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NDK High Purity Crystaline Quartz Products

EPIC Technology Meeting on Innovative Optics

June 25th, 2025

Nihon Dempa Kogyo Co., Ltd.

Company Overview

Corporate Name	NIHON DEMPA KOGYO CO., LTD.
Activities	Production and sales of Crystal-Related products such as Crystal devices (e.g. Crystal Units, Crystal Oscillators, Crystal filters), Ultrasonic Transducers, Synthetic Quartz and Crystal Blank.
Date of Foundation	Apr-1948
Representative Director and President	Hiromi Katoh
Share Capital	¥5.596 billion (As of March 31, 2025)
Number of Shares Issued	Common Stock : 23,128,605 shares (As of March 31, 2025)
Stock Listing	Prime Market, Tokyo Stock Exchange (code:6779)
Annual Sales	Consolidated (IFRS) ¥53.064 billion(Fiscal Year Ended March 31, 2025)
Number of Employees	NDK 674 / Group 2,334 (As of March 31, 2025)
Head Office	Merkmal Keio Sasazuka Bldg., 1-47-1, Sasazuka, Shibuya-ku, Tokyo, 151-8569, Japan
Sayama Plant	1275-2, Kamihirose, Sayama-city, Saitama 350-1321, Japan

Production and R&D bases

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Japan

● Eniwa Office
[Eniwa City, Hokkaido]

● Chitose Technical Center
[Chitose City, Hokkaido]

● Hakodate NDK Co., Ltd.
[Hakodate, Hokkaido]

● Furukawa NDK Co., Ltd.
[Osaki City, Miyagi Prefecture]

●● Sayama Plant
[Sayama City, Saitama Prefecture]

head office
[Shibuya-ku, Tokyo]

● Tokyo Office
[Tokyo]

● Production bases
● R&D bases

China

● Suzhou NDK Co., Ltd.

UK

● Parts Development

Malaysia

● Asian NDK Crystal Sdn.Bhd (ANC)

● NDK Quartz Malaysia Sdn.Bhd. (NQM)

Sales Offices

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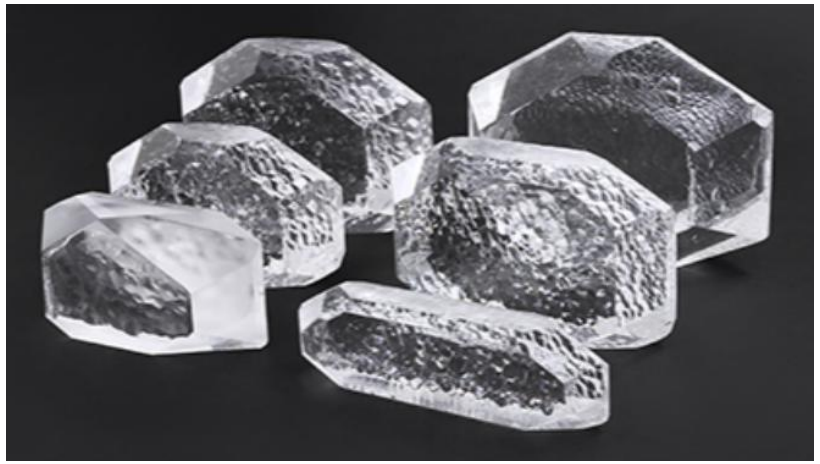
We have sales offices all over the world and have established partnerships with our customers globally.

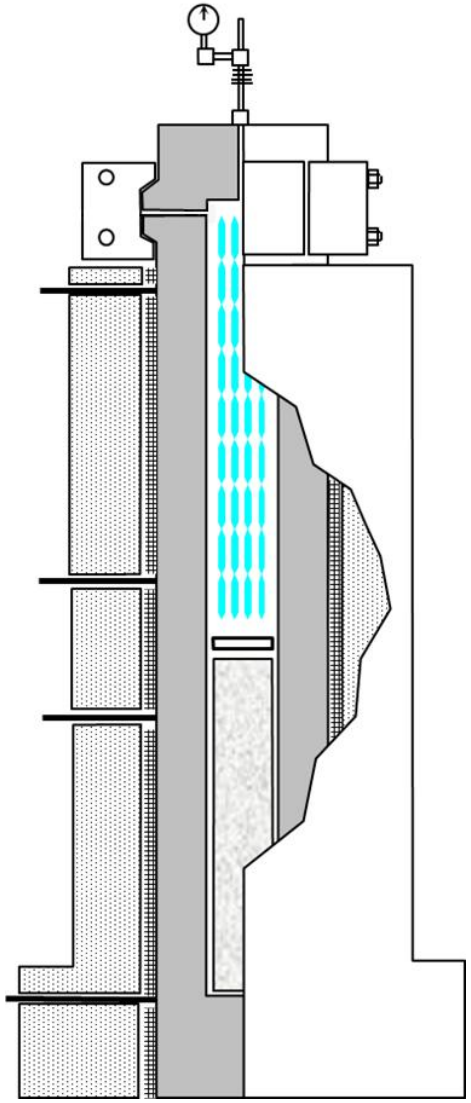
Synthetic Quartz Crystal

Synthetic quartz crystals are grown by hydrothermal synthesis in a high-temperature, high-pressure vessel called an autoclave.



Synthetic Quartz Crystal

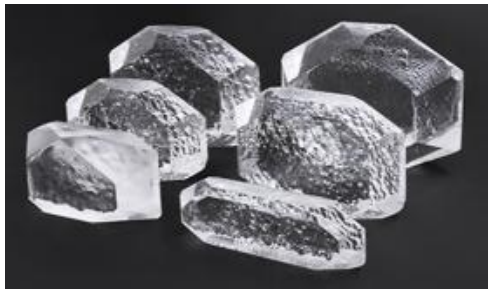
Unloading synthetic quartz crystal



Schematic of autoclave

NDK Product lineup

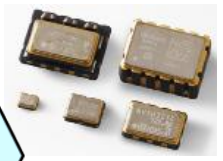
Synthetic Quartz



Product lineup based on high-purity synthetic quartz crystals

Quartz Resonator
- Tuning Fork Crystal Resonator
- Quartz Crystal Resonator with Built-in Thermistor
- MHz

Quartz Oscillator
- kHzXO
- SPXO
- TCXO
- VCXO
- OCXO



Optical Products
- Optical filters
- Waveplates
- Prisms
- Wedge plates

Etc.

Frequency Synthesizer /Signal generator

Ultrasonic devices
- Ultrasonic probes
- Ultrasonic Diagnostic Imaging System

QCM Sensor / Outgas Analysis System

SAW devices
- SAW filters
- SAW resonator
- SAWデュプレクサ
- SAW module

NDK SAW Device Products

Millimeter Wave Converters

Optical Product lineup

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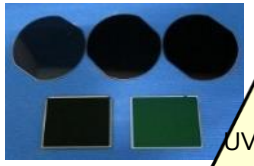
Optical products

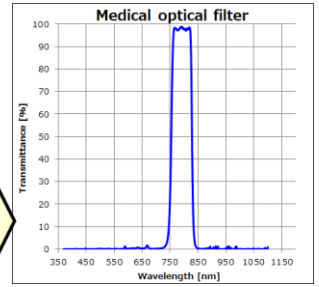
Optical Products

*Coating technology
Low reflection coating
High CRA characteristics
*Inspection technology
*$LiNbO_3$ OLPF

1) Optical Low Pass Filter
- Digital Camera
- Surveillance Camera
- Image sensor lid

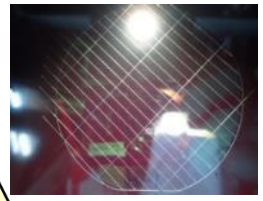


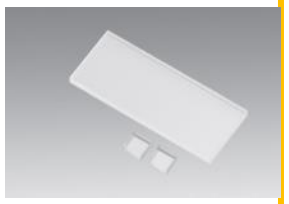
2) Optical Filter
UVIR-cut absorption filters
Band-pass filters
ND filters
Wet coating filters
- Digital Camera
- Surveillance Camera
- Image sensor lid



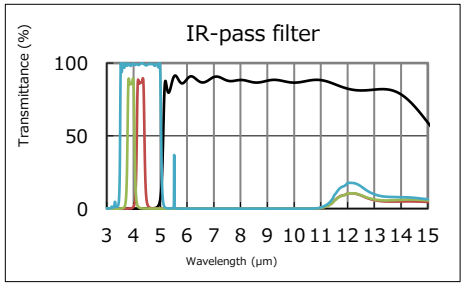
*Coating technology
Low reflection coating
High CRA characteristics
*Inspection technology

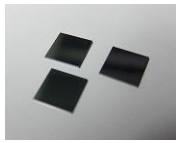
3) Wave Plate
1/4λ, 1/2λ
Zero order/Mulch order
/True zero order type
- LN modulator/amplifier
- Smart glass
- Various measurement Devices, etc.





*Controlled phase accuracy
*Coating technology
*Processing technology for True zero order waveplate
*Crystal growth technology for Large sized quartz crystal up to 6in.

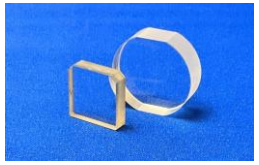




*Coating technology
*Si, Ge wafer

7) Infrared-pass filter
- gas sensor
- temperature sensor

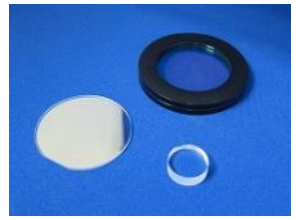
Etc.



6) THz -Windows
Windows
- Various measurement Devices, etc.

5) Radiation -proof filter
Window, Waveplate
Optical Low pass filter
- Space environment
- Radiation environment

4)Waveplates and Quartz windows for Laser applications
- Stepper/Scanner
- Laser product
- Radiation camera



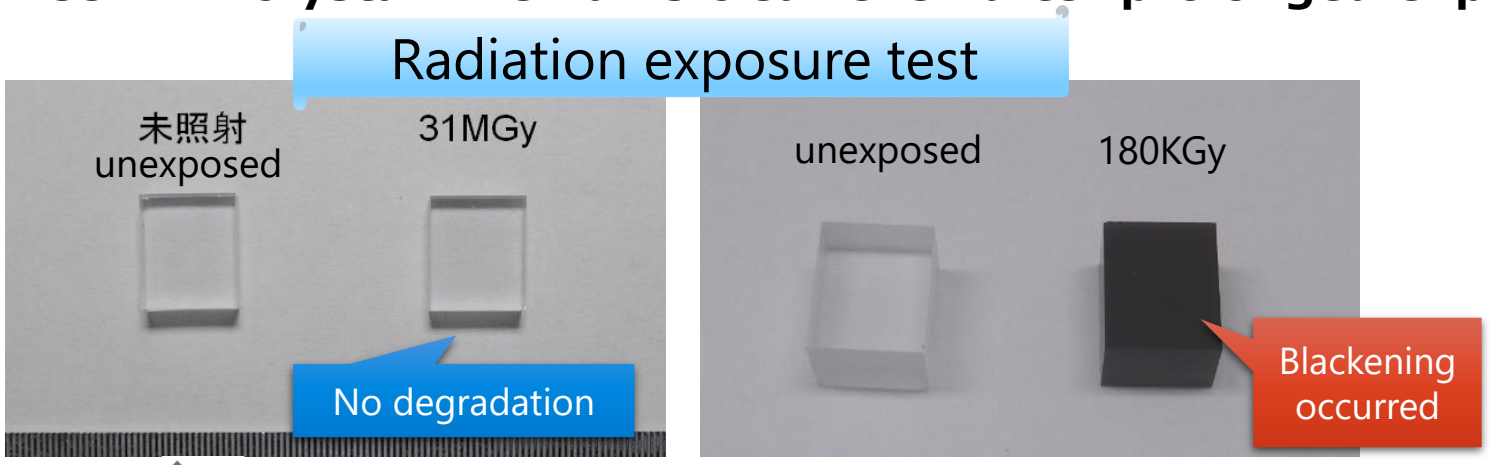
- ***High Purity Quartz***
- *Optical Contact*
- *High durability Coating technology for high power laser*

Quartz Crystal vs. Quartz Glass

No degradation formation under UV and Radiation:
Maintains transparency, resists laser-induced darkening.

Items	Quartz Glass	Quartz Crystal
Crystal structure	Amorphous (non-crystalline) SiO_2	Synthetically grown crystalline SiO_2
Atomic array	No atomic order (optically isotropic)	Has a regular, repeating atomic lattice (crystalline, trigonometric system)
Purity	99.9999%(6N) Highest purity	**99.99999%(7N) N-Grade EX**

Impurity-free NDK crystal : Remains clear even after prolonged exposure in nuclear reactors.



【N-Grade EX】 N-Grade EX
Ultra-High Purity

【Optical/Laser Grade】
Common Purity

※ The measurement and evaluation of Gamma-ray irradiation test is achieved with the cooperation of Professor Kouichi Kajiwara of Tokyo Metropolitan University.
・^{60}Coγ-ray irradiation (National Institutes for Quantum Science and Technology)
・2020-4-3～2020-10-30 (Maximum radiation dose 31MGy)

NDK Quartz crystal Lineup

NDK's "N-Grade EX" Represents the World's Highest-Purity Synthetic Quartz Crystal.

Quartz Grade	Inclusion density	α value	Etch channel densoity	Al contents (ppb)
①N-Grade EX	◎ (Grade.Ia)	◎ (Grade.Aa)	◎ (Grade.1aa)	19
②N-Grade	◎ (Grade.Ia)	○ (Grade.A)	○ (Grade.1)	70
③Laser Grade	◎ (Grade.Ia)	△ (Grade.C)	×	(4,600)
④For Crystal Frade	△ (Grade.II)	△ (Grade.C)	○ (Grade.1)	(4,600)
⑤SAW Grade	△ (Grade.II)	△ (Grade.C)	○ (Grade.1)	(4,600)

<JIS C 6704 spec.>

Inclusion Density

Units: pc./cm²

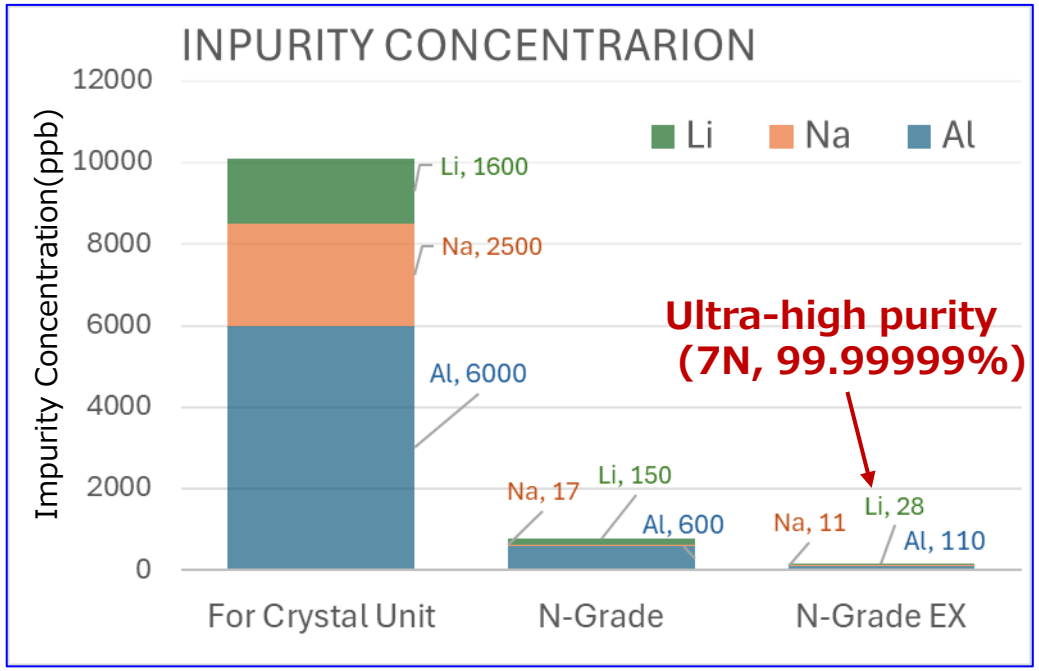
Grade		Ia	Ib	I	II	III
Inclusions	>100μm	0	1	2	3	4
	70-100μm	0	1	2	4	6
	30-70μm	1	2	4	5	8
	10-30μm	2	3	6	9	12

α-Value/Infrared Absorption Coefficient

Measured by infrared spectrophotometry to quantify IR attenuation.

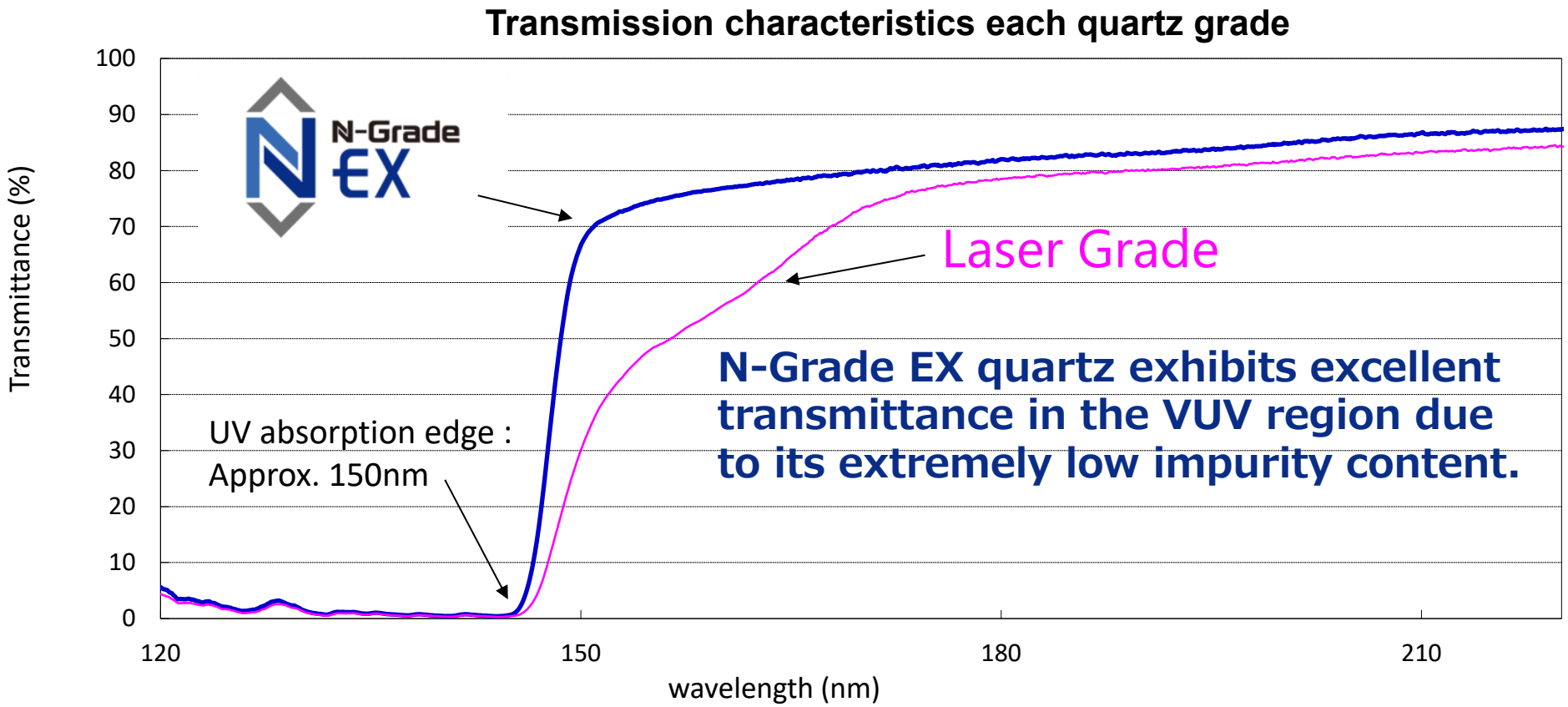
Grade	Aa	A	B	C	D	E
α3585	0.015	0.024	0.050	0.069	0.100	0.140
Applications	High stability crystal oscillator			High stability crystal oscillator for industrial use		Low frequency oscillator

Comparison of Impurity Concentrations



Ultra High-purity Crystaline Quartz Products for Semiconductor

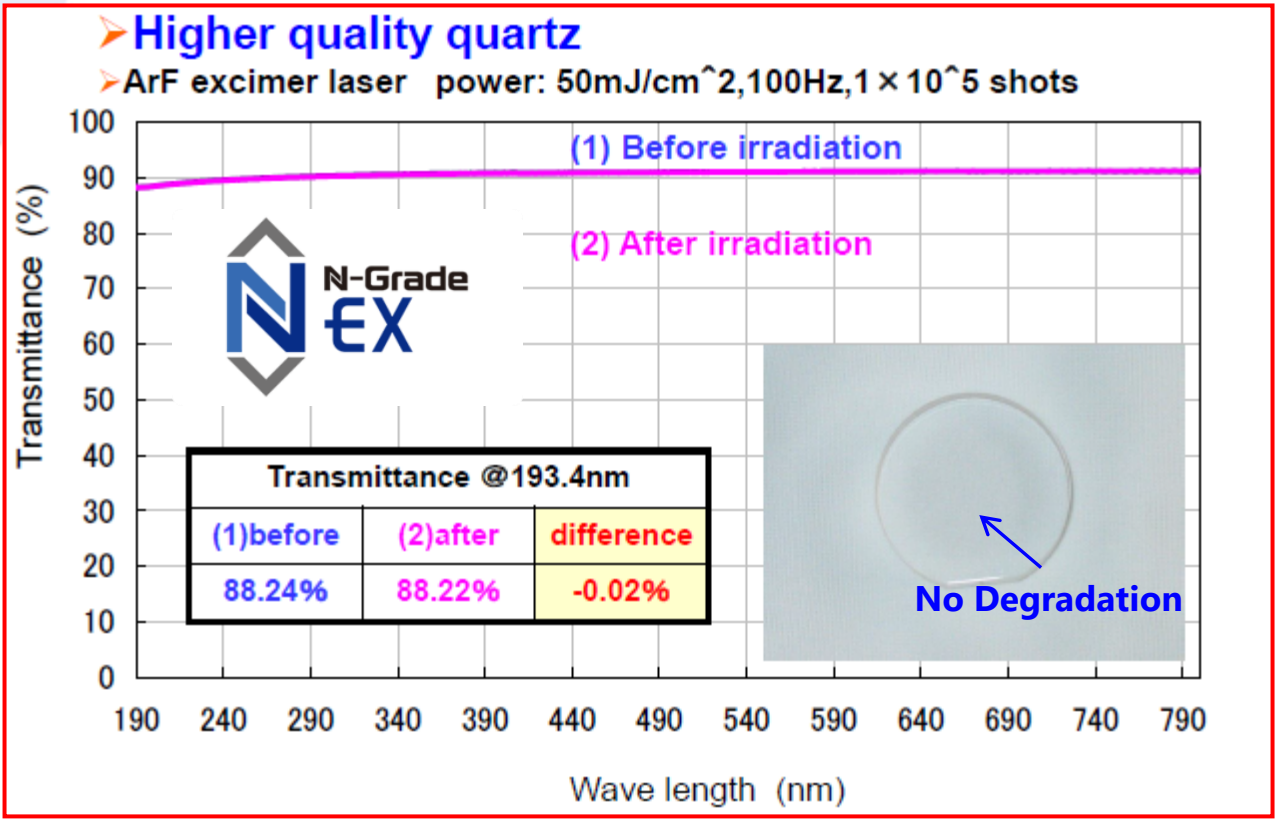
Quartz products made from ultra-high-purity “N-Grade EX” exhibit high laser damage thresholds in the EUV range, demonstrating outstanding performance as optical components for lithography equipment.

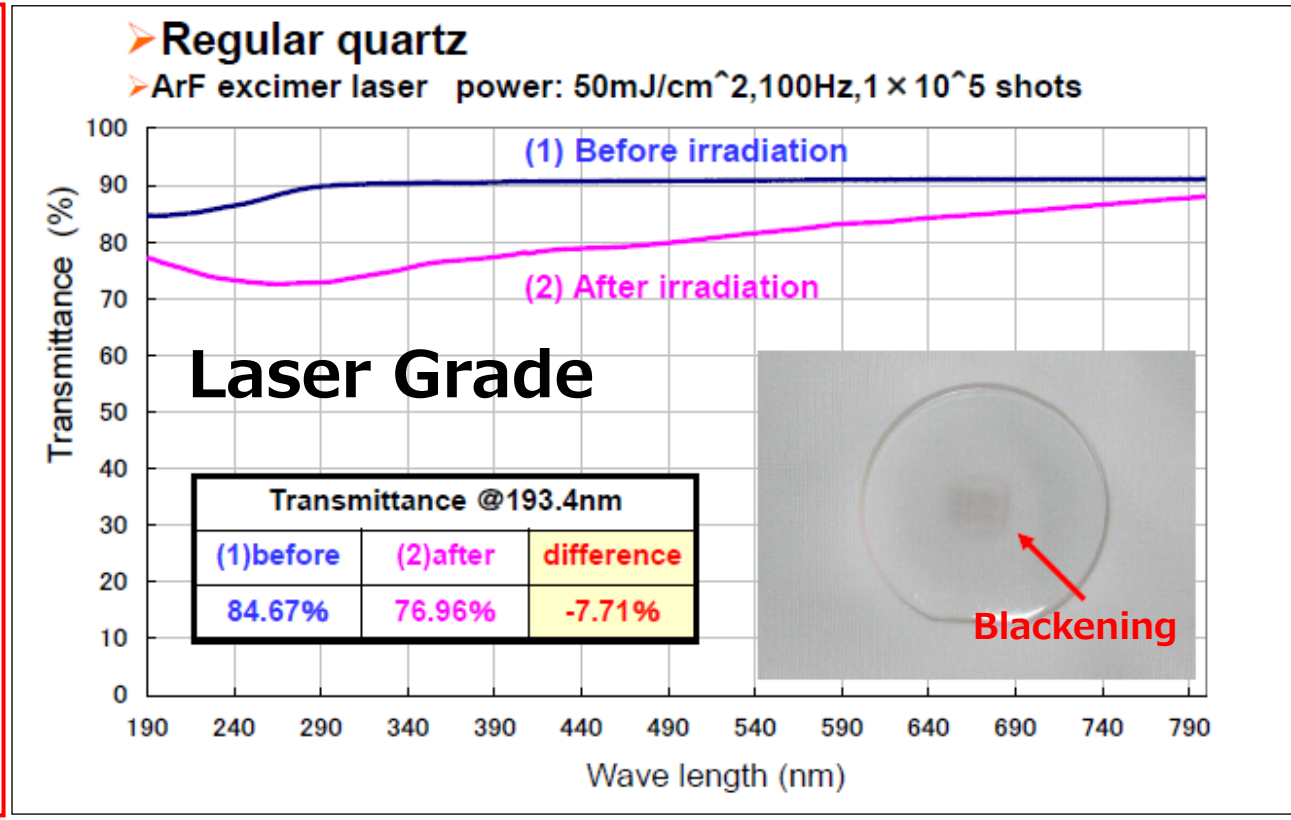


Correlation Between Spectral Transmittance in the VUV Region and Q Value

Ultra High-purity Crystaline Quartz Products for Semiconductor

“N-Grade EX” quartz maintain high transmittance and exhibit no degradation under laser irradiation, unlike Laser-grade quartz.



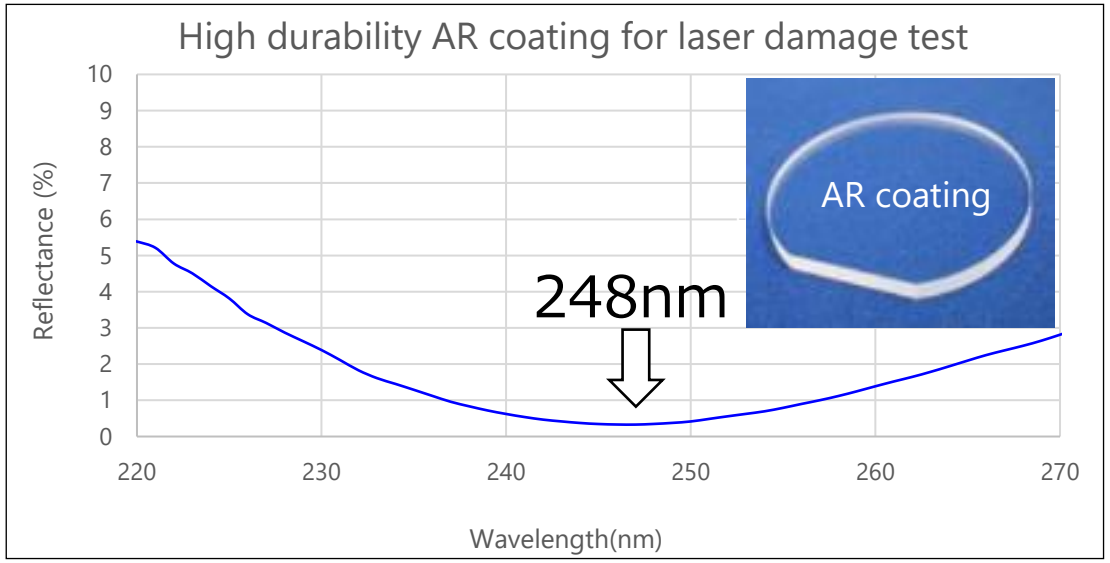


Laser irradiation conditions ; ArF(193nm) Excimer laser 、 50mJ/cm^2, 100Hz,1×10^5 shot

(1) Before Test

(2) After Test

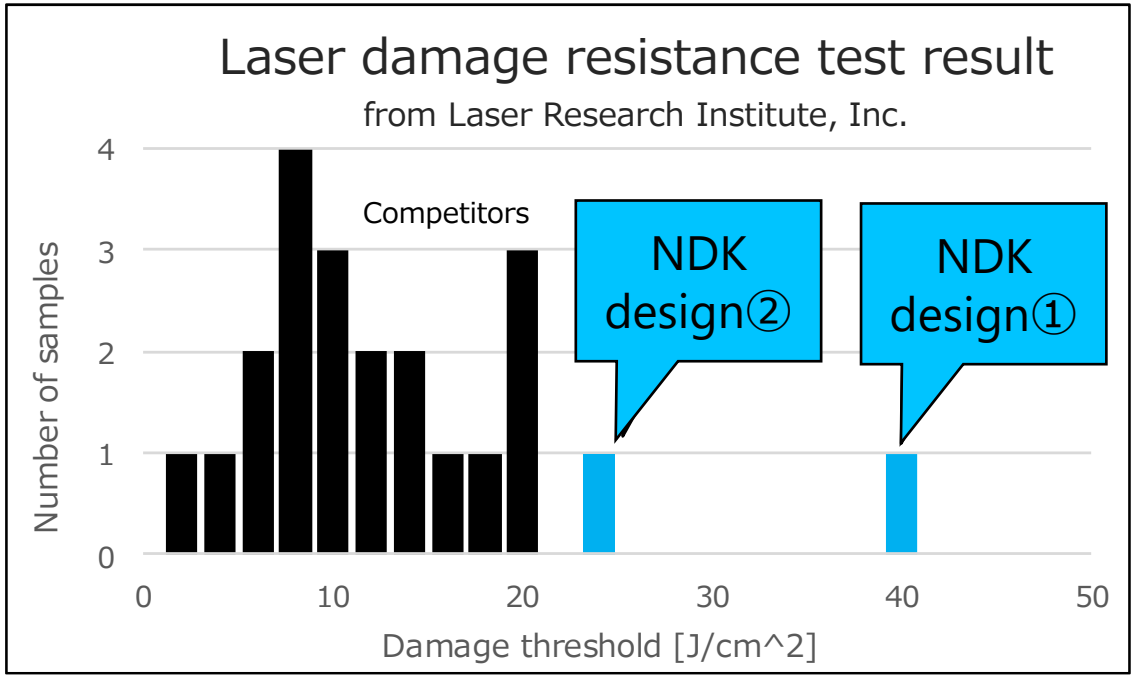
Laser damage resistance evaluation of 248nm waveplates



Laser damaged threshold value

DTp=40 [J/cm²] (actual value)

@248nm, 10nsec, 10Hz, 1000 on 1



※ NDK design① : N-Grade EX + Coating A
NDK design② : N-Grade EX + Coating B

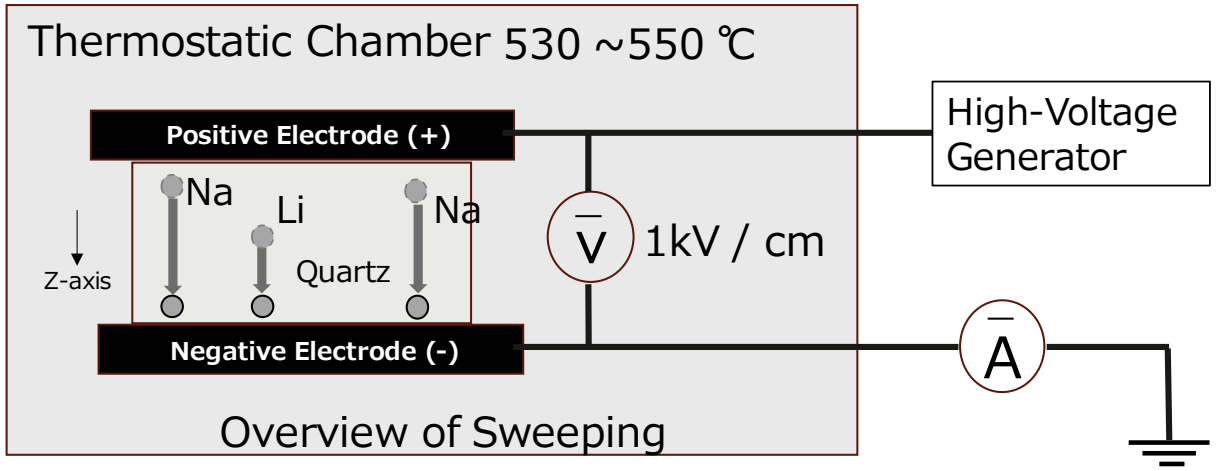
In addition to its ultra-high-purity quartz “N-Grade EX,” NDK possesses advanced substrate processing technologies and coating design/manufacturing capabilities, enabling the production of quartz optical components with top-tier laser resistance.

Available wavelength: 193nm to 1550nm

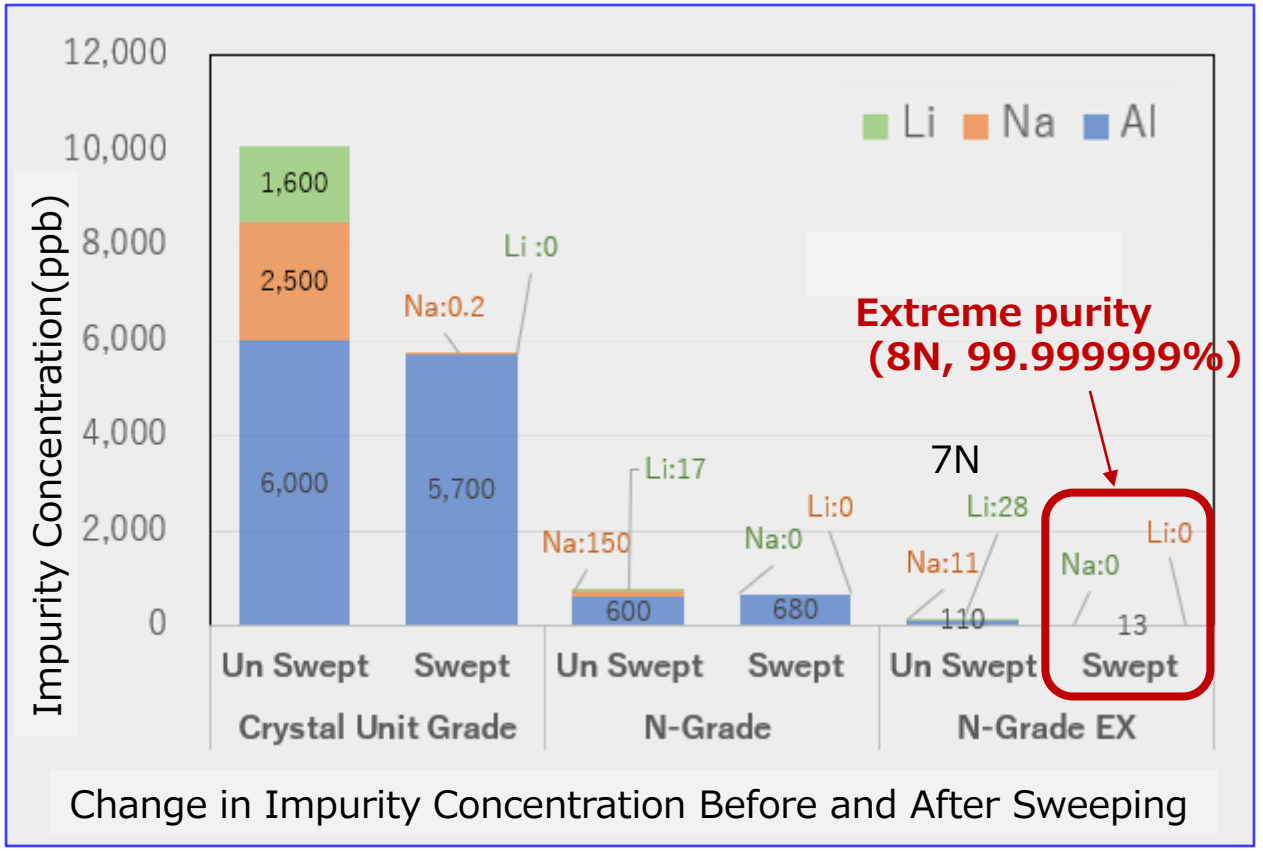
NDK is actively developing “Sweeping Quartz” to achieve even higher levels of quartz purity.

【Sweeping】

High-temperature, high-voltage processing removes Na and Li impurities from quartz.



Overview of Sweeping



Change in Impurity Concentration Before and After Sweeping

QCM Outgassing Analysis System - Impact of Outgassing

Gaseous components released from organic materials that make up products, such as plastics and adhesives, are called "outgassing (volatile gases)."
To prevent contamination problems in space and product defects,
it is important to accurately measure outgassing, select materials with less outgassing, and understand long-term trends in gas emissions.
In recent years, the demand for miniaturization, high precision, and high reliability of parts has led to an increase in the use of outgassing detection,
and it is also attracting attention in general industrial applications.

Impact of outgassing on electronic devices

Electronic Devices	Effects of outgassing
Optical machine	Image quality degradation
Solar Cell	Decreased amount of incident light
Relays, Switches	Poor contact
motor	Poor start
Quartz Crystal	Oscillation frequency drop

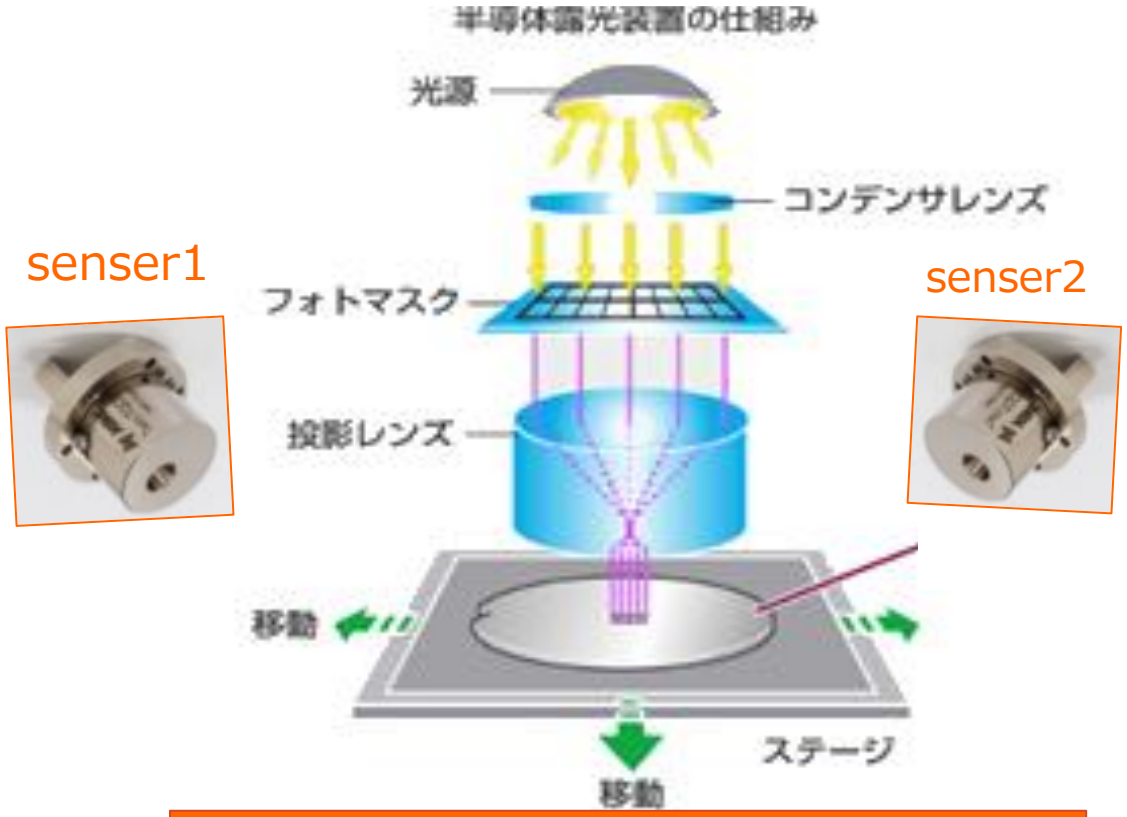
Main applications of outgassing detection and analysis

- **spacecraft components**
- **Development of optical equipment, automotive parts, and automotive materials**
- **Material analysis and evaluation, outgassing analysis (Parts acceptance, shipping inspection)**
- **Development of organic materials**
- **vacuum chamber environmental evaluation (Sensing)**
- **Film formation and abnormality monitoring for semiconductor manufacturing equipment,**

Outgas sensor application fields

Example of QCM sensor application to semiconductor exposure equipment

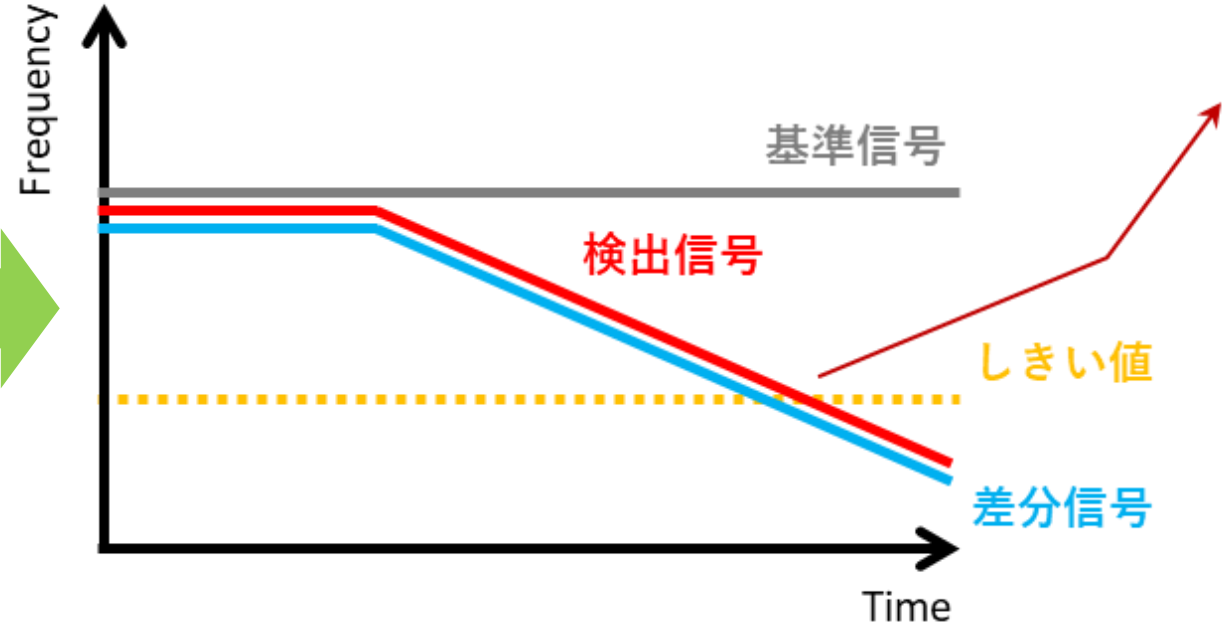
半導体露光装置用レンズ
汚染モニタ用センサの実装例



Install a sensor inside the semiconductor exposure equipment to monitor the lens contamination status
(at one specific location or multiple locations)

Example of application as QCM for dirt and cloudiness of the light detection part

The frequency of the detection signal decreases according to the level of contamination inside the device, and the threshold value decreases after a certain period of use.



Set an arbitrary threshold value to monitor lens contamination.
When the frequency of the detection signal falls below the threshold, the lens is cleaned or replaced to prevent in-process defects.

Thank you very much for your attention.