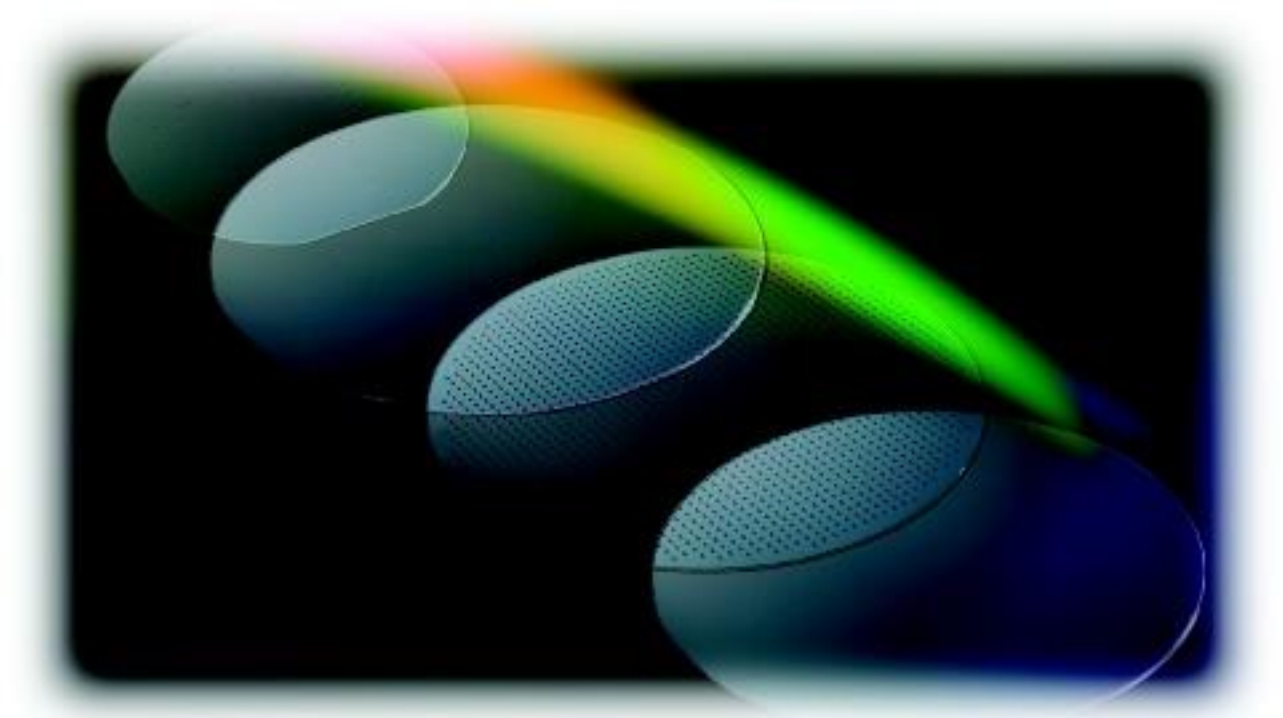


**結晶の未来を拓く**

*Crystals for a bright future*

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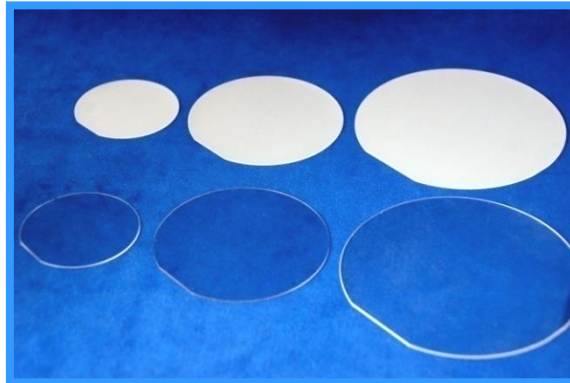
**SHINKOSHA**  
**株式会社 信光社**

# Oxide Single Crystal Substrate

## Sapphire

Sapphire is a suitable material for thin film growth of nitride semiconductor such as blue and white LED. Our sapphire substrates are optimal for epitaxial thin film growth : Our materials are high quality crystals with few defects, and our high quality processing makes no affected layer on the surfaces.

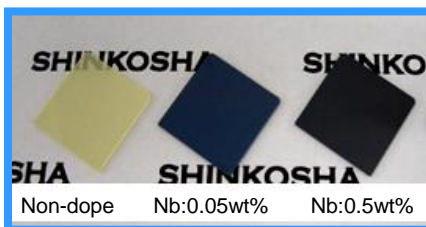
We also offer STEP finished type, OFF (miscut) type, and a variety of orientations.



## $\text{SrTiO}_3$



## $\text{TiO}_2$



## $\text{LaAlO}_3$ , $\text{NdGaO}_3$ , $\text{MgO}$ $\text{YSZ}$ , $\text{LSAT}$ , $\text{MgAl}_2\text{O}_4$ , etc.



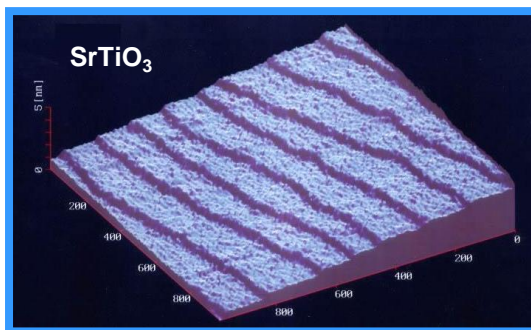
Optimal substrates for epitaxial thin film growth of superconductor, compound semiconductor, dielectric, etc. are all available. You can choose a suitable material for your needs including crystal systems, lattice constant and dielectric constant.

Our substrates have optimal surfaces for epitaxial thin film growth by high quality processing : There are neither affected layer nor scratch. Please feel free to consult us about orientations, shape, OFF angle and so on.

## STEP Substrate

Surface of STEP substrates is composed of molecular layer steps and atomic level flat terraces.

The unique STEP technology is jointly developed by Tokyo Institute of Technology and Shinkosha. It is necessary for good growth of epitaxial thin film.



For the details, please see the individual leaflets.

## Sapphire processed products



### <Sapphire watch windows>

Since sapphire is tough and strong, it is used as the window of luxury watches.

Many famous watch manufacturers adopt our sapphire windows.



### <Sapphire processed products>

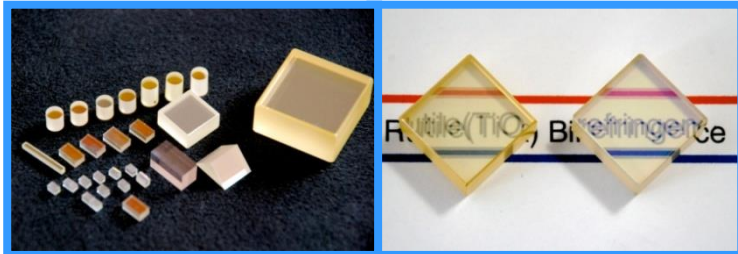
We supply products of various forms and uses : Analytical cells, a large variety of windows, semiconductor production equipment components, heatsinks, ball lenses, bearings and guides, etc.

# Crystal parts for optics & optical components

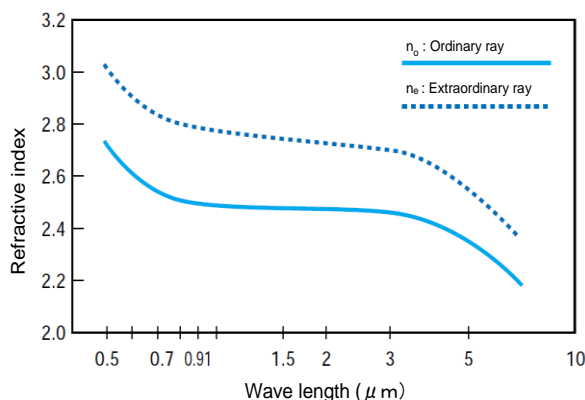
## Rutile prisms

Rutile single crystal has high refractive index and large birefringence. It is perfect for optical applications including polarizers and spectral prisms. We offer high quality rutile crystals with few crystal defects.

Rutile has excellent long term reliability with thermal & chemical stability. We can supply custom-made optical components with our high quality AR coating technology.



### ● Refractive index



## Optical components for high-power laser

High-power fiber laser becomes popular in microfabrication and marking fields. Shinkosha supplies isolators and polarizers for such use.

Our products are available for wide wave length (1040 – 1640nm) and characterized by small size, low insertion loss and high power tolerance.



## Optical fiber sensors

Our optical fiber sensors are used in monitoring system for controlling the water level in the river, opening and closing of a floodgate, etc.

Optical fiber monitoring becomes popular in disaster prevention information system. It enables long-distance monitoring without electric power supply.



## Sapphire laser caps

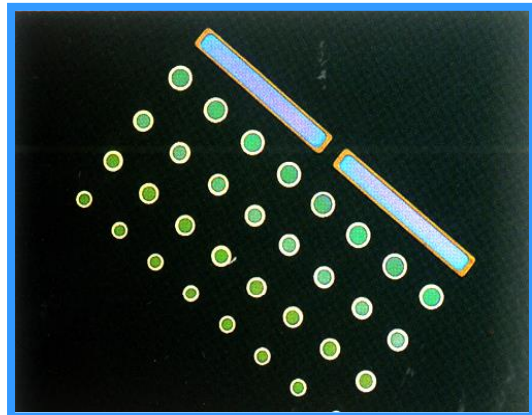
Our sapphire laser caps are used for semiconductor laser packaging windows.

Sapphire, the high-strength material has good thermal conductivity and does not deteriorate with environment. It is optimal for high-power laser and backbone transmission system which requires high reliability.

Our laser caps can be sealed well and strongly by metalizing. You can joint it easily by Au solder.

Stable extinction ratio from high-accuracy optical axis, stable optical property from high-transmission and high-reliable AR coating.

Special shapes including rectangular window, tapered type are also available.





# Molecular Layer STEP Substrate

Our oxide single crystal STEP substrates have extra fine surfaces consisting of atomic level flat terraces and steps.

## 【Features】

- Optimal surface for high quality epitaxial thin-film growth
- Made by Shinkosha's unique STEP treatment technology
- Very flat surface without affected layer by high-precision processing technology
- Shipping with AFM pictures of all items

## Sapphire

Sapphire is an optimal material for epitaxial growth of nitride semiconductors and blue & white LEDs.

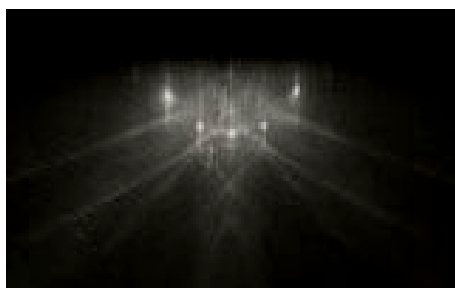


	Crystal system	Lattice constant	Size	Dopant
Al <sub>2</sub> O <sub>3</sub>	Rhombohedral	a=0.47588nm c=1.2992nm	□10×0.5mm	—
SrTiO <sub>3</sub>	Cubic	a=0.3905nm		Nb: ~0.05wt% (~0.1at%)
TiO <sub>2</sub>	Tetragonal	a=0.45935nm c=0.29580nm	□15×0.5mm	Nb: ~0.5wt% (~0.43at%)
NdGaO <sub>3</sub>	Orthorhombic	a = 0.5431 nm b = 0.5499 nm c = 0.7710 nm		—

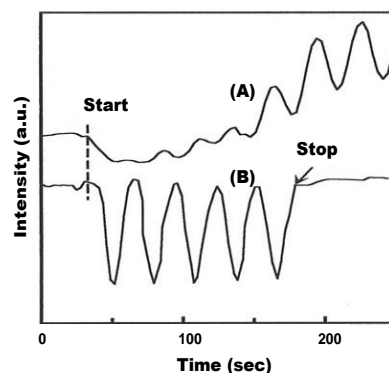
## SrTiO<sub>3</sub>

SrTiO<sub>3</sub> is a typical crystal of Perovskite structure and an optimal material for oxide electronics, dielectrics and superconductor research.

Electroconductive substrates with Nb doping are also available.



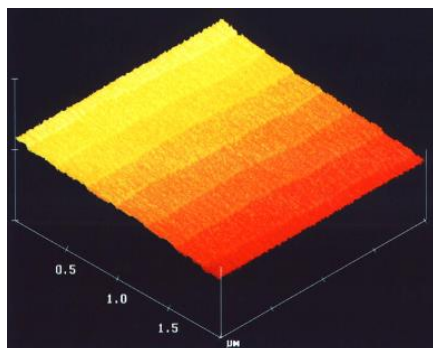
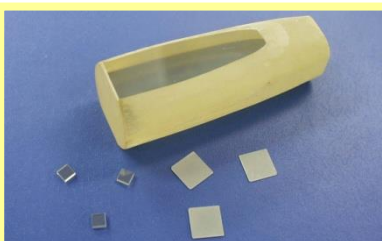
**RHEED pattern of SrTiO<sub>3</sub>(100) substrate**  
Clear spots appear in the first-order Laue zone.



**RHEED intensity oscillation pattern (SrTiO<sub>3</sub> homo-epitaxial growth)**  
(A)Normal polish, (B)STEP surface  
On a STEP substrate, crystal grows layer by layer immediately.

## TiO<sub>2</sub>(Rutile)

Our rutile has the world's best crystallinity. Electroconductive substrates with Nb doping are also available.



**AFM Image of TiO<sub>2</sub> STEP substrate**

All figures in graph and table are typical data (not guaranteed).

# STEP Model List

Model Number	Material	Orientation	Orientation Flat	Size(mm)	Dopant	Model Type
AO-CS-10S	Sapphire	(0001)	(11-20)	10x10x0.5	—	○
AO-CS-15S	"	"	"	15x15x0.5	—	△
AO-AS-10S	"	(11-20)	(0001)	10x10x0.5	—	○
AO-AS-15S	"	"	"	15x15x0.5	—	△
AO-RS-10S	"	(01-12)	(11-20)	10x10x0.5	—	△
AO-RS-15S	"	"	"	15x15x0.5	—	△
ST-AS-10S	SrTiO <sub>3</sub>	(100)	(010)	10x10x0.5	—	○
ST-AS-15S	"	"	"	15x15x0.5	—	○
ST-AS-10S-N05	"	"	"	10x10x0.5	Nb:0.05wt%	○
ST-AS-15S-N05	"	"	"	15x15x0.5	Nb:0.05wt%	○
TO-AS-15S	TiO <sub>2</sub>	(100)	(001)	15x15x0.5	—	△
TO-DS-15S	"	(110)	(110)	"	—	△
TO-AS-15S-N05	"	(100)	(001)	"	Nb:0.05wt%	△
TO-DS-15S-N05	"	(110)	(110)	"	Nb:0.05wt%	△
TO-AS-15S-N50	"	(100)	(001)	"	Nb:0.5wt%	△
TO-DS-15S-N50	"	(110)	(110)	"	Nb:0.5wt%	△
LA-AS-10S	LaAlO <sub>3</sub>	(100)	(010)	10x10x0.5	—	△
LA-AS-15S	"	"	"	15x15x0.5	—	△

- Precision cleaning and specialized package
- Minimum order : 5pcs
- AFM images attached

○ : Standard    △ : Made-to-order

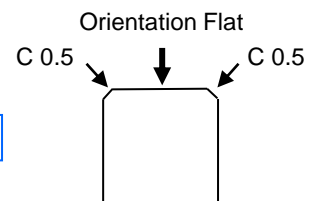
If you are looking for other specs, please contact us.



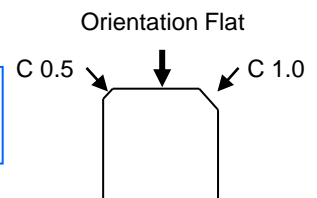
Specialized case for STEP substrate

Orientation Flat

One-side polished type



Both-side polished type  
&  
Offset angle type



<Visual check note>

We pass over the following:

(a) Chips within 0.2mm from the circumference of substrates

(b) Chips on the edge strip under 1/2 size of substrate thickness

(c) Scratches and blemish on the back side of single-side polished substrates

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URL : <http://www.shinkosha.com/>

# Sapphire( $\alpha$ -Al<sub>2</sub>O<sub>3</sub>) Substrate

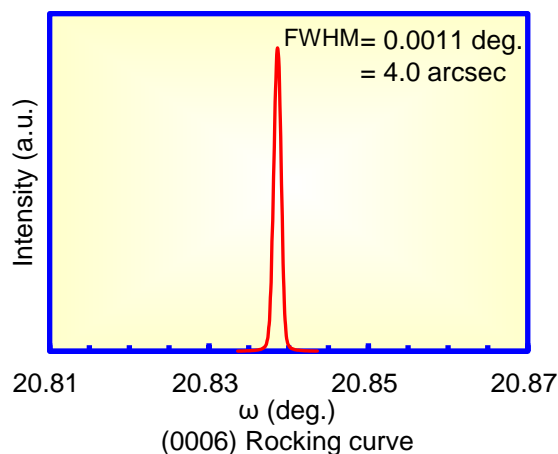
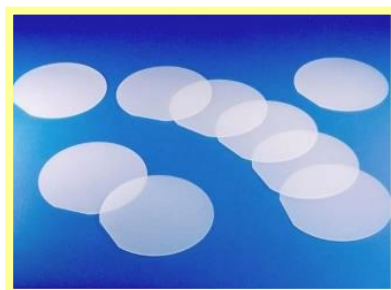
Sapphire is a single crystal of Aluminum oxide( $\alpha$ -Al<sub>2</sub>O<sub>3</sub>). Shinkosha offers optimal sapphire substrates for epitaxial thin film growth of group-III nitride semiconductors, superconductors and dielectrics. Our sapphire is highly praised around the world for its high quality of crystal, surface processing, cleaning and packaging.

## 【Features】

- High quality single crystal materials : Few crystal defects
- High quality processing for epitaxial thin-film growth : No affected layer on the surface

## 【Characteristics】

Crystal system	Trigonal (Rhombohedral)
Crystal structure	Corundum
Space group	$R\bar{3}c$
Lattice constant	$a = 0.47588 \text{ nm}$ , $c = 1.2992 \text{ nm}$ (As hexagonal)
Melting point	2040 °C
Density	3.987 g/cm <sup>3</sup>
Dielectric constant	(//c axis) 9.41 at 30GHz
Dielectric loss	(//c axis) $3 \times 10^{-5}$ at 30GHz
Thermal expansion	(at 200 °C, c axis) $7.63 \times 10^{-6} / ^\circ\text{C}$ (at 200 °C, a axis) $6.93 \times 10^{-6} / ^\circ\text{C}$ (at 1000 °C, c axis) $9.97 \times 10^{-6} / ^\circ\text{C}$ (at 1000 °C, a axis) $8.89 \times 10^{-6} / ^\circ\text{C}$



## 【Standard Specs】

Purity	>99.99%	
Orientation	c(0001) , a(11-20) , r(01-12) , m(10-10)	Tolerance $\pm 0.5^\circ$
Size	10 × 10 mm 15 × 15 mm Tolerance $\pm 0.1 \text{ mm}$	$\phi 2\text{in}(\phi 50.8\text{mm})$ Tolerance $\pm 0.25 \text{ mm}$
Thickness	0.5 mm Tolerance $\pm 0.05 \text{ mm}$	0.33 mm 0.43 mm Tolerance $\pm 0.05 \text{ mm}$
Polishing	One-side / Both-side	
STEP	Available for : c , a , r	—
Surface roughness	$Ra \leq 1.0 \text{ nm}$	
Flatness	$< 1 \mu\text{m}$	$< 16 \mu\text{m}$

If you are looking for other specs, please contact us.

All figures in graph and table are typical data (not guaranteed).

## Sapphire Model List

Size (mm)	Polishing	Surface treatment	c-plane (0001)	a-plane (11-20)	r-plane (01-12)	m-plane (10-10)
10x10x0.5	One-side	Normal	○	○	○	○
"	Both-side	"	○	○	○	△
"	One-side	STEP	○	○	△	—
15x15x0.5	One-side	Normal	○	△	△	△
"	Both-side	"	△	△	△	△
"	One-side	STEP	△	△	△	—
φ2in x 0.33	One-side	Normal	○	△	△	△
"	Both-side	"	○	△	△	△
φ2in x 0.43	One-side	"	○	○	○	△
"	Both-side	"	○	○	○	△

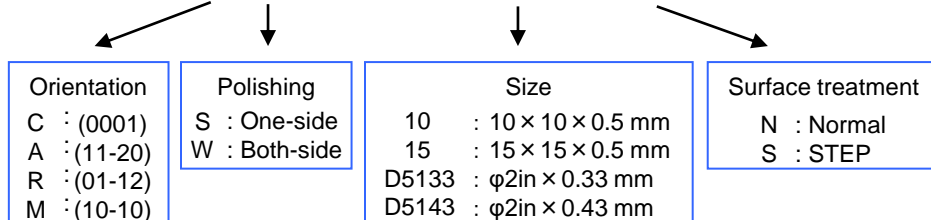
○ : Standard    △ : Made-to-order

If you are looking for different sizes, offset angle type and others, please contact us.

\*Minimum order for made-to-order model or special model : 5pcs (square shape), 10pcs (round shape)

## Model Number

AO — CS — D5143N



## Orientation Flat

Substrate Orientation	Orientation Flat
c-plane (0001)	(11-20)
a-plane (11-20)	(0001)
r-plane (01-12)	(11-20)
m-plane (10-10)	(11-20)

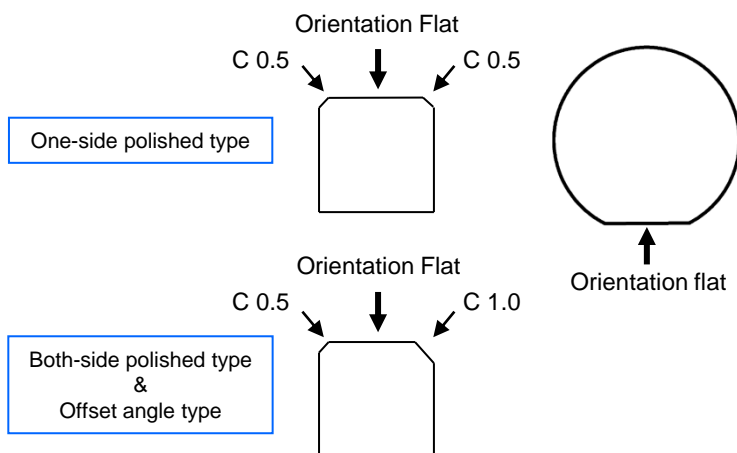
<Visual check note>

We pass over the following:

- (a) Chips within 0.2mm from the circumference of substrates
- (b) Chips on the edge strip under 1/2 size of substrate thickness
- (c) Scratches and blemish on the back side of single-side polished substrates

## Square shape

## Round shape



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E-mail : sales@shinkosha.com

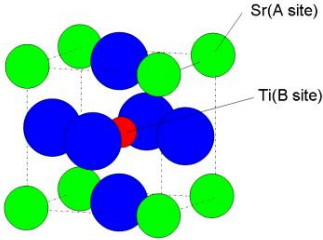
URL : <http://www.shinkosha.com/>

# SrTiO<sub>3</sub>(Strontium Titanate) Substrate

We produce optimal SrTiO<sub>3</sub> substrates for epitaxial thin-film growth to make the fruits of your work excellent.

## 【Features】

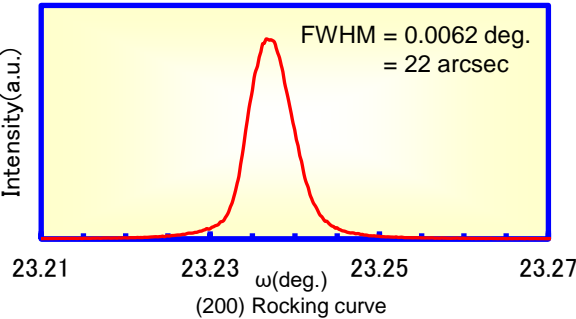
- High quality and high purity single crystal
- Optimal substrates for epitaxial thin-film growth
- High quality surface without affected layer
- Available in a variety of Nb doping concentrations
- Integrated production : From the crystal to the substrate



SrTiO<sub>3</sub> Structure

## 【Characteristics】

Crystal system	Cubic
Crystal structure	Perovskite
Space group	Pm3m
Lattice constant	a = 0.3905 nm
Melting point	2080 °C
Density	5.122 g/cm <sup>3</sup> (20°C)
Dielectric constant	310 (27 °C, 1MHz)
Thermal expansion	11.1 × 10 <sup>-6</sup> /°C (r.t. ~ 1000°C)
Phase transition	110K (tetragonal ⇌ cubic)
Refractive index	2.407 (at 589 nm)



## 【Standard Specs】

	STO	Nb:STO	
Purity	≥99.98%		
Nb concentration	0	0.05wt% (0.1at%)	0.5wt% (1.0at%)
Resistivity	$>10^7 \Omega \cdot \text{cm}$	$7 \sim 10 \times 10^{-2} \Omega \cdot \text{cm}$	$3 \sim 7 \times 10^{-3} \Omega \cdot \text{cm}$
Career density	—	$1 \sim 2 \times 10^{19} \text{ cm}^{-3}$	$1 \sim 2 \times 10^{20} \text{ cm}^{-3}$
Split Angle	$\leq 0.1^\circ$		
Orientation	(100) , (110) , (111) Tolerance $\pm 0.5^\circ$		
Size	10×10×0.5 mm , 15×15×0.5 mm Outer size tolerance: ±0.1 mm Thickness tolerance: ±0.05 mm		
Polishing	One-side / Both-side		
STEP	Available for (100)		—
Surface roughness	$Ra \leq 1.0 \text{ nm}$ , $Rmax \leq 5.0 \text{ nm}$		
Flatness	10×10×0.5 mm : $\leq \lambda$ , 15×15×0.5 mm : $\leq 1.5\lambda$ ( $\lambda=632.8 \text{ nm}$ )		

If you are looking for other specs, please contact us.

All figures in graph and table are typical data (not guaranteed).



# SrTiO<sub>3</sub> Model list

Doping	Size (mm)	Polishing	Surface treatment	Orientation		
				(100)	(110)	(111)
None	10x10x0.5	One-side	Normal	○	○	○
	"	Both-side	"	○	△	△
	"	One-side	STEP	○	—	—
	"	Both-side	"	○	—	—
	15x15x0.5	One-side	Normal	○	△	△
	"	Both-side	"	△	△	△
	"	One-side	STEP	○	—	—
Nb:0.05wt%	10x10x0.5	One-side	Normal	○	△	△
	"	Both-side	"	△	△	△
	"	One-side	STEP	○	—	—
	15x15x0.5	One-side	Normal	○	△	△
	"	Both-side	"	△	△	△
	"	One-side	STEP	○	—	—
Nb:0.5wt%	10x10x0.5	One-side	Normal	○	△	△
	"	Both-side	"	△	△	△
	15x15x0.5	One-side	"	○	△	△
	"	Both-side	"	△	△	△

If you are looking for different sizes, offset angle type and others, please contact us.

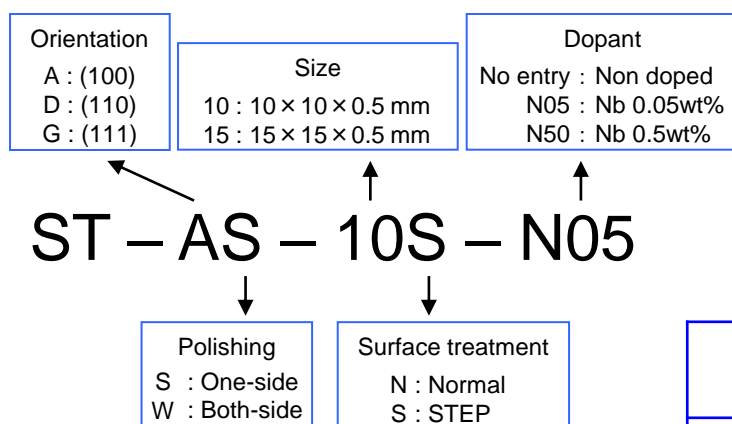
\*Minimum order for STEP model, made-to-order model and special model : 5pcs

○ : Standard

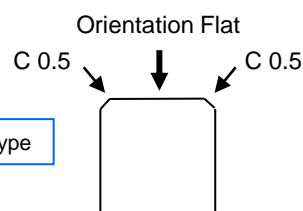
△ : Made-to-order

## Model Number

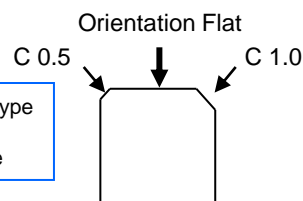
## Orientation Flat



One-side polished type



Both-side polished type  
&  
Offset angle type



Substrate Orientation	Orientation Flat
(100)	(010)
(110)	(100)
(110)	(110)

<Visual check note>

We pass over the following:

(a) Chips within 0.2mm from the circumference of substrates

(b) Chips on the edge strip under 1/2 size of substrate thickness

(c) Scratches and blemish on the back side of single-side polished substrates

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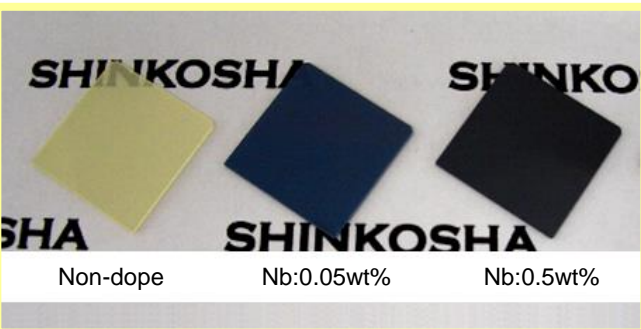
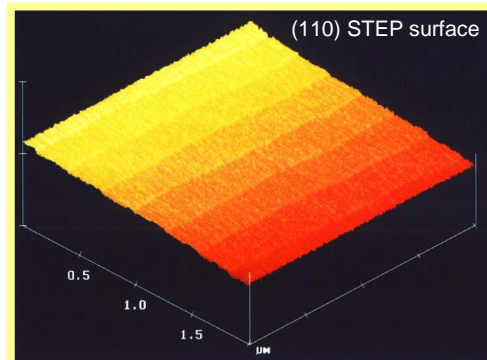
URL : <http://www.shinkosha.com/>

# TiO<sub>2</sub>(Rutile) Substrate

We offer world's best TiO<sub>2</sub>(rutile) substrates to make the fruits of your work excellent.

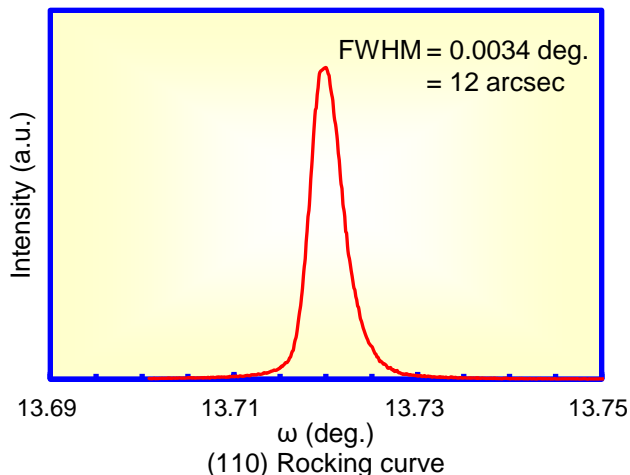
## 【Features】

- World's top-class crystal quality
- STEP substrates are also available.
- Electrically-conductive type is available by Nb doping.



## 【Characteristics】

Crystal system	Tetragonal
Crystal structure	Rutile
Space group	P4 <sub>2</sub> /mnm
Lattice constant	a = 0.45935 nm c = 0.29580 nm
Melting point	1840 °C
Density	4.252 g/cm <sup>3</sup> (20°C)
Dielectric constant	113 (1MHz)
Thermal expansion	(// a-axis) 7.81 × 10 <sup>-6</sup> /°C (// c-axis) 10.1 × 10 <sup>-6</sup> /°C
Band gap	3.0 eV
Refractive index	n <sub>o</sub> = 2.5490 n <sub>e</sub> = 2.8226 (at 706.5nm)



## 【Standard Specs】

	TiO <sub>2</sub>	Nb:TiO <sub>2</sub>	
Nb concentration	0	0.05wt% (0.04at%)	0.5wt% (0.43at%)
Resistivity	>10 <sup>7</sup> Ω·cm	2.5~10 Ω·cm	0.20~0.35 Ω·cm
Orientation	(100) , (001) , (110) Tolerance : ±0.5°		
Size	10 × 10 × 0.5 mm , 15 × 15 × 0.5 mm Tolerance (outside dimension) : ±0.1 mm Tolerance (thickness) : ±0.05 mm		
Polishing	One-side / Both-side		
STEP	Available for (100), (110)		
Surface roughness	Ra ≤ 1.0nm , Rmax ≤ 5.0nm		
Flatness	10 × 10 × 0.5 mm : ≤λ , 15 × 15 × 0.5 mm : ≤1.5λ (λ=632.8 nm)		

If you are looking for other specs, please contact us.

All figures in graph and table are typical data (not guaranteed).

# TiO2 Model list

Doping	Size (mm)	Polishing	Surface treatment	Orientation		
				(100)	(110)	(001)
None	10x10x0.5	One-side	Normal	○	○	○
	"	Both-side	"	△	△	○
	"	One-side	STEP	△	△	—
	15x15x0.5	One-side	Normal	○	○	○
	"	Both-side	"	△	△	○
	"	One-side	STEP	△	△	—
Nb:0.05wt%	10x10x0.5	One-side	Normal	○	○	△
	"	Both-side	"	△	△	△
	"	One-side	STEP	△	△	—
	15x15x0.5	One-side	Normal	○	○	△
	"	Both-side	"	△	△	△
	"	One-side	STEP	△	△	—
Nb:0.5wt%	10x10x0.5	One-side	Normal	○	○	△
	"	Both-side	"	△	△	△
	"	One-side	STEP	△	△	—
	15x15x0.5	One-side	Normal	○	○	△
	"	Both-side	"	△	△	△
	"	One-side	STEP	△	△	—

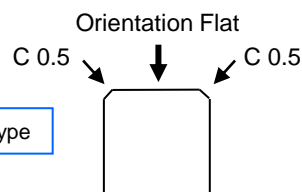
○ : Standard    △ : Made-to-order

If you are looking for different sizes, offset angle type and others, please contact us.

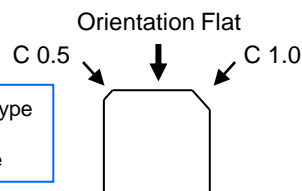
\*Minimum order for STEP model, made-to-order model and special model : 5pcs

## Orientation Flat

One-side polished type



Both-side polished type  
&  
Offset angle type



## Model Number

Polishing  
S : One-side  
W : Both-side

Surface treatment  
N : Normal  
S : STEP

TO - AS - 10N - N05

Orientation  
A : (100)  
D : (110)  
C : (001)  
E : (101)  
G : (111)

Size  
10 : 10 × 10 × 0.5 mm  
15 : 15 × 15 × 0.5 mm

Dopant  
No entry : Non doped  
N05 : Nb 0.05wt%  
N50 : Nb 0.5wt%

<Visual check note>

We pass over the following:

- (a) Chips within 0.2mm from the circumference of substrates
- (b) Chips on the edge strip under 1/2 size of substrate thickness
- (c) Scratches and blemish on the back side of single-side polished substrates

Substrate Orientation	Orientation Flat
(100)	(001)
(110)	(110)
(001)	(110)
(101)	(100)
(111)	(110)

**SHINKOSHA Co., Ltd.**

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# LaAlO<sub>3</sub> (Lanthanum Aluminate) Substrate

We produce optimal LaAlO<sub>3</sub> substrates for epitaxial thin-film growth to make the fruits of your work excellent.

## 【Features】

- STEP substrates are also available.
- Large diameter : max 2 inch available



## 【Characteristics】

Crystal system	Trigonal (Pseudo-cubic) *
Crystal structure	Pseudo-Perovskite
Space group	$R\bar{3}c$
Lattice constant	$a_0 = 0.379 \text{ nm}$ (Pseudo-cubic)
Melting point	2100 °C
Density	6.52 g/cm <sup>3</sup>
Dielectric constant	15~22 (27°C, 1MHz)
Thermal expansion	$12.6 \times 10^{-6}/^{\circ}\text{C}$
Phase transition temperature	Approx. 420 °C (Trigonal $\leftrightarrow$ Cubic)
Twin crystal	Generated by phase transition

## 【Standard Specs】

Orientation	(100) , (110) Tolerance $\pm 0.5^{\circ}$ (in Pseudo-cubic)
Size	10×10×0.5 mm , 15×15×0.5 mm Tolerance (outside dimension) : $\pm 0.1 \text{ mm}$ Tolerance (thickness) : $\pm 0.05 \text{ mm}$
Polishing	One-side / Both-side
STEP	Available for (100)
Surface roughness	$R_a \leq 1.0 \text{ nm}$ , $R_{\text{max}} \leq 5.0 \text{ nm}$
Flatness	10×10×0.5mm: $\leq \lambda$ 15×15×0.5mm: $\leq 1.5\lambda$ ( $\lambda=632.8 \text{ nm}$ )

If you are looking for other specs, please contact us.

\*LaAlO<sub>3</sub> is a trigonal crystal ( $a=0.5357 \text{ nm}$ ,  $\alpha=60.1^{\circ}$  ) accurately, but it is treated as a pseudo-cubic or hexagonal crystal generally.



## LaAlO<sub>3</sub> Model list

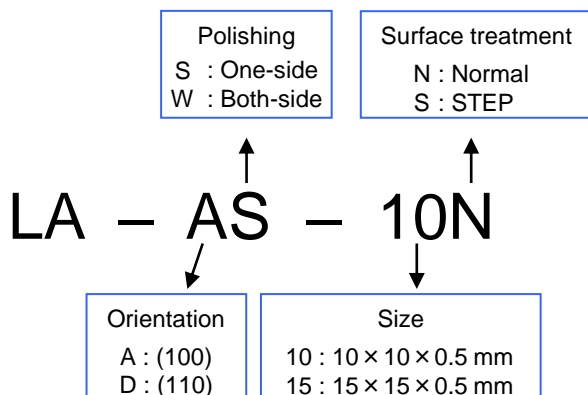
Size (mm)	Polishing	Surface treatment	Orientation	
			(100)	(110)
10x10x0.5mm	One-side	Normal	○	△
"	Both-side	"	○	△
"	One-side	STEP	△	—
15x15x0.5mm	One-side	Normal	○	△
"	Both-side	"	△	△
"	One-side	STEP	△	—

○ : Standard    △ : Made-to-order

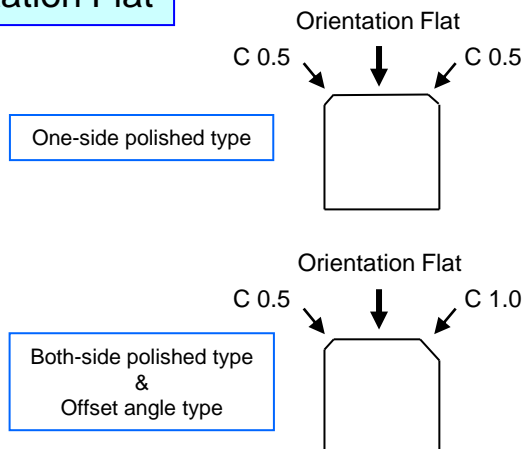
If you are looking for different sizes (up to φ2 in), offset angle type and others, please contact us.

\*Minimum order for STEP model, made-to-order model and special model : 5pcs

### Model Number



### Orientation Flat



Substrate Orientation	Orientation Flat
(100)	(010)
(110)	(100)

<Visual check note>

We pass over the following:

- (a) Chips within 0.2mm from the circumference of substrates
- (b) Chips on the edge strip under 1/2 size of substrate thickness
- (c) Scratches and blemish on the back side of single-side polished substrates

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# NdGaO<sub>3</sub> (Neodymium Gallate) Substrate

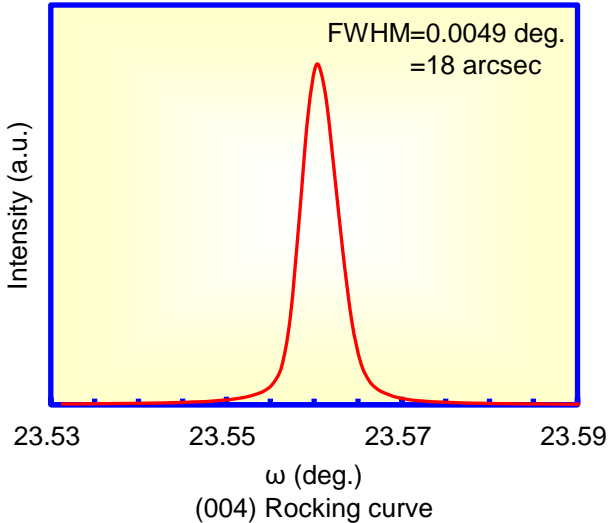
We produce optimal NdGaO<sub>3</sub> substrates for epitaxial thin-film growth to make the fruits of your work excellent.

## 【Features】

- Excellent lattice match with superconductor film
- High quality crystal
- Integrated production : From the crystal to the substrate

## 【Characteristics】

Crystal system	Orthorhombic
Crystal structure	Perovskite
Lattice constant	a = 0.5431 nm b = 0.5499 nm c = 0.7710 nm
Melting point	1650 °C
Density	7.56 g/cm <sup>3</sup>
Dielectric constant	20~25 (27°C,1MHz)
Thermal expansion	10 × 10 <sup>-6</sup> /°C



## 【Standard Specs】

Orientation	(100) , (001) , (110) , (011) Tolerance : ±0.5°
Size	10 × 10 × 0.5mm 15 × 15 × 0.5mm Tolerance (outside dimension) : ±0.1 mm Tolerance (thickness) : ±0.05 mm
Polishing	One-side / Both-side
Surface roughness	Ra ≤ 1.0nm , Rmax ≤ 5.0nm
Flatness	10 × 10 × 0.5mm : ≤ λ 15 × 15 × 0.5mm : ≤ 1.5λ (λ = 632.8nm)

If you are looking for other specs, please contact us.

## NdGaO<sub>3</sub> Model list

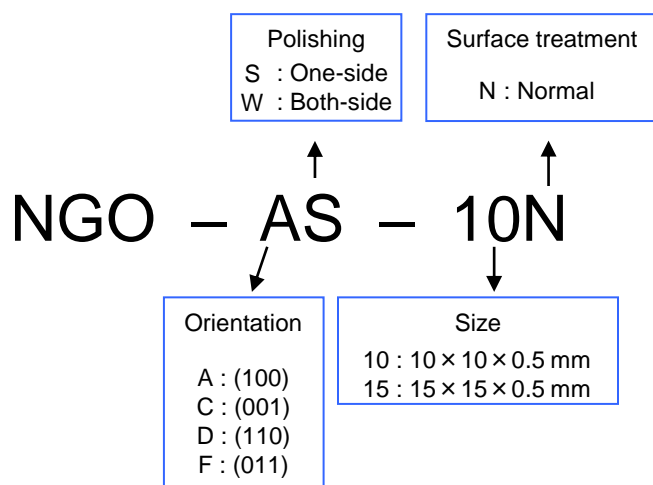
Size (mm)	Polishing	Orientation			
		(100)	(001)	(110)	(011)
10x10x0.5mm	One-side	○	○	○	△
"	Both-side	△	△	△	△
15x15x0.5mm	One-side	△	△	△	△
"	Both-side	△	△	△	△

○ : Standard    △ : Made-to-order

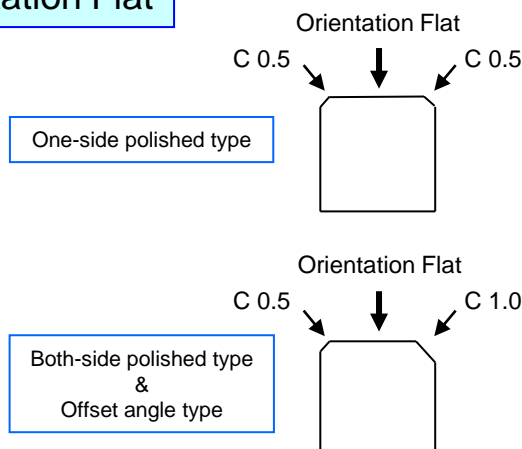
If you are looking for different sizes, offset angle type and others, please contact us.

\*Minimum order for made-to-order model and special model : 5pcs

### Model Number



### Orientation Flat



Substrate Orientation	Orientation Flat
(100)	(001)
(001)	(100)
(110)	(001)
(011)	(001)

<Visual check note>

We pass over the following:

- (a) Chips within 0.2mm from the circumference of substrates
- (b) Chips on the edge strip under 1/2 size of substrate thickness
- (c) Scratches and blemish on the back side of single-side polished substrates

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# Oxide Single Crystal Substrate

Shinkosha provides various optimal oxide single crystal substrates for epitaxial thin-film growth (Sapphire, SrTiO<sub>3</sub>, Rutile, LaAlO<sub>3</sub> and NdGaO<sub>3</sub> are each treated in a separate catalog).

## 【Characteristics】 (Reference data)

Crystal	MgO	YSZ	LSAT	MgAl <sub>2</sub> O <sub>4</sub>
Crystal system	Cubic	Cubic	Cubic	Cubic
Crystal structure	NaCl	CaF <sub>2</sub>	Perovskite	Spinel
Lattice constant	a = 0.4213 nm	a = 0.5139 nm	a = 0.7736 nm	a = 0.8083 nm
Melting point	2800 °C	2500 °C	1840 °C	2130 °C
Density	3.59 g/cm <sup>3</sup>	6.05 g/cm <sup>3</sup>	6.79 g/cm <sup>3</sup>	3.64 g/cm <sup>3</sup>
Thermal expansion	13.5x10 <sup>-6</sup> /°C	10.3x10 <sup>-6</sup> /°C	10x10 <sup>-6</sup> /°C	7.5x10 <sup>-6</sup> /°C
Dielectric constant	10	27	22	—

## 【Standard Specs】

Orientation tolerance	±0.5°
Size	10×10×0.5 mm , 15×15×0.5 mm (max : ϕ2in) Outer size tolerance : ±0.1 mm Thickness tolerance : ±0.05 mm
Surface roughness	Ra ≤1.0nm , Rmax ≤5.0nm
Flatness	10×10×0.5mm : ≤λ , 15×15×0.5mm : ≤1.5λ (λ=632.8nm)

\*This table is made for a general specification. Since it may differ from above specs depending on materials and orientations, please ask us for the details.

### MgO

Orientation	Orientation flat	Size	One-side polishing	Both-side polishing
(100)	(010)	10x10x0.5mm	○	○
〃	〃	15x15x0.5mm	○	△

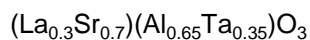
### YSZ

Yttria Stabilized Zirconia  
(Y<sub>2</sub>O<sub>3</sub> ≒ 10mol%)

Orientation	Orientation flat	Size	One-side polishing	Both-side polishing
(100)	(010)	10x10x0.5mm	○	○
〃	〃	15x15x0.5mm	○	△
(111)	(110)	10x10x0.5mm	○	○



## LSAT



Orientation	Orientation flat	Size	One-side polishing	Both-side polishing
(100)	(010)	10x10x0.5mm	○	△
"	"	15x15x0.5mm	○	△

## MgAl<sub>2</sub>O<sub>4</sub>

Spinel

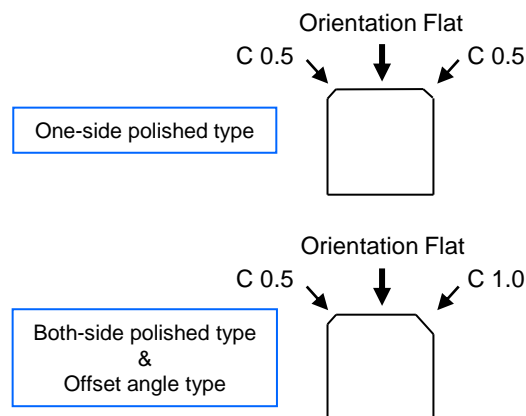
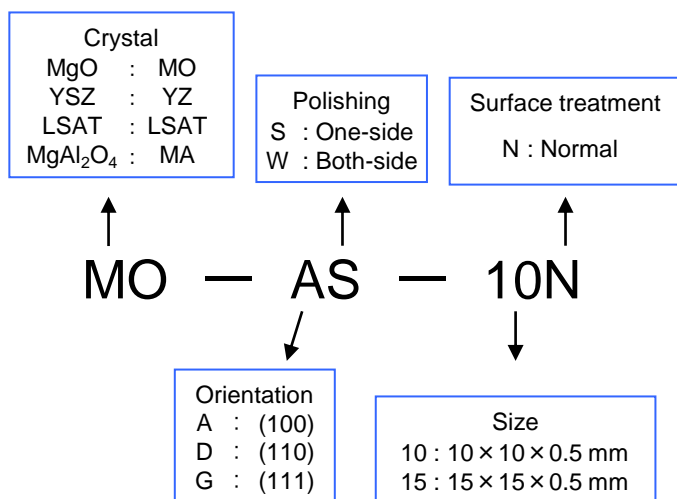
Orientation	Orientation flat	Size	One-side polishing	Both-side polishing
(100)	(010)	10x10x0.5mm	○	△
(111)	(110)	10x10x0.5mm	△	△

○ : Standard    △ : Made-to-order

If you are looking for different sizes, offset angle type and others, please contact us.  
\*Minimum order for made-to-order model and special model : 5pcs

## Model Number

## Orientation Flat



### <Visual check note>

We pass over the following:

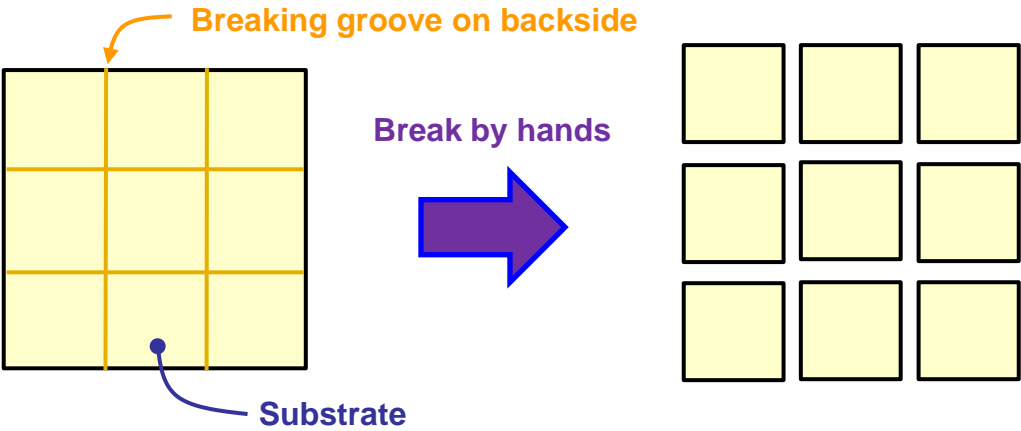
- (a) Chips within 0.2mm from the circumference of substrates
- (b) Chips on the edge strip under 1/2 size of substrate thickness
- (c) Scratches and blemish on the back side of single-side polished substrates

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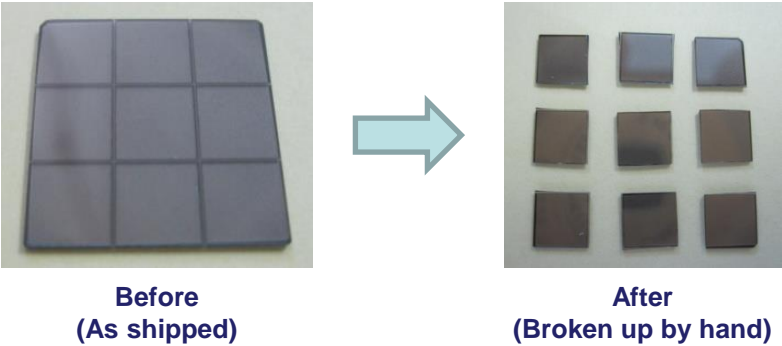
# Breakable Substrates

SHINKOSHA provides breakable substrates. Breaking grooves on backside make it easy to divide a substrate into small pieces.



No need to use a diamond cutter or other cutting machines! You can break a substrate **finely by your hands** as easily as cutting a chocolate bar.

Example:  
Nb:SrTiO<sub>3</sub>  
15x15x0.5mmt

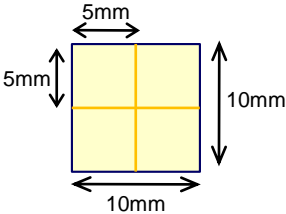


## Standard model

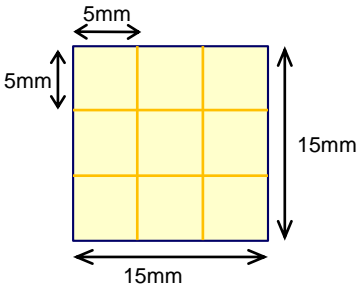
Material	Substrate size	Breakup pattern
SrTiO <sub>3</sub>	①10x10 mm  ②15x15 mm	①4 segments of 5x5 mm  ②9 segments of 5x5 mm
TiO <sub>2</sub>		
LaAlO <sub>3</sub>		
LSAT		
YSZ		
MgAl <sub>2</sub> O <sub>4</sub>		

\*Please feel free to ask us for other breakup patterns.

### ① For 10x10 mm substrate



### ② For 15x15 mm substrate



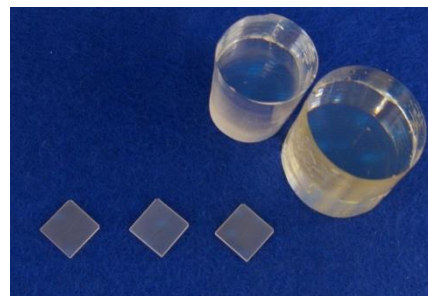
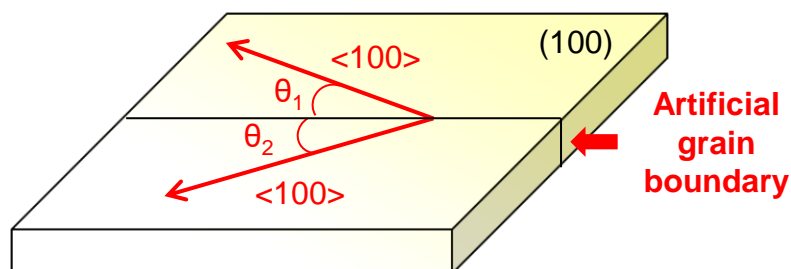
<Visual check note>

We pass over the following:

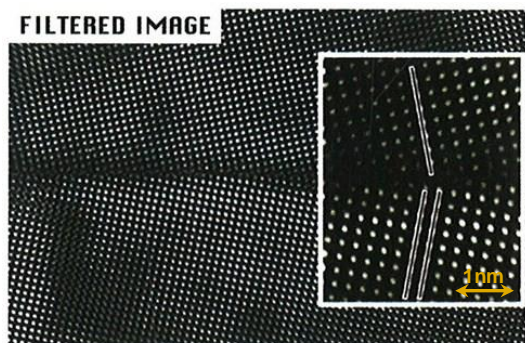
- (a) Chips within 0.2mm from the circumference of substrates
- (b) Chips on the edge strip under 1/2 size of substrate thickness
- (c) Scratches and blemish on the back side of single-side polished substrates
- (d) Chips from grooving process on the back side of substrates

# SrTiO<sub>3</sub> Bicrystal Substrate

Bicrystal substrates have an artificial grain boundary which is made by spliced two crystals with controlled crystal axis.



You can get a thin film with the designed grain boundary by epitaxial growth on a bicrystal substrate. Many bicrystal substrates are used for grain boundary research for understanding of the properties and basic research for device applications.



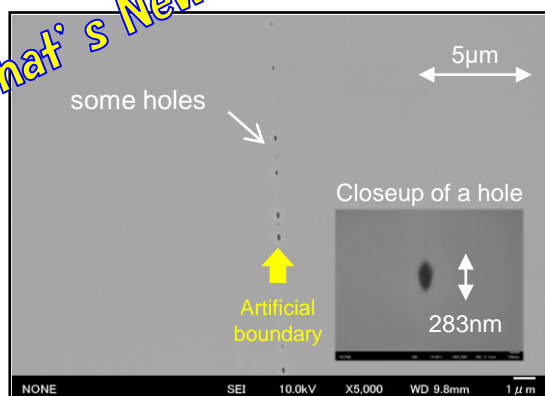
Electronic microscope image of bicrystal  
(from Ikuhara laboratory, University of Tokyo)

## 【Standard Specs】

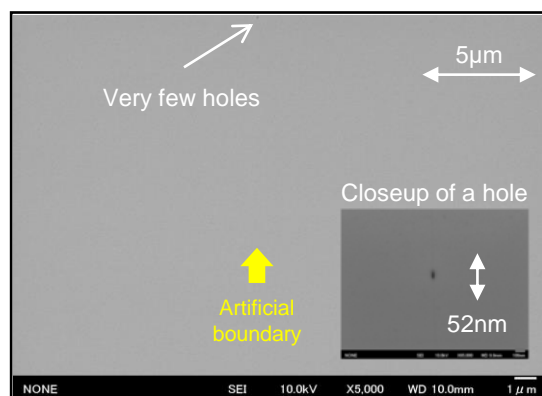
Crystal	SrTiO <sub>3</sub>		
Size	10 x 10 x 0.5 mm Tolerance (outside dimension) : ±0.1 mm Tolerance (thickness) : ±0.05 mm		
Orientation	(100)±0.5°		
Polishing	One-side		
Axis angle (2θ)	10.0°	22.6°	36.8°

If you are looking for other axis angle and crystals, please contact us.

What's New!



SEM image of Conventional products



SEM image of New model

**We succeeded in cutting back dramatically on voids of the bonded interface.**

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# Operating Suggestions for Oxide Single Crystal Substrates

## (1) Guaranteed figures

	Guaranteed figures
Size tolerance	$\pm 0.1\text{ mm}$
Thickness tolerance	$\pm 0.05\text{ mm}$
Orientation tolerance <sub>1)</sub>	$\pm 0.5^\circ$
Orientation flat tolerance	$\pm 1.0^\circ$
Flatness <sub>2)</sub>	10 × 10 × 0.5 mm substrate : $\leq \lambda$ 15 × 15 × 0.5 mm substrate : $\leq 1.5\lambda$ ( $\lambda=632.8\text{nm}$ )

1) STEP substrates :  $\pm 0.3^\circ$  , OFF substrates : Designed OFF angle  $\pm 0.1^\circ$

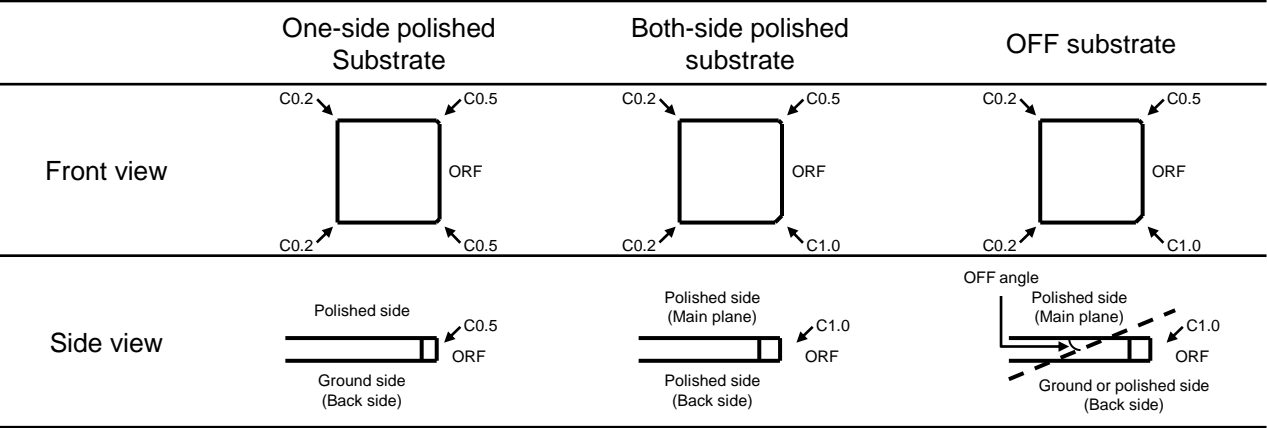
2) Excluding LaAlO<sub>3</sub>, MgO and MgAl<sub>2</sub>O<sub>4</sub> substrates

## (2) Cleaning of substrates

- Normal substrates :  
Standard cleaning is done, but we recommend an additional cleaning by yourself.
- STEP substrates :  
For 10 × 10 × 0.5 mm and 15 × 15 × 0.5 mm size substrates, precision cleaning and special packing are done, so that there is no need for additional cleaning. For other sizes, standard cleaning and packing are done. We recommend an additional cleaning by yourself.

## (3) Orientation Flat (ORF)

- Standard size substrates have “Orientation Flat Markings” (size C0.5 or C1.0) at the corners as below .



## (4) Main plane

- We can only assure the quality of “Main plane” for both-side polished substrates (including STEP substrates) due to the nature of our manufacturing process. Please use “Main plane” for your work.

## (5) Visual check note

- We pass over the following:
  - (a) Chips within 0.2mm from the circumference of substrates
  - (b) Chips on the edge strip under 1/2 size of substrate thickness
  - (c) Scratches and blemish on the back side of single-side polished substrates

## (6) Crystallinity

- LaAlO<sub>3</sub> substrates contain twins.
- SrTiO<sub>3</sub>, TiO<sub>2</sub>, MgO and YSZ substrates may contain small sub-grain boundaries due to the nature of their manufacturing process. It may be shown in multi peaks in their X-ray rocking curve.

If you have any questions, please feel free to contact us.