



Industry-leading sapphire products  
for next-generation product development and R&D

**Orbray**



## NAPHIA™ Series

Orbray Co., Ltd., has manufactured a variety of sapphire substrates during the era of LED adoption, and the crystal growth / cleaning / polishing technology we've cultivated through this has evolved further to support the next generation of device development. Our new series of substrates, the NAPHIA™ series, is primarily suited for research and development of new semiconductor devices, and can preclude problems caused by other substrates.

In addition to the conventional standard grade, we also offer prime grade, which has a higher level of flatness and cleanliness. Furthermore, with precision cleaning and re-polishing, it can be used repeatedly, contributing to a reduction in total cost.

NAPHIA™  
Sapphire wafers  
Standard grade / Prime grade

NAPHIA™  
Carrier wafers

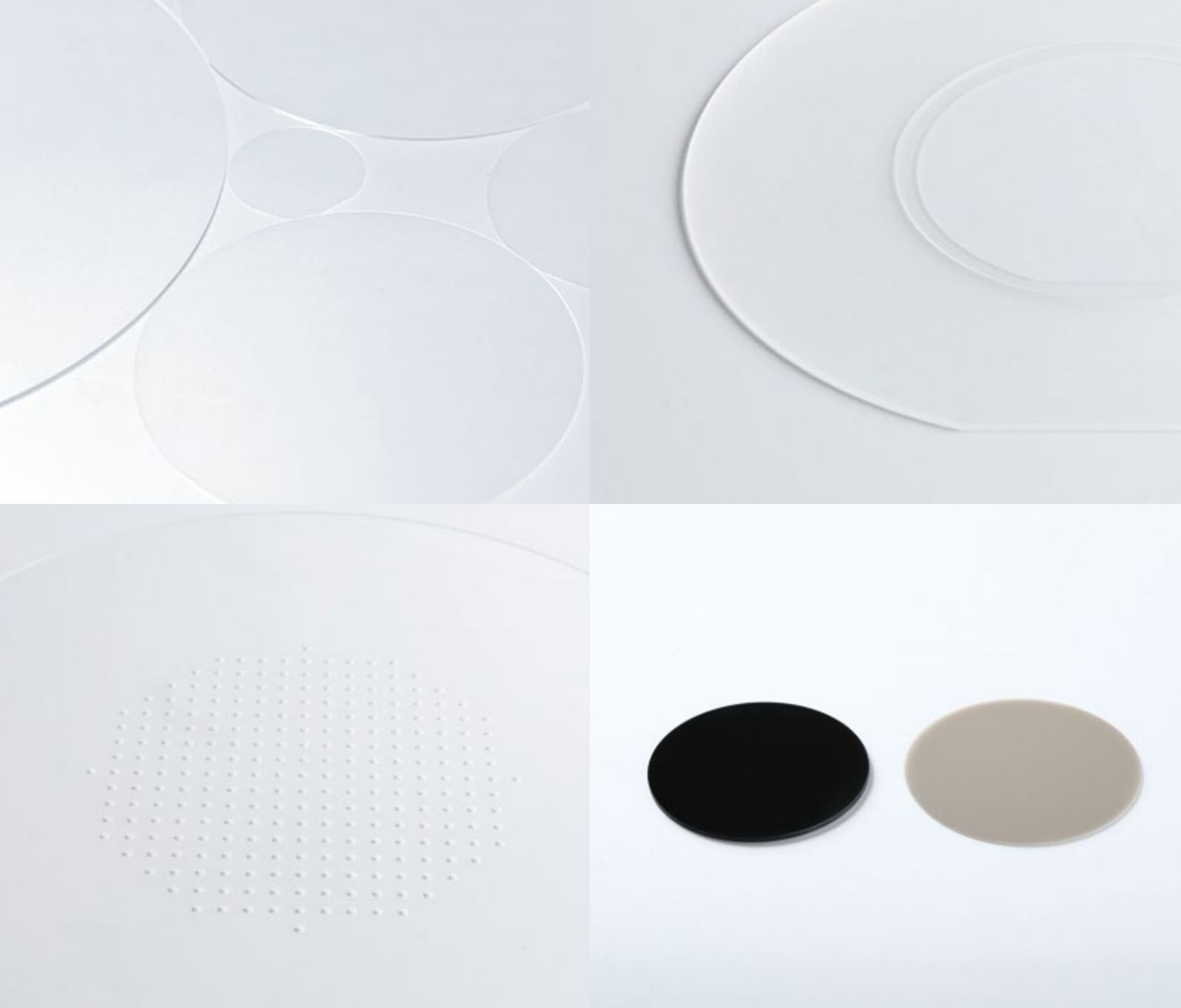
NAPHIA™  
Sapphire setters (firing process tools)

NAPHIA™  
Optical flat lenses/covers

NAPHIA™  
Through-hole wafers

NAPHIA™  
Ceramic wafers

NAPHIA™  
Contract processing



## Orbray's high-quality polishing technology

Utilizing our precision processing, we can customize the off-cut angle and ensure high-quality cleaning to support such applications as epitaxial growth and wafer bonding.

We also offer prime grade wafers, which are characterized by high flatness ( $TTV < 2\mu\text{m}$ ), low metal contamination ( $\text{K, Ti, Cr, Mn, Fe, Co, Ni, Cu, Zn} \leq 2\text{E}10/\text{cm}^2$ ), and low particle contamination ( $[\text{Particle size} \geq 0.3\mu\text{m}] \leq 0.18\text{pcs}/\text{cm}^2$ ).

To meet recent demand for uses such as wafer bonding and other semiconductor processes, we offer high-quality polishing technology for various poly-crystal wafers in addition to sapphire, by applying our prime grade technology.

# NAPHIA™ Sapphire wafers

In addition to standard grade substrates for general LED use, we also offer high-quality prime grade wafers. The high-quality cleaning we apply to prime grade wafers results in low contamination from both particles and metal\*.

We control flatness (TTV, bow, warp, etc.) with our precision manufacturing technology, to minimize any warpage that can occur during epitaxial growth. Our prime grade wafer is optimal for development of new processes and new products. Applications for prime grade wafers include micro-LED, DUV-LED, RF devices, and GaN / AlN / Ga<sub>2</sub>O<sub>3</sub> templates.

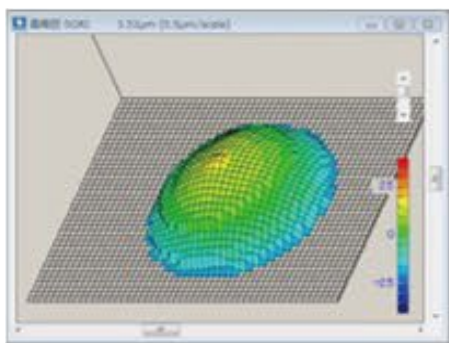
\* K, Ti, Cr, Mn, Fe, Co, Ni, Cu, Zn < 2E10/cm<sup>2</sup> with TXRF.

Item	Specifications			
	φ2inch	φ4inch	φ6inch	φ8inch
Material	Artificial sapphire (Al <sub>2</sub> O <sub>3</sub> ≥ 99.99%)			
Thickness	430±15μm	650±15μm	1300±20μm	1300±20μm
Surface orientation	c-plane (0001)			
OF length	16±1mm	30±1mm	47.5±2.5mm	47.5±2.5mm
OF orientation	a-plane 0±0.3°			
TTV*	≤10μm	≤10μm	≤15μm	≤15μm
Bow*	-10μm ~ 0μm	-15μm ~ 0μm	-20μm ~ 0μm	-25μm ~ 0μm
Warp*	≤15μm	≤20μm	≤25μm	≤30μm
Remarks	Epi-ready (Ra<0.3nm)			
Backside finishing	Lapping (Ra 0.6μm - 1.2μm)			
Packaging	Vacuum packaging in cleanroom			
Prime grade	High-quality cleaning: (particle size≥0.3μm) ≤0.18pcs/cm <sup>2</sup> , metal contamination ≤ 2E10/cm <sup>2</sup>			
Remarks	Customizable specifications: a-/ r-/ m-plane orientation, off-angle, shape, double-side polishing			

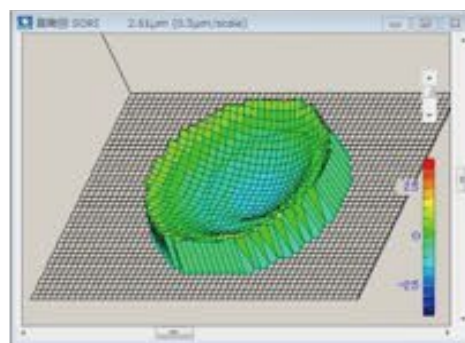
\*TTV (Total Thickness Variation): The difference between the maximum and minimum values of the wafer thickness.

\*Bow: The deviation of the center point of the median surface of a free, un-clamped wafer from the reference plane, where the reference plane is defined by the three corners of an equilateral triangle.

\*Warp: The difference between the maximum and the minimum distances of the median surface of a free, un-clamped wafer from the reference plane defined above.



+Bow (convex) : 2.61μm



-Bow (concave) : 3.53μm

## High-quality products and services for next-generation semiconductor devices and epitaxial growth

- High degree of flatness (controlled TTV, bow, warp etc.)
- High-quality cleaning (low particle contamination, low metal contamination)
- Substrate drilling, grooving, cutting, and backside polishing
- Attachment of data such as cleanliness and shape of substrate (optional)

Depending on the specs, we have inventory for substrates of 2 to 8 inches, or up to 300mm in diameter.

Please contact us for any inquiries.

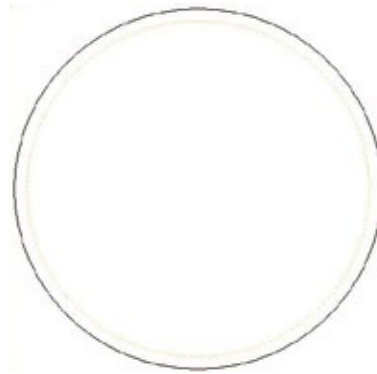
# NAPHIA™ Prime grade wafers

What is prime grade? Our prime grade sapphire wafer has best-in-class quality in terms of flatness and cleanliness. Aiming for the equivalent cleanliness as for silicon wafers, we have produced sapphire wafers with very low metal contamination ( $\leq 5E10/cm^2$ ). We are currently achieving lower metal contamination than  $2E10/cm^2$ , which is near the detection limit of our measuring instruments (TXRF).

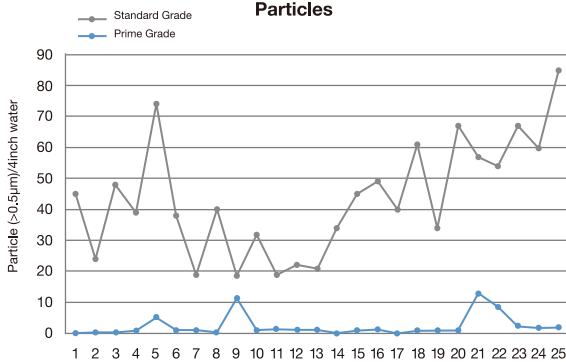
Standard grade



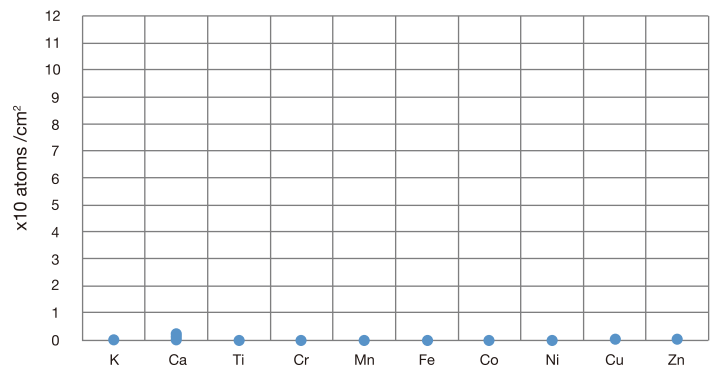
Prime grade



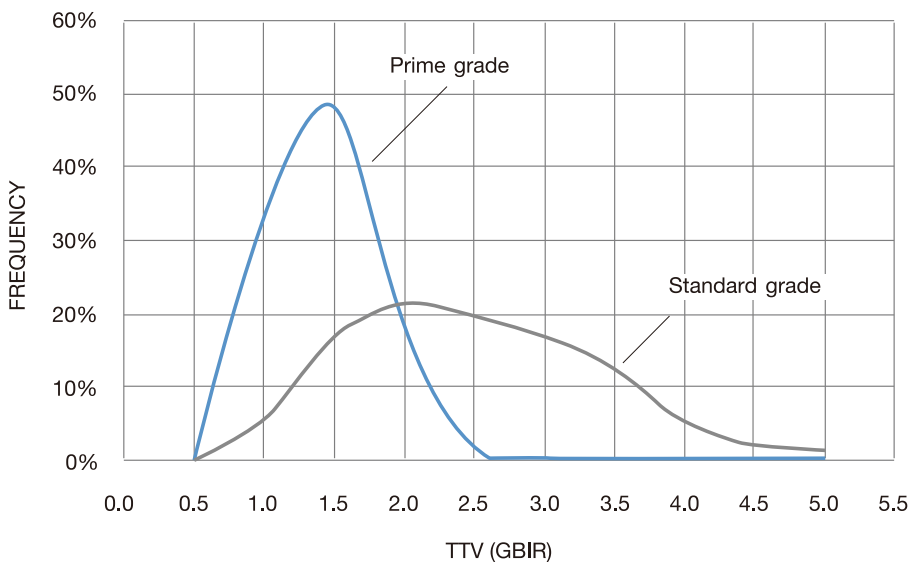
Particles



Metal contamination



TTV DISTRIBUTION



For single-side polished wafers, the TTV achieved is equivalent to that for double-side polished wafers.  
 \*TTV (GBIR) = Difference in thickness between maximum value and minimum value.

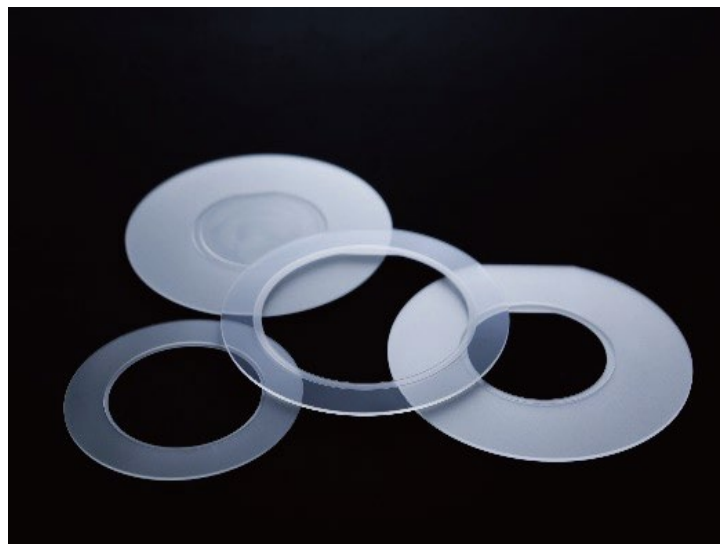
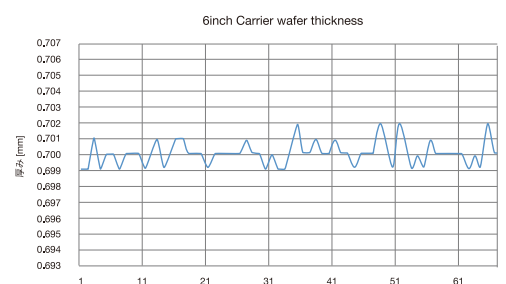
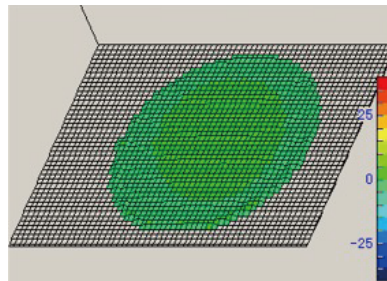
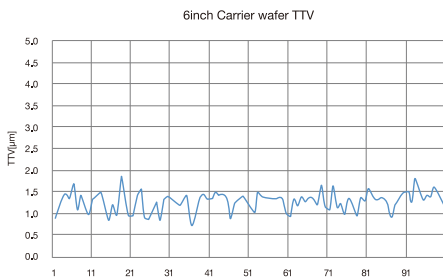
# NAPHIA™ Carrier wafers

NAPHIA™ sapphire is used in semiconductor processing as a carrier wafer, such as for a support in the handling of ultra-thin device wafers. Utilizing the polishing technology we have cultivated over many years, we are able to manufacture ultra-large support wafers and carrier plates with a diameter of up to 12 inches (300mm). The TTV of carrier wafers is a critical parameter, and our carrier wafer has best-in-class minimal TTV.

Furthermore, we have the capability of additional processing, such as drilling and grooving, which is available for all specifications. We also offer adapter wafers, which allow the use of small wafers in equipment designed for large wafers.

Compared to glass/ceramics, sapphire has excellent heat, chemical, and plasma resistance, so it can be used in high-temperature processes or harsh environments without distortion or deformation.

Item	Specifications				
	φ4 inch	φ5 inch	φ6 inch	φ8 inch	φ12 inch
Material	Artificial sapphire ( $Al_2O_3 \geq 99.99\%$ )				
Thickness	1±0.003mm				3±0.005mm
Orientation	c-plane (0001) / r-plane (-1012)				c-plane (0001)
OF	Flat / Notch / None				
TTV	≤2.5μm			≤3.0μm	
Frontside finishing	Polish (Ra<0.3nm)				
Backside finishing	Polish (Ra<0.3nm)				
Remarks	Customizable specifications: thickness, orientation, single-side polishing. Other options: drilling, laser marking, delivery by thickness classification, re-polishing				

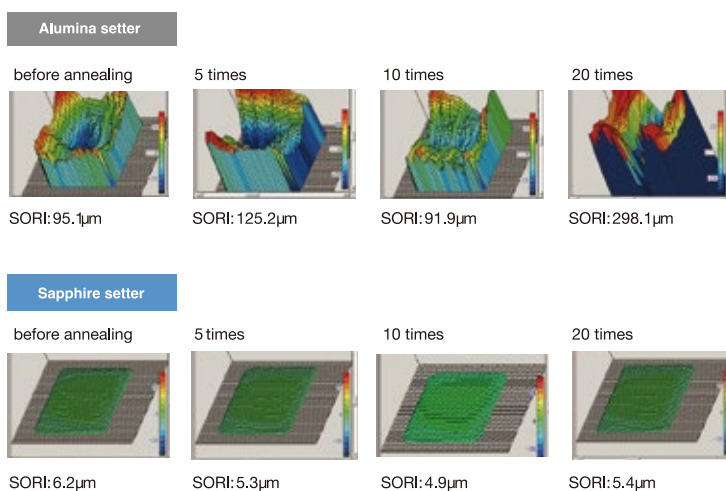
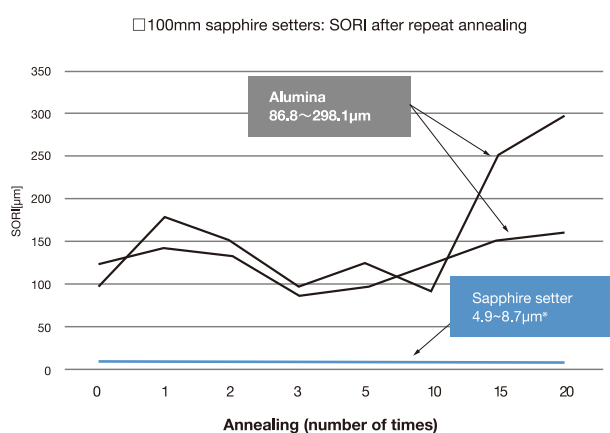


# NAPHIA™ Sapphire setters (firing process tools)

Compared with ceramic setters, our sapphire setters have the advantage of being resistant to deformation even with continuous use, due to the excellent heat resistance of sapphire. We can re-clean or re-process our sapphire setters to allow for reuse, for total cost reduction.

Item	Specifications	
Dimensions	100 × 100 ±0.5mm	150 × 150 ±0.5mm
Thickness	1 ±0.5mm	
SORI	≤20μm	≤40μm
Surface finishing	Both sides have matte finish Ra≤1μm	

For custom specs, please contact us.



Experiment: Deformation of sapphire setters after repeated annealing  
Example: 100mm×1mm thickness sapphire setters (both surfaces have matte finish)  
Annealing conditions: 1500°C, nitrogen in atmosphere, 8hours



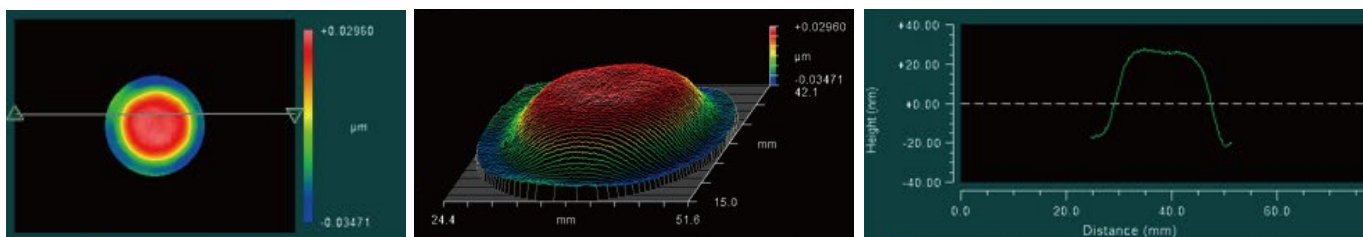


# NAPHIA™ Optical flat lenses / covers

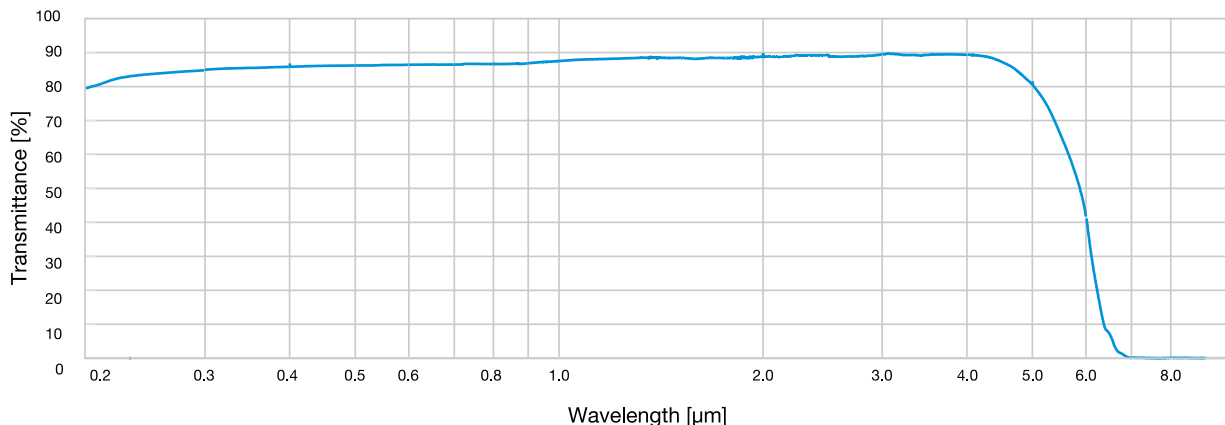
NAPHIA™ optical flat lenses / covers are optical windows and lenses that are ultra-precision processed in shape and flatness (indicated by  $\lambda$ ) for small diameters such as  $\Phi 1\text{mm}$  to  $\Phi 3\text{mm}$ , and large diameters such as  $\Phi 300\text{mm}$ . Both circular and square shapes are available. If the thickness is 3mm or more, we can provide a higher degree of flatness. Transparent materials with a minimal difference in thickness have such advantages as the ability to bond to different materials while maintaining flatness, and more uniform transmission of light. Sapphire, as a transparent material, allows for clear visibility of the bonded surface, and offers high temperature resistance, excellent thermal conductivity, scratch resistance, and high durability.

Item	Specifications						
Diameter	$\phi 1\text{mm} \sim$	$\phi 50\text{mm}$	$\phi 75\text{mm}$	$\phi 100\text{mm}$	$\phi 125\text{mm}$	$\phi 175\text{mm}$	$\phi 200\text{mm}$
Material	Artificial sapphire ( $\text{Al}_2\text{O}_3 \geq 99.99\%$ )						
Thickness	$0.5\text{mm} \sim$	1mm, 5mm, 10mm					
Orientation	c-plane (0001)						
Frontside finishing	Polish ( $\text{Ra} < 0.3\text{nm}$ )						
Backside finishing	Polish ( $\text{Ra} < 0.3\text{nm}$ )						
Remarks	Customizable specifications: diameter, thickness, orientation, etc. Other options: re-polishing						

Item	Specifications						
Diameter	$\square 1\text{mm} \sim$	$\square 25\text{mm}$	$\square 50\text{mm}$	$\square 75\text{mm}$	$\square 100\text{mm}$	$\square 125\text{mm}$	$\square 150\text{mm}$
Material	Artificial sapphire ( $\text{Al}_2\text{O}_3 \geq 99.99\%$ )						
Thickness	$0.5\text{mm} \sim$	1mm, 5mm, 10mm					
Orientation	c-plane (0001)						
Frontside finishing	Polish ( $\text{Ra} < 0.3\text{nm}$ )						
Backside finishing	Polish ( $\text{Ra} < 0.3\text{nm}$ )						
Remarks	Customizable specifications: diameter, thickness, orientation, etc. Other options: re-polishing						



Transmittance for c-plane sapphire (0.2~10 $\mu\text{m}$ , ultraviolet ~ infrared)



As sapphire provides uniform light transmittance across a wide range of wavelengths, and can be used in harsh environments, it is suitable for ultraviolet and infrared transmission windows and sensor covers. (We can customize lenses/covers according to customers' size requirements and other specifications, such as  $\lambda$  to  $\lambda/20$ .)

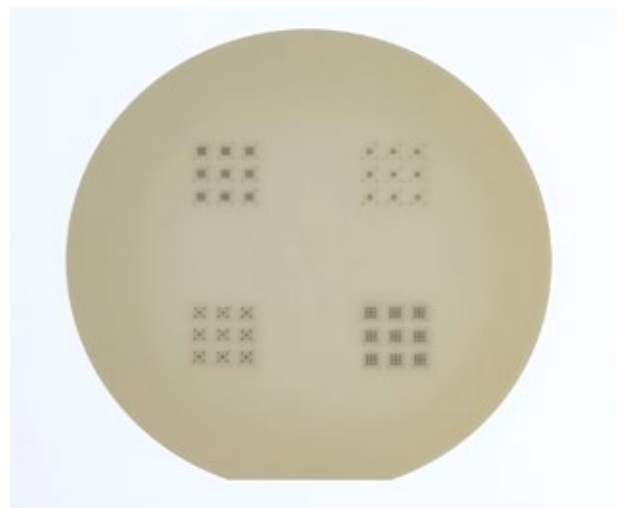
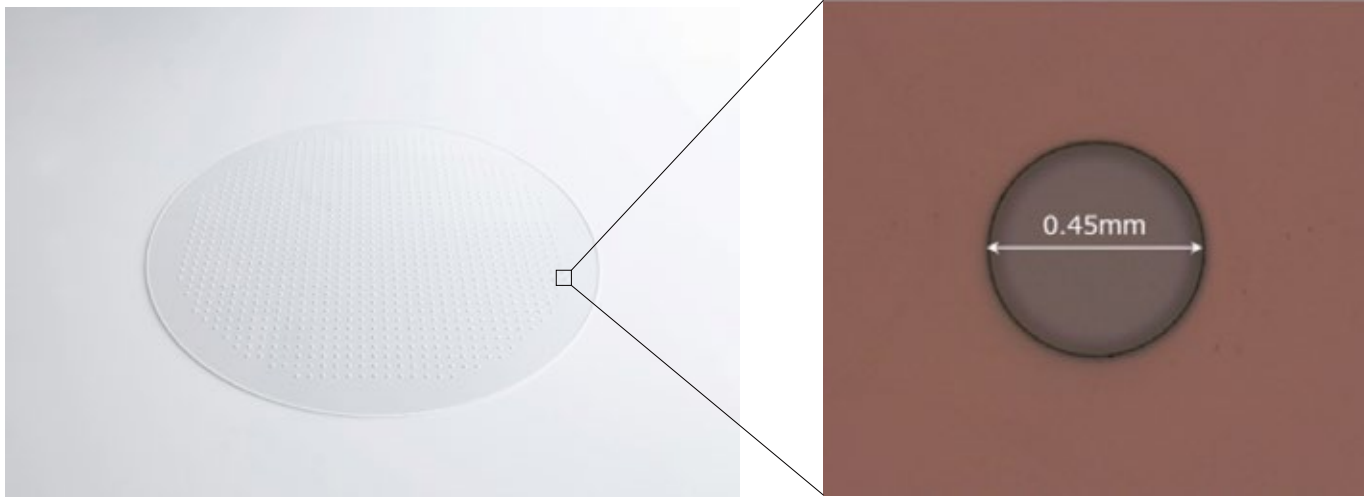
Sapphire is also used for high-end watch crystals. Moreover, in recent years, it has been increasingly adopted for exterior parts for smartphones and smartwatches, with new product designs often incorporating sapphire.



# NAPHIA™ Through-hole wafers (sapphire, AlN, SiC, etc.)

We have drill and laser processing capability. Our NAPHIA™ through-hole sapphire wafers have high surface quality equivalent to that of bare sapphire wafers, and are suitable for semiconductor processing.

We can make through-hole wafers not only from sapphire, but also from other materials (ceramics, silica glass, etc.).



	Example 1	Example 2	Typical value
Hole diameter [ $\mu\text{m}$ ]	$\phi 100\mu\text{m}$	$\phi 700\mu\text{m}$	$\phi 50\mu\text{m} \sim 1000\mu\text{m}$
Material diameter [mm]	$\phi 150\mu\text{m}$	$\phi 80\mu\text{m}$	$\sim \phi 200\mu\text{m}$
Material thickness [mm]	0.5mm	1mm	0.25~1mm
TTV [ $\mu\text{m}$ ]	$\leq 10\mu\text{m}$	$\leq 2\mu\text{m}$	$\leq 10\mu\text{m}$
Number of holes	150 holes / wafer	600 holes/ wafer	-

# NAPHIA™ Ceramic wafers (AlN · SiC)

Our NAPHIA™ ceramic wafers are appropriate for semiconductor processes, thanks to the processing technology we have developed through our extensive experience with sapphire wafer polishing. We are able to process any material with minimal damage or grain boundary fractures on the wafer surface, and to a high degree of flatness.

Furthermore, we can do hole processing and cutting of ceramic wafers.

Aluminum Nitride



Silicon Carbide

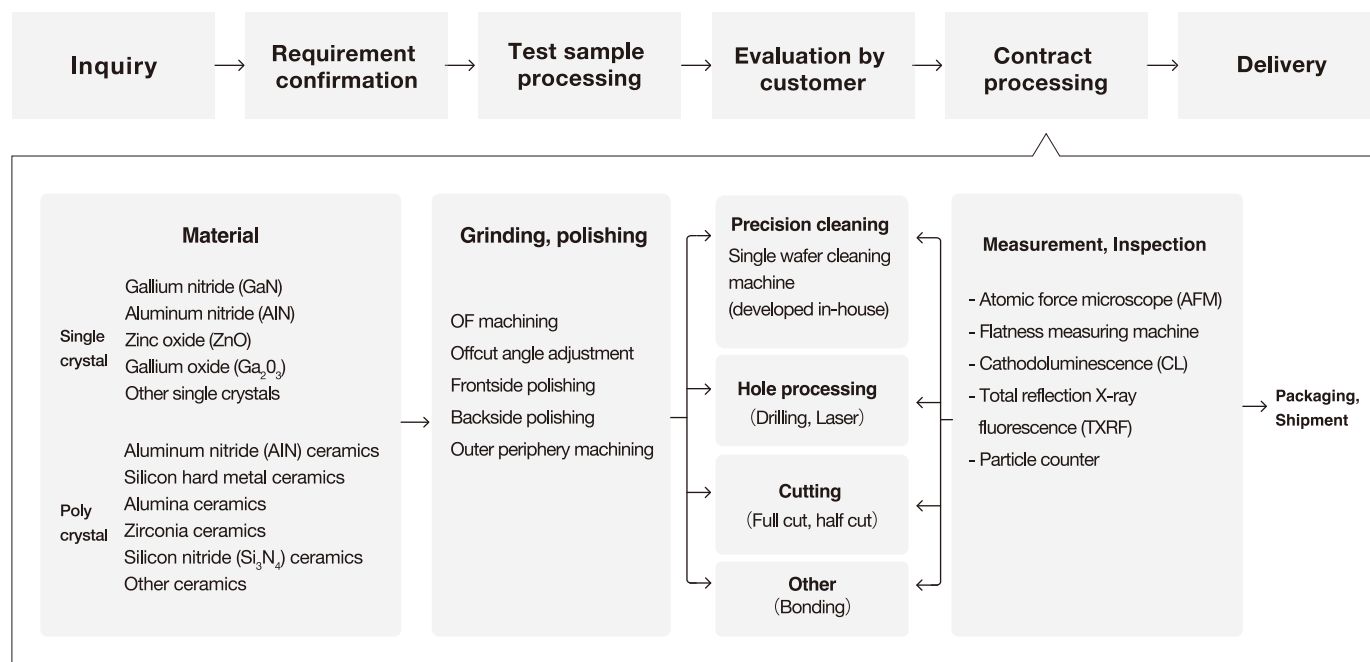


Material		SiC (Poly crystal)	
Polishing		CMP	Mechanical polishing
Surface Roughness	Ra AFM	0.45nm	0.12nm
	P-V AFM	5.75nm	0.97nm
Shape	P-V (SORI) ※ F.T	1.73μm	1.65μm

※Flatness Tester

# NAPHIA™ Contract processing

Utilizing our polishing technology for high-hardness sapphire material, we do contract polishing and grinding of various materials, such as aluminum nitride ceramics, alumina ceramics, and zirconia ceramics. In addition, we can polish single crystals such as gallium nitride (GaN), aluminum nitride (AlN), zinc oxide (ZnO), gallium oxide (Ga<sub>2</sub>O<sub>3</sub>), and yttrium aluminum garnet (YAG). Please feel free to contact us with any request, as we can also process materials other than those listed. We also offer fine hole processing (drill/laser processing), bonding (atomic bonding), backside polishing, and full cutting (groove processing). For single-crystal materials, we support wafer processing, such as orientation flat processing and off-angle adjustment.



We have a variety of other processes available; please contact us.

## Contract processing

Processing	Processing equipment	Work		Processing accuracy
		Maximum size	Maximum thickness	
Cutting	Peripheral blade cutting machine	□200mm	5mm	±0.5mm
	Inner peripheral blade cutting machine	φ8 inchL150mm	10mm	±0.1mm
	Wire cutting machine	φ8 inchL300mm	3mm	±0.03mm
	Dicing machine	□150mm	1.5mm	±0.02mm
Surface grinding	Surface grinder	600×300mm	200mm	0.03mm
	Horizontal grinder	φ5 inch	50mm	±0.01mm
	Vertical grinder	φ8 inch	100mm	
	Double-side lapping machine	φ12 inch	30mm	
Outer periphery grinding	Cylindrical grinder	φ8 inch	300mm	±0.01mm
	Centerless grinder	L150mm	20mm	0.01mm
	NC machine	φ300mm	Depends on the processing (please contact us)	
Surface polishing	Double-side lapping machine (Diamond/CMP)	φ12 inch	30mm	±0.005mm
	One side polishing machine	φ 6 inch	50mm	
Drilling	Micro drilling	φ12 inch	10mm	φ0.25mm
	Laser processing machine	φ6 inch	See below	

Laser type	Minimum hole diameter	Minimum pitch	Accuracy	Maximum processing thickness
Femtosecond laser	φ0.05mm	0.08mm	0.25mm	±0.01mm
UV laser	φ0.23mm	0.5mm	0.8mm	±0.015mm

\*Above are typical values. For customization, please contact us.

# Orbray



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Specifications and product design are subject to change without notice.

Adamant Namiki Precision Jewel Co., Ltd. changed its name to Orbray Co., Ltd., effective January 1, 2023.