

# **Optical Sputtering System**

## **Model: NSC-15**

### **Specifications**

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Optorun Co., Ltd		
Approve	Check	Author



OPTORUN CO., LTD.



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## 1. General description

- 1) This document covers the technical conditions and the scope of supply of NSC-15 system, a load-lock type meta-mode sputtering system for optical applications.
- 2) This system includes load lock chamber and process chamber. Three dual magnetron metal sputter cathodes, and two ICP source are installed in process chamber.
- 3) Optical, semiconductor and metal multilayer coatings can be coated in one vacuum process which is handled by automatic substrate load/unload system.
- 4) Multi-plates for loading substrates can be load/unload in one batch coating. Max 290mm width substrate can be handled by automatic load/unload system.
- 5) High deposition rate achieved by meta-mode sputtering process with two large area inductivity coupled plasma reactive sources.

## 2. Specification of System

### 2.1 Main specification of system

2.1.1 Model:	NSC-15 Load-lock type. Meta-mode sputtering process Depo-side on vertical rotated drum substrate holder system	
2.1.2 Process chamber:		1 unit
Chamber dimension:	Φ1650 mm × H1200mm (SUS304)	
Effective coating area:	approx. Φ1520 mm × H500 mm	
Substrate holder dimension:	H650mm×W360mm×13pcs	2 sets
2.1.3 Load-lock chamber		1 unit
Load-lock chamber:	approx. W500mm×H795mm×D2885mm (SUS304)	1 set
Substrate holder transfer door for load/unload (manual)		1 set
Substrate holder cassette station for load/unload common use		1 set
2.1.4 Deposition source:		
MF dual cathode with plate metal or semiconductor target (15kW)		3 units
ICP reactive source (5kW)		2 units
2.1.5 Substrate carrier:		1 unit
Substrate carrier dimension:	Φ1520mm × H600mm drum type	

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Substrate rotation speed: 10 ~ 100 rpm

### 2.1.6 Vacuum performance of process chamber:

Ultimate pressure  $\leq 5.0 \times 10^{-4}$  Pa

Pumping speed: From atmospheric pressure to  $5.0 \times 10^{-3}$  Pa in 40 minutes

※ Include 10 minutes of starting Turbo Molecular Pump (TMP)

Build-up  $\leq 5.0 \times 10^{-4}$  Pa · m<sup>3</sup> / s

Measuring condition:

- ※ No substrate holder inside the process chamber
- ※ Vacuum performance is measured during the process chamber is clean.
- ※ The test is done after more than 24 hours continuous evacuation of system.

### 2.1.7 Vacuum performance of load-lock chamber

Ultimate pressure  $\leq 10$  Pa

Pumping speed: From atmospheric pressure to 10 Pa in 8 minutes.

Build-up  $\leq 5.0 \times 10^{-4}$  Pa · m<sup>3</sup> / s

- ※ High vacuum evacuate from process chamber.
- ※ There is no substrate holder inside the process chamber
- ※ Vacuum performance is measured during the process chamber is clean.
- ※ The test is done after more than 24 hours continuous evacuation of system.

### 2.1.8 Operation mode:

Automatic operation

Manual operation

### 2.1.9 Control Interface:

PC = keyboard (software language: English)

### 2.1.10 List of equipment

No.	Equipment Name	Quantity	Remark
1	Load lock chamber	1set	
2	Load/Unload cassette	2set	
3	Gate-valve	1set	
4	Process chamber	1set	
5	Sputter cathode	3set	MF 15kW Dual cathode with rotary metal target
6	Film thickness correction mask	3set	
7	ICP source	2set	RF 5kW
8	Exhaust system	1set	4 turbo-pumps, 2 sets rotary with mechanical boost pumps

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9	Gauge system	1set	
10	Compressed air control system	1set	
11	Cooling water system	1set	
12	Automatic coating control system	1set	
13	Substrate holder	2set	26pcs of blank plate
14	Shield	1set	
15	Accessories	1set	
16	Spare parts	1set	

**3. Description of System**

**3.1 Load lock chamber**

3.1.1 Vacuum chamber configuration

Main door for load/unload: Manual 1

1) Main port:

Cassette monitoring window 1

Substrate transfer port 1

2) Gauge port

Pirani gauge port for pipe pressure check 1

Pirani gauge port for chamber pressure check 1

Atmospheric pressure validator gauge port 1

3) Spare port

Maintenance port (right side) 1

Maintenance port (rear side) 1

3.1.2 Substrate holder transport system 1set

Substrate holder transfer system 1

Substrate holder detection system 1

Substrate holder load/unload system 1

Automatic distance detection by laser sensor (loading / unloading) 1

Substrate holder cassette station (load/unload common use) 1

3.1.3 Substrate holder cassette:

Variable holder cassette 2set

Material: Aluminum alloy

3.1.4 Door valve 1

Load lock chamber ↔ process chamber, high vacuum separation

Material: SUS304 steel

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3.1.5 Vacuum gauge	
Pirani gauge: (Pipe pressure check)	1
Pirani gauge: (Chamber pressure check)	1
Atmospheric pressure validator	1
3.1.6 Exhaust system	
1) Exhaust unit	
Oil rotary pump: E2M275(EDWARDS)	1
Mechanical booster pump: EH4200 (EDWARDS)	1
2) Valve	
Roughing valve (6 inch)	1
Slow roughing valve (1 inch)	1
Leak valve/slow leak valve (2 inch)	1
<b>3.2 Process chamber</b>	
3.2.1 Vacuum chamber configuration	
1) Main port	
Dual sputter cathode port (with thickness correction mask plate)	3
Material monitoring window (on the door of each cathode port)	1×3
ICP reaction source port	2
Process Gas introducing port (for ICP source)	1
Holder monitor port	2
Substrate rotation system port	1
Drum expansion monitor port	1
Substrate transfer monitoring window	1
Substrate transfer port	1
2) Gauge port	
Pirani gauge port: (Pipe pressure check)	1
Pirani gauge port: (Chamber pressure check)	2
Penning gauge Port: (Chamber high vacuum check)	1
Baratron gauge port: (coating working pressure control)	1
3) Spare port	
NW25 flange port	2
NW40 flange port	2
Φ 29 port	4
3.2.2 Backward maintenance door (mounted with 2 ICP reaction sources)	1set
Material: SUS304	
Manual opening and closing, with water cooling jacket	

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3.2.3 Polycold	1 set
3.2.4 MF dual magnetron sputter cathode for Si (Cathode port 2)	1 set
Horizon open/close door	1
Material: SUS304	
Sputter cathode: dual magnetron cylindrical sputter cathode for metal target	1
Target: $\phi 141 \times H800$ (metal or semiconductor)	2
Drive system: DC brushless motor (120W)	2
Sputtering power: Hüttinger True Plasma 3020 or equivalent (20kW)	1
Medium Frequency: 60kHz-100kHz	
Control interface: analog	
Sputter Gas control system (MFC): Ar (Max 300 sccm)	1
Thickness correction mask plate: fixed on vacuum chamber	1 set
View port	1
Shield: stainless material with sandblasting / aluminum thermal spraying	1 set
3.2.5 MF dual magnetron sputter cathode for Si (Cathode port 3)	1 set
Horizon open/close door	1
Material: SUS304	
Sputter cathode: dual magnetron cylindrical sputter cathode for metal target	1
Target: $\phi 141 \times H800$ (metal or semiconductor)	2
Drive system: DC brushless motor (120W)	2
sputtering power: Hüttinger True Plasma 3020 or equivalent (20kW)	1
Medium Frequency: 60kHz-100kHz	
Control interface: analog	
Sputter Gas control system (MFC): Ar (Max 300 sccm)	1
View port	1
Shield: stainless material with sandblasting / aluminum thermal spraying	1 set
3.2.6 MF dual magnetron sputter cathode for Aluminum (Cathode port 4)	1 set
Horizon open/close door	1
Material: SUS304	
Sputter cathode: dual magnetron cylindrical sputter cathode for metal target	1
Target: $\phi 141 \times H800$ (metal or semiconductor)	2
Drive system: DC brushless motor (120W)	2
sputtering power: Hüttinger True Plasma 3020 or equivalent (20kW)	1
Medium Frequency: 60kHz-100kHz	
Control interface: analog	

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Sputter Gas control system (MFC): Ar (Max 300 sccm)	1
Thickness correction mask plate: fixed on vacuum chamber	1
View port	1
Shield: stainless material with sandblasting / aluminum thermal spraying	1 set
3.2.7 ICP reaction source	2set
1) ICP method oxygen / nitration plasma system	2set
2) Introducing window: quartz (W400mmxH600mm)	2
3) RF power supply (ADTEC)	1set
RF power: 5 kW	2
RF matching box	2
Phase shifter	1
4) Process gas control system	4 sets
MFC for Ar: (Max 500 sccm)	1
MFC for N2: (Max 300 sccm)	1
MFC for O2 (Max 300 sccm)	1
MFC for O2 (Max 50 sccm)	1
Stop valve	4
5) Shield: SUS304 with sandblasting / Al2O3 thermal spraying	1 set
3.2.8 Substrate rotation system	
1) Work dome	
Size: $\Phi 1520\text{mm} \times \text{H}600\text{ mm}$	1set
2) Substrate holder	
Blank holder:	
Material: Aluminum alloy	
Surface treatment: sandblasting	
3) Substrate rotation drive system	1unit
Rotation speed: 10 ~ 100 rpm (magnetic seal type)	
Regular rotation direction: CCW	
Drive system: Servo motor type (slow start/stop)	
Stop position accuracy: $\pm 0.2$ degree ( $\pm 2\text{mm}$ on drum circle)	
Home check system: chopper method	
Collision avoidance sensor: laser sensor	1set
Drum temperature compensation sensor: laser sensor	1set
3.2.9 Vacuum gauge	
Pirani gauge: (Pipe pressure check)	1
Pirani gauge: (Chamber pressure check)	2

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Penning gauge: (Chamber high vacuum check)	1
Baratron gauge: (Coating working pressure control)	1
<b>3.2.10 Exhaust system</b>	
1) Exhaust unit	1 set
Oil rotary pump: E2M-275(EDWARDS)	1
Mechanical booster pump: EH-4200 (EDWARDS)	1
2) High vacuum exhaust system	1 set
Turbo molecular pump: TMP-V2304LM (SHIMADZU)	4
3) Valve	1 set
Assistant valve	2
Roughing valve: 6 inch	1
Slow roughing valve: 1 inch	1
Leak valve, slow leak valve: 2 inch	1
4) Pipe	2 set
<b>3.3 Automatic deposition control system</b>	
Automatic deposition control program	1
Computer: Dell	1
Display: 17 inches color TFT	1
OS: MS-Windows English version	1
UPS for PC and PLC	1set
<b>3.4 Control panel</b>	
Control panel (Load Lock chamber side / English version)	1
<b>3.5 Cooling water system</b>	
Water supply manifold, solenoid valves, etc.	1 set
Water flow rate switches (various pump, ICP, various cathode, rotation system etc.)	1 set
Water drainage: ICP / Target /RF power supply/ MF power supply (manual operation)	1 set
<b>3.6 Compressed air system</b>	
Valve, filter, regulators, pipe, etc.	1 set
<b>3.7 Paint Color</b>	
1) Panel: GN-80(Light Gray), Pump Shelf GN-40(Light Black), others: 2.5Y8/12(Yellow)	
<b>4. Accessories and spare parts</b>	
<b>4.1 Accessories</b>	

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1) Instruction manual	1set
2) Standard tool	1set
3) Recovery software	1 set

### 4.2 spare parts

1) Shield	1set
2) Consumable vacuum seal O-ring	1set

## 5. Installation and utility requirements

The utility conditions described below, such as utility interface point, pressure regulating valve, pressure gauge, should be prepared by customer side.

### 1) Footprint:

Installation space: W5800mm × D9000mm × H3200mm

Entrance size: W3100mm x D4000mm x H3200mm

Gross weight: 16000kg

Floor load: 1000kg/m<sup>2</sup> or more

### 2) Electrical Power:

3-phase AC 380V ± 10%, 125KVA, 50/60 Hz

### 3) Ground:

Resistance of ground line less than 10Ω and its cross area larger than 60 mm<sup>2</sup>

### 4) Cooling water

Flow rate: 233 l/min or more

Water temperature (at inlet): 20~25°C

Water pressure (inlet): 0.3MPa~0.4MPaG

Water pressure (outlet): less 0.1MPaG, difference between inlet and outlet about 0.3MPa

Water quality: resistance no less than 5kΩcm

Pipe connection: Rp2 inch (female thread)

### 5) Compressed air

Pressure : 0.5MPa~0.7MPaG

Pipe connection (inlet): Φ10 mm tube hose fitting.

Pipe connection (outlet): open to air

### 6) Vent plumb

Pipe connection: outlet at pumping unit 4in (female thread)

Fan placed at outlet of exhaust plumb.

If grounded metallic exhaust plumb used, the resistance must be below 100Ω.

### 7) Sputtering gas (Ar)

Stainless pipe connection: 1/4-inch swagelok.

The secondary pressure (outlet) of the regulator must be under 0.1MPaG

Purity: Ar 99.999%

### (8) ICP Plasma gas (Ar / O<sub>2</sub> / N<sub>2</sub>)

Stainless pipe connection: 1/4-inch swagelok.

The secondary pressure (outlet) of the regulator must be under 0.1MPaG

Purity: Ar 99.999%

Purity: O<sub>2</sub> 99.99%

Purity: N<sub>2</sub> 99.99%

- (9) Environmental condition  
20~25°C, below 60%RH (no condensation)

## 6. Safety circuit and interlock

### 6.1 Safety Measures

- (1) Emergency off  
Emergency buttons (EMO) are provided in most of the areas and on the right side of the system. The system stops entirely.
- (2) High voltage areas  
RF power supply and all charged parts over 24V are covered so that nobody can touch high voltage areas directly.
- (3) Electrical terminals  
The electrical current terminals for cathode are covered so that nobody can touch terminals directly. When these cover removed, the power is shutting down immediately.
- (4) High temperature areas  
The high temperature areas are covered so that nobody can touch high temperature areas directly.
- (5) Movable parts  
The transfer motor, various vacuum valves, gears, etc are paneled or covered for protection.
- (6) Ground leakage  
A leakage breaker is used in the system. In case of leakage, all power supply will be turned OFF.
- (7) Control system  
The control system is designed to operate at 24VDC.

### 6.2 Protection (interlock)

- (1) Turbo molecular pump  
Does not operate unless there is a specified amount of cooling water
- (2) Power/water failures  
The main pump stops and the vacuum valves close if a power failure or suspension of water supply occurs. They cannot be recovered automatically.
- (3) Compressed air  
All valves related to vacuum system shall be closed when compressed air pressure is below 0.35MPa for a pre-setting period. Patrol lamp switches on with buzzer alarming.
- (4) Cover  
Does not input power without high voltage protection cover
- (5) Cathode

The high voltage power is not turned on if the water flow is below the specified values.

(6) Sputter power supply

Can be turned ON only when the process gas is running and the sputtering chamber is under vacuum.

(7) Process gas

MFC can be opened only when the main valve is open and the sputtering chamber is under vacuum. (Exclude the main breaker and all breakers are placed inside the power board)

### 6.3 Signal tower indication

This system is equipped with three colors (red, yellow and green) signal tower to indicate system status. Please inform Oporun in advance if changes are required based on customer standard.

## 7. Scope of quotation

### 7.1 Scope of quotation

- 1) Design the system as above specification.
- 2) Manufacture, fabrication, assembly, tests the system as above specification.
- 3) Installation and acceptance test at factory and customer site

### 7.2 Items excluded from quotation

- 1) Fundamentals and building work, reinforcement of work location (load capacity over 1300 kg/m<sup>2</sup>)
- 2) Primary side electricity piping work (Customer's facility – operation board, grounding work)
- 3) Primary side cooling water piping work and piping materials (Customer's facility – equipment) (This system does not include cooling water circulation chiller unit, and/or circulating pump related)
- 4) Primary side compressed air piping work and piping materials (Customer's facility – equipment)
- 5) Primary side gas piping work and piping materials (Customer's facility – equipment) (This system does not include cylinder cabinet, etc utility equipment)
- 6) Pump discharge side pumping duct work and piping materials (This system does not include abatement system for gas exhaust. Current specification does not use special gas required to use such abatement system)
- 7) Clean air inlet and pumping duct work
- 8) Facility required for disposing of exhaust gas (if necessary) and work (leak test on the connection parts is not included)
- 9) Work if vacuum piping is too long because the pump is moved to a different position or under the grating
- 10) Electricity, gas, compressed air, and consumable parts required during the installation.

assembly, acceptance test at the customer's site

- 11) Targets and wafers used during the test operation, acceptance test at customer's site
- 12) Improvement of optical, mechanical and environmental stability properties of coating after acceptance test
- 13) Other spare parts and consumable not included (minimum Deposition shield, backing plate are included within the price)
- 14) Crane during transfer
- 15) Customer's safety basic adjustment cost
- 16) Fees of disposing system
- 17) Fees of cleaning deposition shields after acceptance test

### **8. Acceptance test condition**

System will be accepted with a confirmation from section 8.3 to 8.6 at customer site. The performance of section 8.1 to 8.2 will be taken as acceptance by measuring data at factory site.

#### **8.1 Vacuum performance**

- 1) Ultimate pressure (Each chamber cleaning, no heating, no load)  
Conditions described in the specification of Section 2.1
- 2) Pumping speed (Each room cleaning, room temperature, no load)  
Conditions described in the specification of Section 2.1

#### **8.2 Appearance check**

#### **8.3 Operation function check**

#### **8.4 Safety circuitry, interlocks check**

#### **8.5 Automatic deposition control system test**

#### **8.6 Coating acceptance test**

1. Substrate: B270
2. Single layer uniformity
3. Single side AR coating: AR Tavg>95% @ 420-700nm, Tmin>94%
4. Colour: Transparent or pale blue

Acceptance coating test will be done at Optorun site before shipment and at Customer site after setup.

### **9. Warranty**

Optorun shall undertake to repair or replace defective parts, resulting from failures due to defects in design or fabrication of this system, at no cost for a period of one (1) year from the date of acceptance test at Customer's site. The warranty, however, will not cover regular consumable items such as O-rings, vacuum oils, heaters are not covered by this warranty.