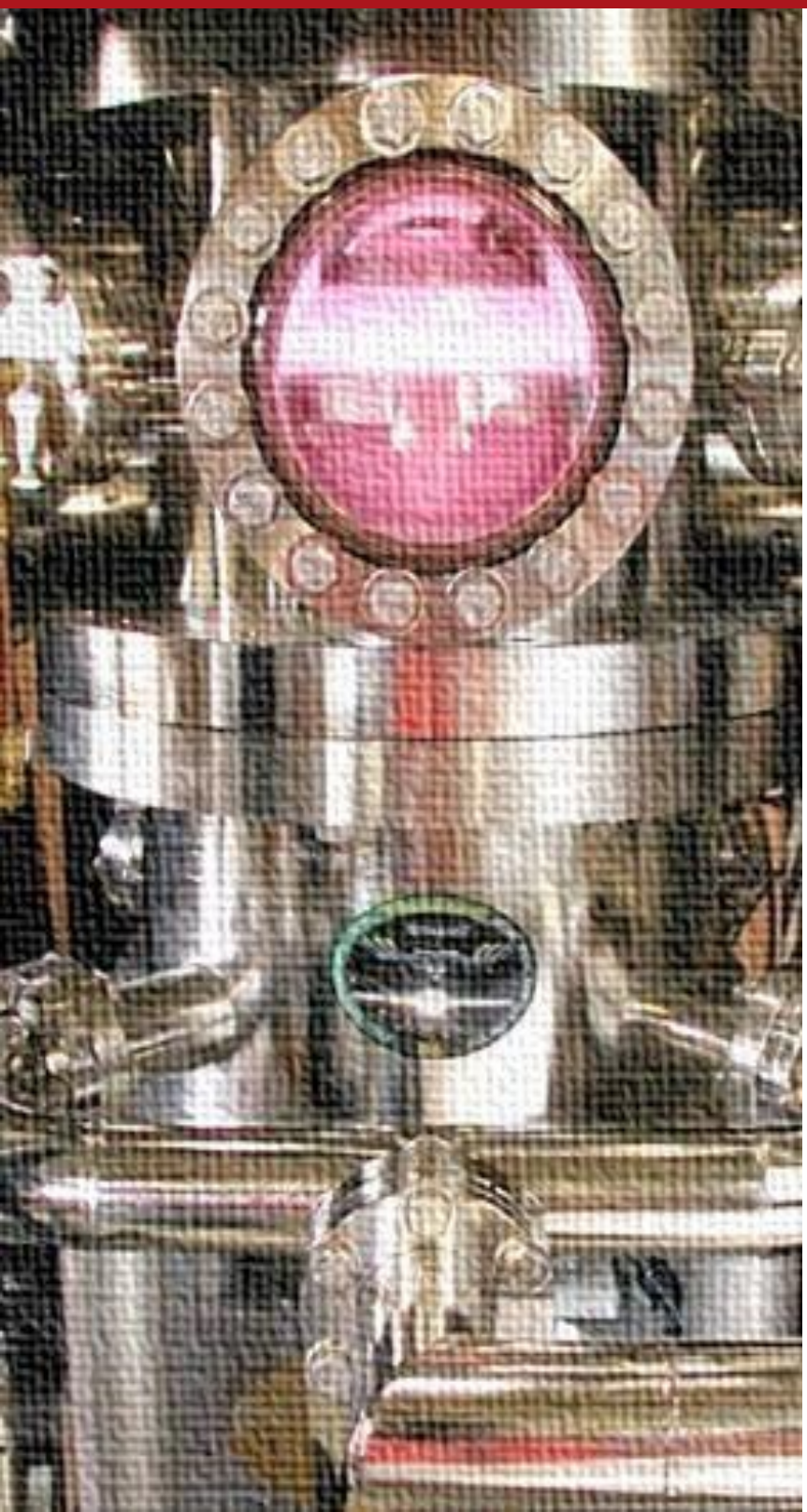
Impedans
PLASMA MEASUREMENT

PLATO PROBE SYSTEM

DEPOSITION TOLERANT LANGMUIR PROBE



Plato Probe™

Novel Langmuir probe designed for use in Plasma Deposition Systems

Compatible Plasma Power Types

DC, Pulsed DC, RF, Pulsed RF, Microwave and other plasma excitation methods

Designed to work in deposition tools

Measures plasma density, ion current density and electron temperature even with an insulating layer covering the tip (up to 10 microns)

Plato Probe System

The Plato Probe is a planar Langmuir Probe designed to work in deposition plasmas when an insulating film will be deposited on the probe surface. The deposition tolerant probe can remain inside a plasma reactor while deposition processes are in progress. This allows the plasma parameters such as plasma density, ion current density and electron temperature to be measured in chambers where a standard Langmuir probe would not be suitable, such as plasma enhanced chemical vapour deposition (PECVD) systems. This probe also has a sync function for time resolved measurements, to measure plasma evolution in Pulsed DC and HiPIMS processes with 1 microsecond resolution.

Key Features

- Measures plasma density, ion current density and electron temperature even with an insulating layer covering the tip (up to 10 microns).
- Time averaged, time trend and synchronized pulse profile measurements available.
- Integrated linear drive mechanism available to automatically profile spatial plasma uniformity.
- Advanced models for pressure compensation included in the software, with a reanalysis function for old data sets.
- Compatible with DC, Pulsed DC, RF, Pulsed RF, Microwave and other plasma excitation methods.
- 1 microsecond resolution available for pulsed processes, with a TTL port for pulses

Key Benefits

- State of the art plasma models built into the software for automatic data analysis.
- Intuitive and user-friendly interface with built in graphing functions.
- Compatible with deposition processes where standard DC Langmuir probes cannot be used.
- Robust and durable design to survive in extreme plasma environments
- Custom probe options including right angle elbows and flexible probe shafts to fit any chamber.
- Provides measurements for fundamental research, process development and model benchmarking.

Deposition Tolerant

The Plato Probe has the most advanced patented technology on the market using ultra-fast biasing to penetrate the deposited film to obtain accurate measurements of the real plasma parameters in a wide range of plasma applications. This probe can measure plasma parameters such as plasma density, ion current density and electron temperature in plasmas with high deposition rates, like plasma enhanced chemical vapour deposition (PEVCD). It can tolerate up to 10 microns of an insulating layer and still measure plasma parameters accurately.

Expert Analysis

The Plato Probe incorporates sophisticated analysis method accomplished using Impedans Octiv Suite VI Probe technology. The Octiv Suite data is processed using the Sobolewski method with compensation techniques of a Booth/Braithwaite probe.

Elimination of RF Distortion

RF chokes, with high impedance at the plasma excitation frequency (and harmonics), are installed close to the probe tips so that they float at the RF plasma potential. The probe tips are tightly coupled to the RF plasma potential, eliminating RF distortion of the IV characteristic.

Designed with Productivity in Mind

Multiple operating modes make plasma measurement in various plasma reactor types possible. A basic “Time-Averaged” mode accumulates and averages IV curves for the duration configured by the user. A “Time-Trend” mode can be used to configure short IV curve accumulation times (on a time scale of **seconds**) which is repeated at set time intervals over the process duration (up to time scales of **hours**). The “Time-Resolved” mode is for fast pulsing applications (time scales of **milliseconds** and less). The user can synchronize with the plasma pulse generator and take plasma measurements as a function of time through the pulse period.

An optional automated linear drive allows data collection across the plasma volume to investigate plasma uniformity or gradients.

High Speed Acquisition for Pulsed Plasmas

The Impedans Plato Probe has time resolved step resolution of 1 µs when synced with a TTL. This enabled the study of pulsed-DC and pulsed-RF plasma evolution, which can be quite complex to model due to the chemistry involved.

Model Options

Table 1: Plato Probe System – Controller Options

Model #	Product Name	Current Range
02-0238-01	Plato Probe | Electronics Unit	300 µA to 20 mA

Table 2: Plato Probe System – Rigid Probe Options

Model #	Product Name	Description
02-0073-01	Plato Probe | Fixed Probe 10mm | <1m	9.5 mm OD, rigid, alumina shaft (< 1.4 m length)

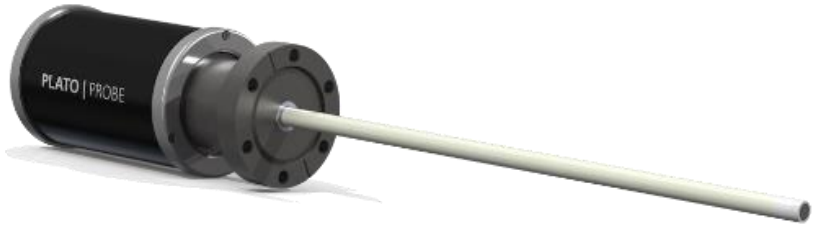


Table 3: Plato Probe System – Flexible Probe Options

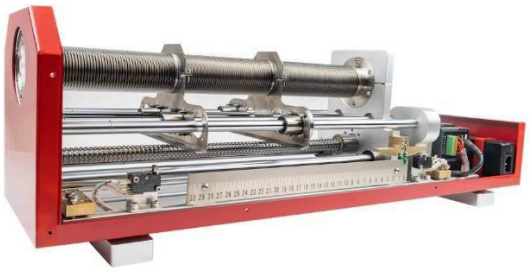
Model #	Product Name	Description
02-0239-01	Plato Probe | Feedthrough for flexible shaft models	Feedthrough for flexible Plato Probes
02-0240-01	Plato Probe | Holder | 70mm flexible	Rigid tip section with flexible ceramic beaded cable

Table 4: Optional Accessories

Accessory	Part number
Replacement Ceramic Coated Shafts	AOR [1]
Tip Holder	05-0095-03
Stainless Steel Tip	05-0662-01
Aluminum Tip	05-0094-03
Platinum Tip	02-0526-01

Table 5: Plato Probe System – Linear Drive Options

Model #	Product Name	Stroke Length
02-0507-01	150mm Linear Drive	150 mm
02-0033-04	300mm Linear Drive	300 mm
02-0034-04	450mm Linear Drive	450 mm
02-0035-04	600mm Linear Drive	600 mm
02-0508-01	900mm Linear Drive	900 mm



[1] Available upon Request

Parameters Reported

Table 6: Plasma parameters reported by the Plato Probe System

Parameter	Description	Units
kT_e	Electron Temperature	eV
J_p	Ion Current Density	Am^{-2}
N_i	Ion Density	m^{-3}
L_d	Debye Length	µm

Table 7: Plato Probe System graphical displays

Graph Type	Description	Mode
IV Characteristic	Current versus voltage characteristic	TA[2], TT[3], TR[4]
Parameter trend	Parameter versus time or space	TT, TR

[2]Time Average Mode
[3] Time Trend Mode
[4] Time Resolved Mode

Specifications

Table 8: General Controller Specifications

Controller Environmental Specifications	
Mains voltage	100 – 200 V AC
Mains Current	1.6 A AC
Mains frequency	47 – 63 Hz
Installation category	II
Pollution degree	1
Max. relative humidity	95%, non-condensing
Max. operating temperature	$55°C$
Max. altitude	3000 meters
Protection rating	IP20 (IEC 60529)

Table 9: Controller Operating Specifications

Controller Operating Specifications	
Voltage Scan Range	Floating Potential +/- 30 V
Current Range	300 µA to 20 mA
Connectivity	USB 2.0
PC Operating System	Windows 7 / 8 / 10
Sampling Rate	1 MS/s
Data Acquisition Resolution	$16\ bit$
Time Resolved Step Resolution	1 µs
External Sync (for time resolved mode)	TTL
Synchronization frequency range	1 Hz to 1 MHz
Probe Electrical Connection	Serial

Table 10: Plato Probe System Plasma Parameter Ranges

Probe System – Plasma Parameter Ranges	
Plasma Density	4 x 10^8 to 3 x 10^{13} cm^{-3}
Ion Current Density	26 µA/cm^2 to 300 mA/cm^2
Electron Temperature	0.1 to 15 eV
Debye Length	$0.4\ \mu m$ to $1.4\ mm$

Table 11: Probe Specifications

Probe Specifications	
Probe Length	300 mm to 1400 mm, Customisable
Probe Tip Diameter	7 mm as standard (Customisable)
Probe Tip Material Options	Aluminium, Stainless steel
Max. Operating Temperature	$125°C$
Linear drive types	150, 300, 450, 600 and 900 mm
Time resolved step resolution	1 µs
Voltage scan range	Floating potential $\pm$ 30 V
Current range	300 µA to 20 mA
Sensor pulse synchronisation	External sync: TTL input trigger (10 Hz to 10 kHz)

Table 12: Compatible Plasma Conditions

Compatible Plasma Conditions	
Plasma Reactor Types	DC, Pulsed DC < 10 kHz, RF > 5 MHz, Pulsed RF, Microwave
Gas Chemistry	Inert to Highly Reactive
Pressure Range	< 1 mTorr to 10 Torr

Software Display

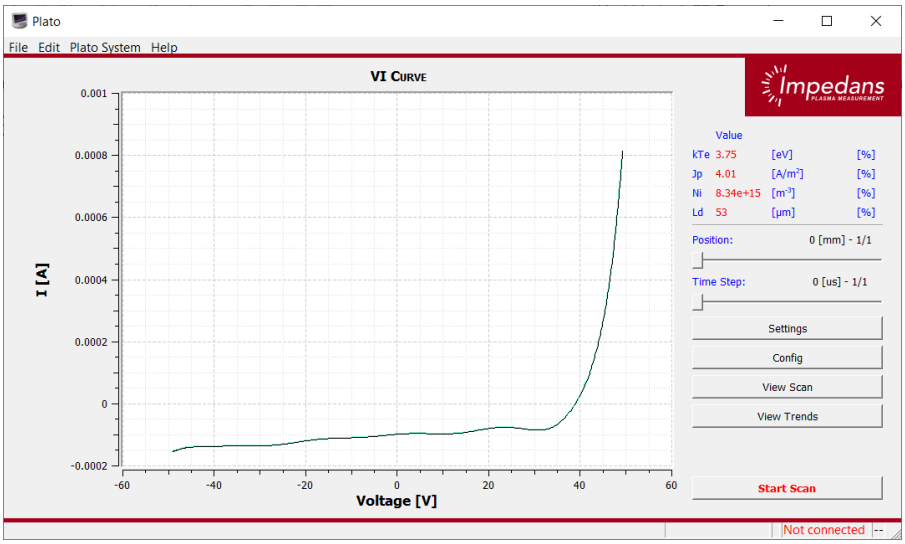


Figure 1: Typical IV characteristic of Plato probe.

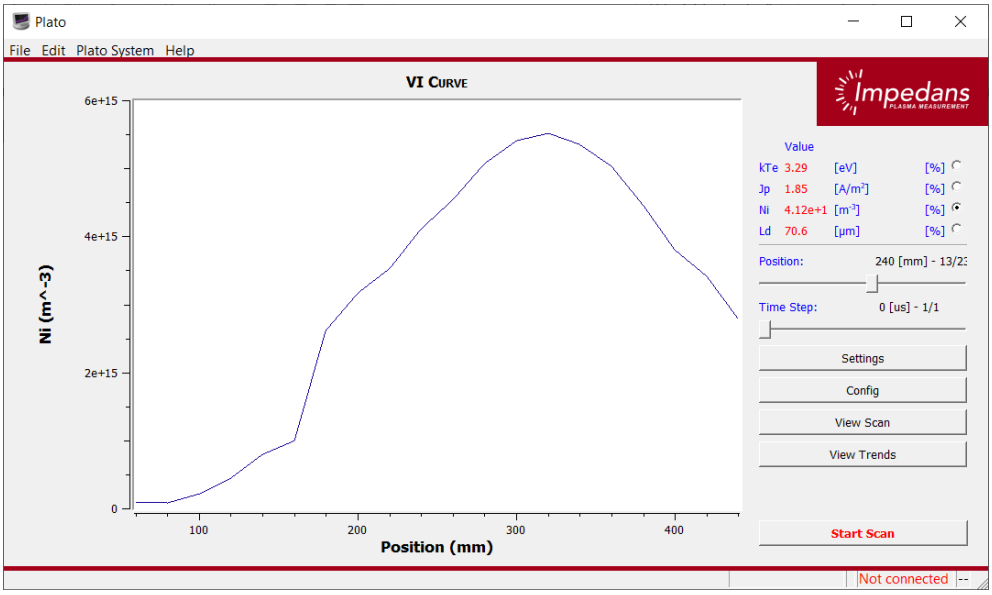


Figure 2: Example of the spatial trend of ion density.