JEOL

Solutions for Innovation

Industrial Equipment

Plasma-Assist Plasma Source / Power Supply

BS-800 Series
BS-920 Series

Plasma Sources and Power Supplies

JEOL Ltd.

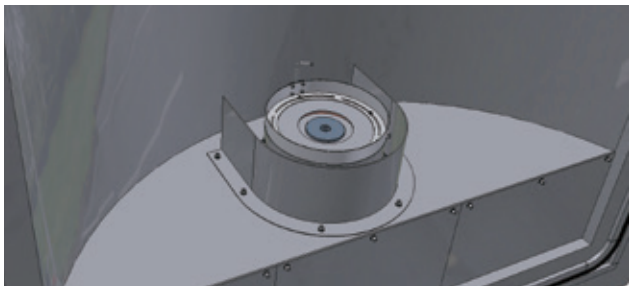
Overview

This equipment is a plasma source to be installed in a vacuum chamber to generate high-density plasma. The plasma sources can be used for Ion Plating (Plasma Assisted Deposition) and it is possible to improve film properties for optilcal thin films, protective films and functional films.
Since high-density plasma is generated in a large volume space, high-rate film deposition onto a large area is possible.
There are 2 types available; a type capable of low-temperature films deposition and surface treatment (BS-80020CPPS) and a high power type capable of large area films deposition (BS-80011BPG).

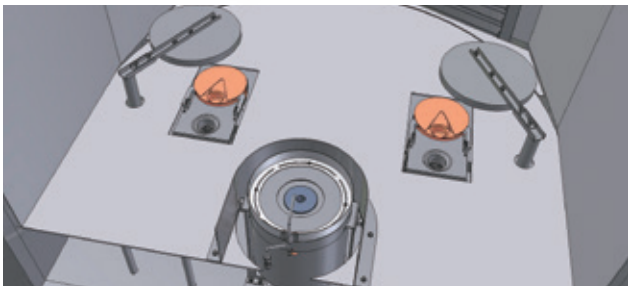
BS-80020CPPS

BS-80011BPG

Example of installation in the vacuum chamber



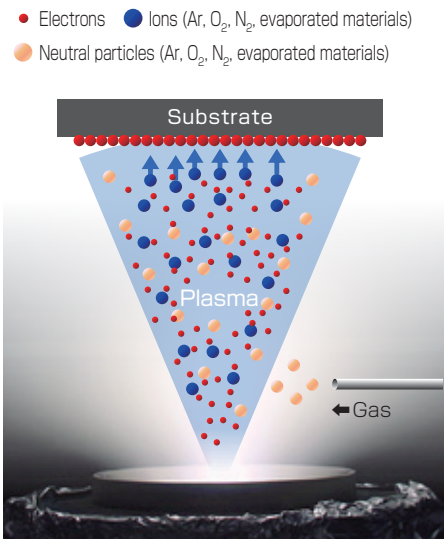
Installation example: On a front door of a chamber



Installation example: On a baseplate in a chamber

Plasma generating procedure

Argon plasma is generated inside the plasma source by the direct-current discharge of thermoelectrons emitted from the filament. The electrons in the plasma are accelerated by the electric field generated by the extracting electrode and irradiated to a space inside a vacuum chamber. Irradiated low-voltage large-current electron beam can ionize and excite gas molecules and evaporated materials, and can generate high-density plasma whole area in the vacuum chamber.



Usage

- Ion plating
  - Evaporated materials are ionized/ excited and accelerated to a substrate
  - Reactive deposition
- Cleaning
  Removal of dust, oil and organic contamination on a surface of a substrate or a film
- Surface modification
  Oxidation, nitridation, surface activation of a substrate or a film

Effect

- Improvement of film density, refractive index
- Improvement of environmental stability
- Low wavelength shift
- Low optical absorption (promotion of oxidation)
- Improvement of film adhesion
- Improvement of surface roughness
- Control of film stress

Cold Process Plasma Source

BS-80020CPPS

Low-temperature film formation **surface treatment**

Ion Plating + Ion Assistance + Activated Reactive Evaporation

BS-80020CPPS
Plasma Source

BS-92040CPPC
Plasma Source Control Power Supply

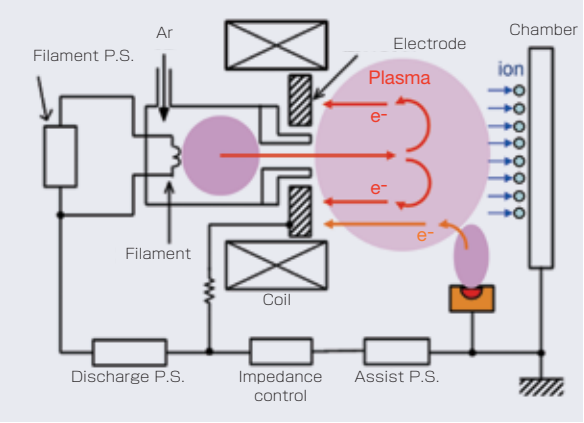
Specifications

Model	BS-80020CPPS
Maximum plasma output	3.2 kW (160 V, 20 A)
Maximum assisted output	2.0 kW (200 V, 10 A)
Operating pressure (Pa)	8×10^{-3} to 8×10^{-2} (Ar, O_2, N_2 atmosphere)
Discharge gas (Ar)	8 to 20 mL/min
Cooling water flow rate	5 to 8 L/min
External dimensions (mm)	270(W) × 225(D) × 324(H)*
Weight	Approx. 21 kg

* Protrusions not included

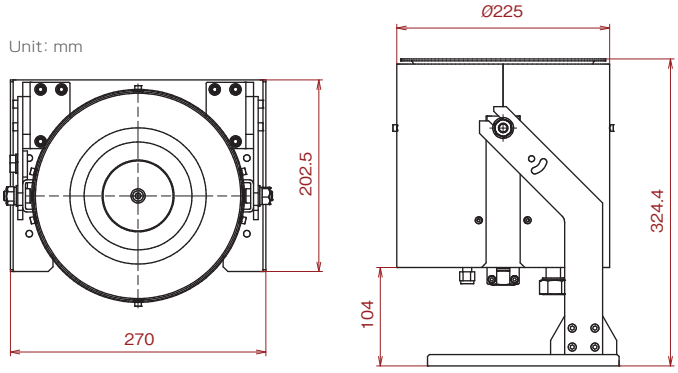
Model	BS-92040CPPC
Maximum output	Filament : 26 V, 50 A Discharge : 160 V, 20 A Coil : 30 V, 20 A Assist : 200 V, 10 A
Input power	3-phase, 200 V ±10% 12 kVA 50/60 Hz Groud resistance 100Ω or less
External control	Analog
External dimensions (mm)	570(W) × 800(D) × 1,550(H)
Weight	Approx. 270 kg

Schematic diagram



External dimension

Unit: mm



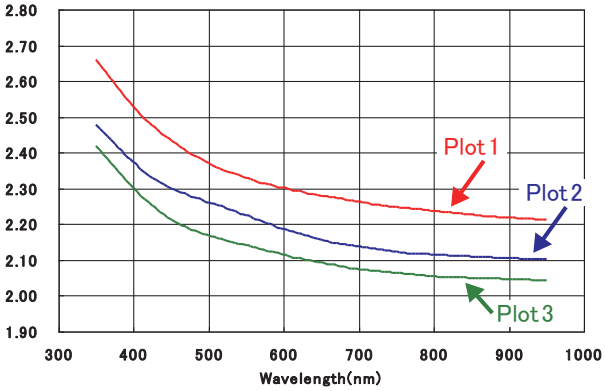
Application data

TiO_2 Refractive Index

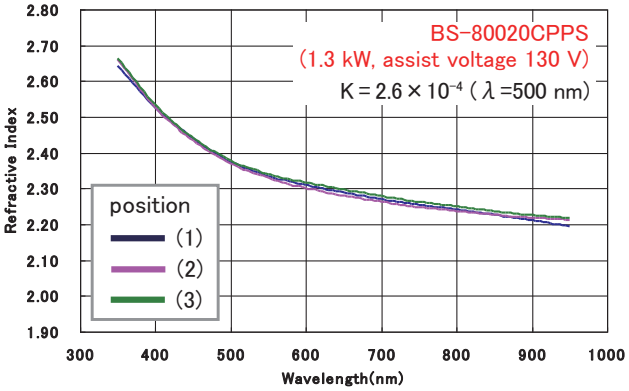
· Substrate temperature: 40℃ → 70℃ · Film formation pressure: 1.6×10^{-2} Pa · Film formation rate: 0.5 nm/s · Film thickness: 500 nm

High refractive index can be achieved even without substrate heating.

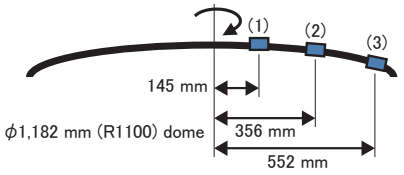
Refractive index wavelength distribution



Refractive index comparison for each substrate dome position



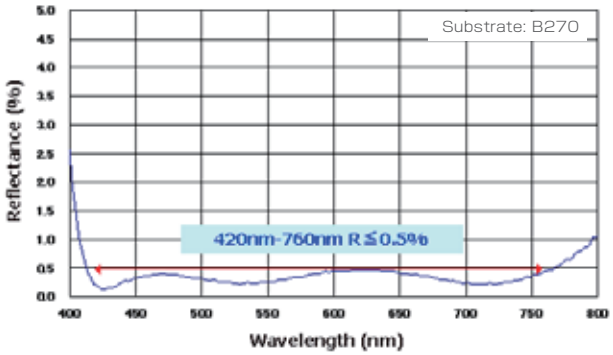
Plot1: BS-80020CPPS (output 1.3 kW, assist voltage 130 V)
Plot2: BS-80011BPG (output 1.3 kW)
Plot3: Conventional vacuum evaporation



Optical thin film deposition

In addition to obtaining superior optical spectroscopic properties by ion plating, it is possible to suppress excessive temperature increases of the substrate which is likely to occur with ion plating method. Low temperature film deposition is possible.

$TiO_2/MgF_2/SiO_2$ 7 layers AR film
Temperature rise of a substrate: from 20℃ (68℉) to 63℃ (145℉)
(Including 10 minutes plasma pretreatmet)

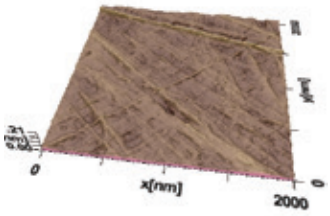


Surface treatment

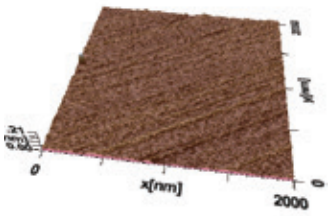
Measurement: JEOL scanning probe microscope JSPM series Substrate: PMMA (with hardcoat)

By varying the processing conditions, like the exposure time, the surface condition can be controlled.

- Improvement of film adhesion
  Improvement of film adhesion by means of plasma cleaning and modification of the substrate surface.
- Formation of anti-refletive structure
  Creation of moth-eye structures on the surface makes it possible to decrease the surface reflectance.

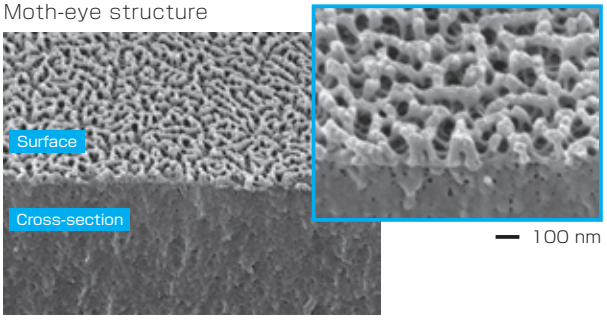


Substrate (without treatment)
Ra =1.51 nm



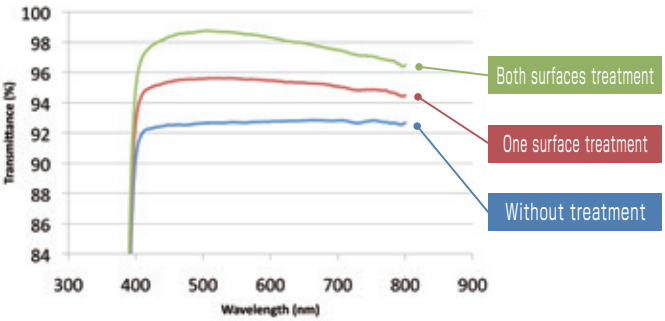
Surface treatment (3 min.)
Ra =1.12 nm
★ Smooth/ Good film adhesion

Moth-eye structure



Substrate:
PMMA (without hardcoat)

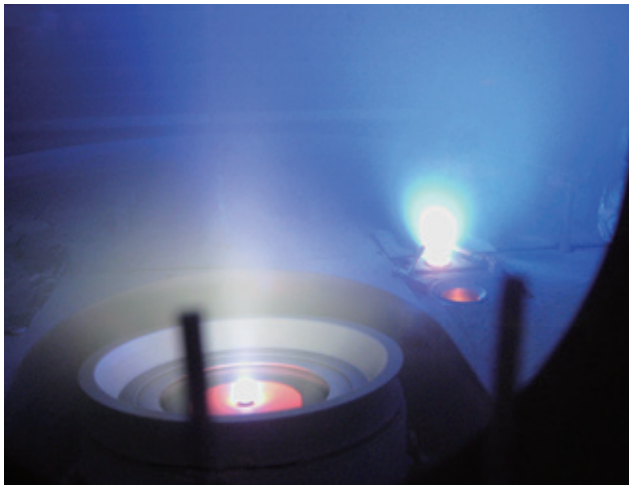
Transmittance



BS-80020CPPS ARE (Activated Reactive Evaporation) Effect

Effective reactive evaporation is possible by ionizing the process gas and evaporated materials. For oxides, this method can improve refractive index and reduce absorption resulting from an enhancement of oxidation. For transparent conductive films, improved conductivity is expected.

Discharge above the crucible and plasma source during ITO film deposition



Example of ITO film deposition results

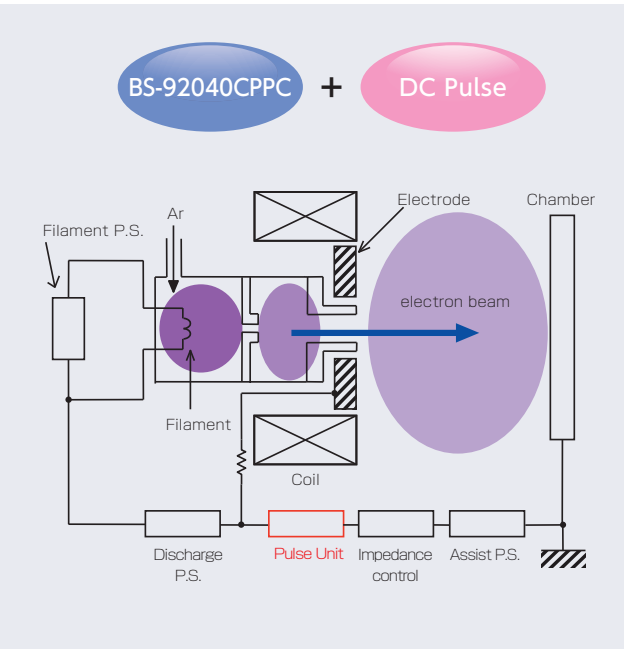
Substrate temperature	250℃
Sheet resistance (resistivity)	16 Ω/□ (1.7 × 10^{-4} Ω · cm)
Total light transmittance	> 85%
Absorption	1.1%
Film deposition rate	1.5 nm/s
Substrate material	B270 (Total light transmittance: 91.7%)

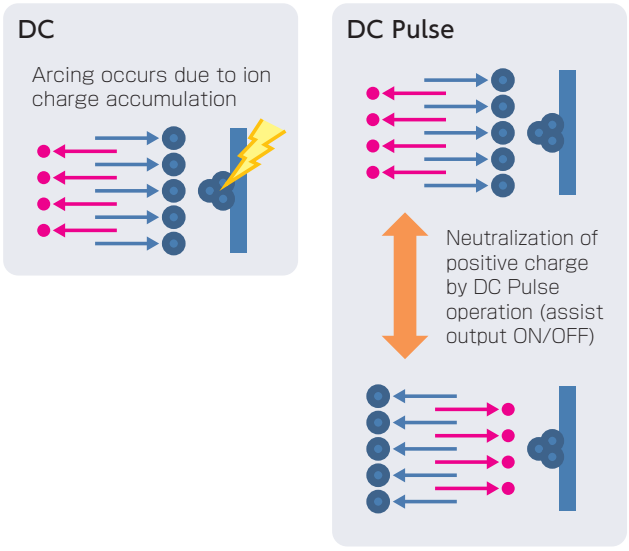
Material: ITO pellet (Sn doped 5 Wt%)

Pulse Unit (Option)

By converting the assist voltage to DC Pulse, arcing is suppressed. Even in the case of high insulating material, the plasma output can be increased with superior assist effects.

Schematic diagram





Specifications

Output voltage	Maximum 200 V DC
Output current	20 Ap-p (pulse output) or DC 20 A
Input power supply	Branched from the power supply input line of the BS-92040CPPC*
External dimensions (mm)	480(W) × 330(D) × 149(H)
Weight	Approx. 30 kg

* The pulse unit is installed by replacing the operation unit in the BS-92040CPPC power supply. The operation unit is then installed separately.

High Power Plasma Source

BS-80011BPG

High power **Large area**

BS-80011BPG
Plasma Source

BS-92020
Plasma Source Control Power Supply

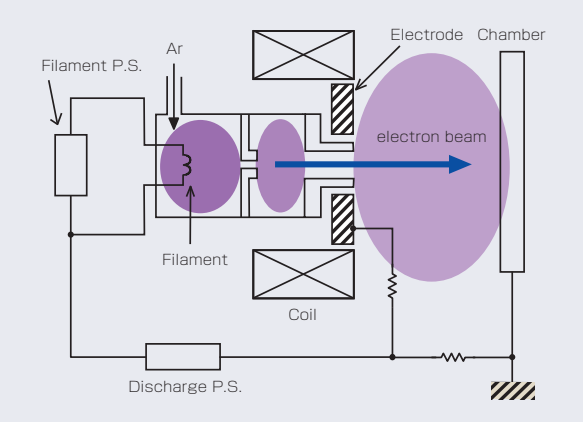
Specifications

Model	BS-80011BPG
Maximum plasma output	6 kW (160 V, 38 A)
Operating pressure (Pa)	1×10^{-2} to 1×10^{-1} (Ar, O_2, N_2 atmosphere)
Discharge gas (Ar)	8 to 20 mL/min
Cooling water flow rate	7 to 10 L/min
External dimensions (mm)	273(W) × 233(D) × 388(H)*
Weight	Approx. 23 kg

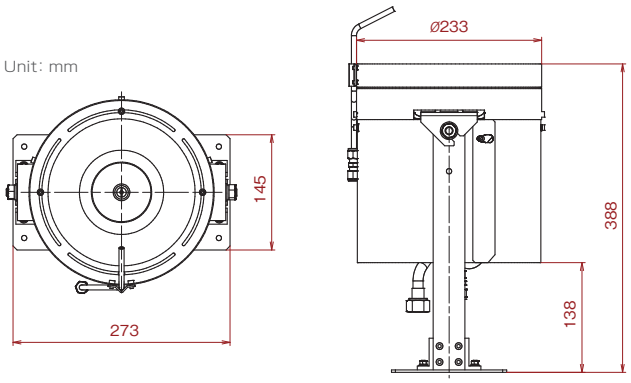
* Protrusions not included

Model	BS-92020
Maximum output	Filament : 26 V, 50 A Discharge : 160 V, 38 A Coil : 30 V, 20 A
Input power	3-phase, 200 V ±10% 12 kVA 50/60 Hz Groud resistance 100Ω or less
External control	Digital/Analog input, output
External dimensions (mm)	570(W) × 800(D) × 1,550(H)
Weight	Approx. 270 kg

Schematic diagram



External dimension



Application data

TiO_2/SiO_2 Optical Film

Wavelength shift and film density are greatly improved compared to those by conventional vacuum evaporation techniques.

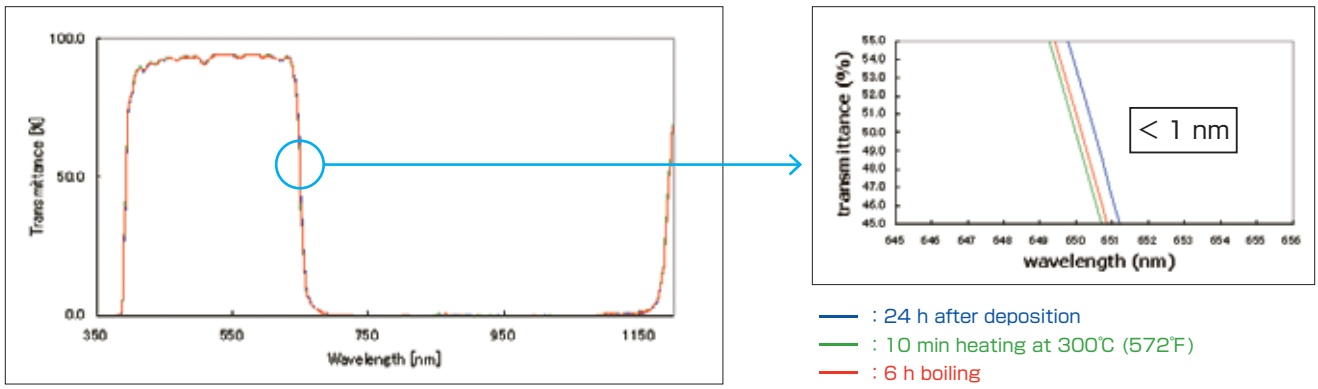


Fig.A

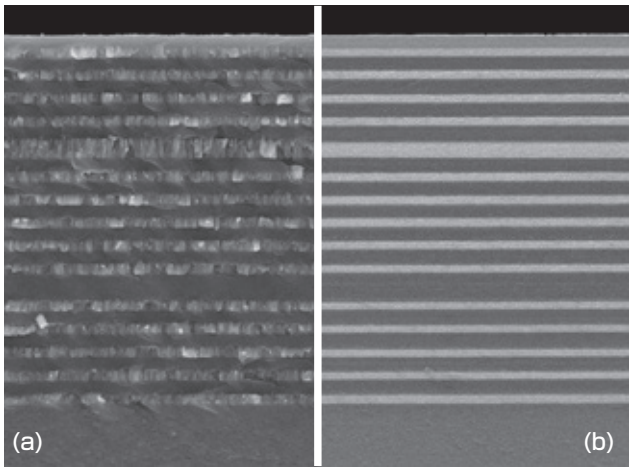


Fig.B

TiO_2/SiO_2 multilayer was deposited using the BS-80011BPG in a vacuum chamber of 1,300 mm in diameter.

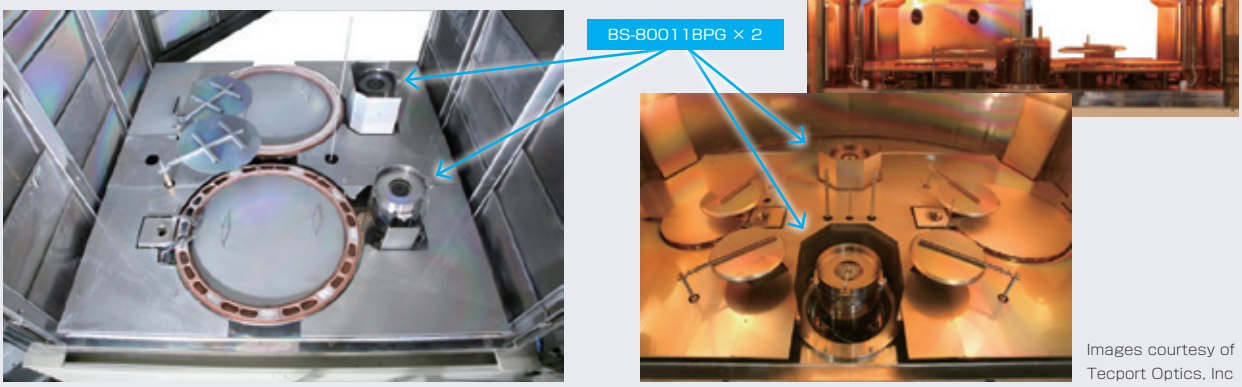
Fig.A Wavelength shift at T=50% after environmental tests.

Fig.B Corss-section SEM images of TiO_2/SiO_2 multilayar.
(a) Conventional vacuum evaporation method
(b) Ion plating method using BS-80011BPG

Simultaneous use of 2 sources

Large area film deposition is possible by using two sources simultaneously.

(Ex) · Increase in plasma density in a large volume chamber (2,000mm in diameter or more)
· Even plasma distribution for in-line equipment



Images courtesy of Tecport Optics, Inc

Specifications are guaranteed when no modification or addition is made, and are subject to change without notice.

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