$SrTiO_3$

$SrTiO_3$ is an excellent and wide applied high Tc superconductive single crystalline substrate. Its lattice constant (3.905Å) fits the common high Tc superconductive material YBCO (3.88 Å) very well. It has twin-less crystal structure and very good physical and mechanical properties for film growth. It is suitable for various high Tc films such as YBCO, Bi-system, La-system and others. It is also suitable for different film growth technologies such as Magnet Sputtering, Pulsed Laser Deposition (PLD), Vapourization, MOCVD, CVD, and laser MBE etc. Films made by these materials and technologies on SrTiO3 substrate have excellent performance, for instance Tc > 90°, Jc> = $10^6 A/cm^2$.

Basic Properties

Crystal Structure	**Cubic m3m, Peroviskite**
Cell Parameter	a=3.905Å
Melting point	2353K
Density	$5.117 g/cm^3$
Specific Heat	0.544J/g·k (300K)
Thermal Conductivity	11.2W/m·k
Thermal Expansion	$9.4x10^{-6}k^{-1}$
Dielectric Constant (ε_r)	300(295K), 2000(80K), (7-15GHz)
Dielectric Loss (tgδ)	$5x10^{-4}$(295K), $2.5x10^{-4}$(80K), Microwave
Mohs Hardness	6-6.5
Growth Method	Flame

Substrate Specifications

Standard Size	Φ25，20x20，10x10，10x5，10x3mm, or customer design
Thickness	0.5mm，1.0mm
Thickness Tolerance	±0.02mm or ±0.005mm for special order
Polish	one or two sides
Orientation	[100], [110], [111]
Orientation Accuracy	±0.5°
Edge Orientation Accuracy	2°(or 1°for special order)
Cut with Special Tilt Angle	available (tilt angle: 1°—45°)
Micro Roughness Ra	≤5Å（5μm×5μm）

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MgO

Magnesium Oxide substrate is widely used for various films: magnet film, semiconductive film, optical film as well as high Tc superconductive film. MgO crystal is possible to get large size (larger than 2 inch) and has low dielectric loss in microwave band, so it is an important material for high Tc superconductive microwave devices in the mobile communication as well as other industrial areas.

Basic Properties

Crystal Structure	Cubic, m3m, NaCl Type
Cell Parameter	a = 4.213 Å
Melting Point	3250K
Density	3.58g/cm^3
Specific Heat	0.879J/g·k (298K)
Thermal Conductivity	59W/m·k (300K)
Thermal Expansion	11x10^{-6}k^{-1}(300K)
Dielectric Constant (ε_r)	9.8(295K), 9.7(80K), (17-28GHz)
Dielectric Loss (tgδ)	3.5x10^{-6}(80K) microwave
Mohs Hardness	5.5
Growth Method	Arc Melt

Substrate Specifications

Standard Size	Φ2″ , 2"x2", 20x20, 10x10, 10x5,10x3mm, or customer design
Thickness	0.5mm，1.0mm
Thickness Tolerance	±0.02mm or ±0.005mm for special order
Polish	one or two sides
Orientation	[100], [110], [111]
Orientation Accuracy	±0.5°
Edge Orientation Accuracy	2°（or 1°for special order）
Cut with Special Tilt Angle	available (tilt angle:1°—45°)
Micro Roughness Ra	≤5Å（5μm×5μm）

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$LaAlO_3$

$LaAlO_3$ single crystal has a lattice constant (a=3.790 Å) which fits high Tc superconductive material (such as YBCO: 3.86 Å) very well, proper dielectric constant and low dielectric loss in microwave band, so it is suitable for high Tc microwave electronic devices (for example high Tc superconductive filter in mobile communication). It is grown by Czechrolsky method, possible to get large size (2"and 3" in diameter) and high quality crystal and substrate. It is an important substrate that has been applied in communication industry.

Basic Properties

Crystal Structure	Triclinic, m3m, Peroviskite
Cell Parameter	a = 3.790Å, α=90˚5', Pseudo-cubic
Melting Point	2373K
Density	6.52g/cm^3
Specific Heat	0.427J/g·k（298K）
Thermal Conductivity	11.6W/m·k (300K)
Thermal Expansion	11.6x10^{-6}k^{-1} (940K)
Dielectric Constant (ε_r)	24 (295K), 23.7 (80K), (18-35GHz)
Dielectric Loss (tgδ)	6x10^{-6} (80K) Microwave
Mohs Hardness	6.5
Growth Method	Czokralski

Substrate Specifications

Standard Size	ϕ3″, ϕ2″, ϕ1″, 20x20, 10x10, 10x3mm, or customer design
Thickness	0.5mm, 1.0mm
Thickness Tolerance	±0.02mm or ±0.005mm for special order
Polish	one or two sides
Orientation	[100], [110], [111]
Orientation Accuracy	±0.5°
Edge Orientation Accuracy	2°（or 1°for special order）
Cut with Special Tilt Angle	available (tilt angle:1°—45°)
Micro Roughness Ra	≤5Å（5μm×5μm）

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ZrO_2 (YSZ)

Zirconium Oxide is one of the early developed substrate and is used as many kinds of films. ZrO_2 needs a doping of element Yttrium to stabilize its crystal structure so it is called YSZ (Yttrium stabilized Zirconium oxide) normally. It has good mechanical, physical and chemical properties for films.

Basic Properties

Crystal Structure	cubic，m3m
Cell Parameter	a = 5.147 Å
Melting Point	2973K
Density	6.0g/cm^3
Specific Heat	10.3J/g • k
Dielectric Constant (ε_r)	27
Mohs Hardness	8-8.5
Growth Method	Arc Melt

Substrate Specifications

Standard Size	Φ1″ , 1"x1", 20x20, 10x10, 10x5, 10x3mm, or customer design
Thickness	0.5mm，1.0mm
Thickness Tolerance	±0.02mm or ±0.005mm for special order
Polish	one or two sides
Orientation	[100], [110], [111]
Orientation Accuracy	±0.5°
Edge Orientation Accuracy	2°（or 1°for special order）
Cut with Special Tilt Angle	available (tilt angle: 1°－45°)
Micro Roughness Ra	≤5Å（5μm×5μm）

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LSAT

LSAT (Lanthanum Strontium Aluminum Tantalum Oxide) is a newly developed multi-functional substrate. It is grown by Czockralski method and possible to get large size (larger than 2" in diameter) and good quality by accurate controlling of the temperature distribution and growth rate. LSAT has less structure defect, no domain, no twin structure. It also has low dielectric loss in microwave band.

Basic Properties

Approximately Molecular Form	$(La_{0.3}Sr_{0.7})(Al_{0.65}Ta_{0.35})O_3$
Crystal Structure	Cubic m3m Mixed Peroviskite
Cell Parameter	a=7.737 Å
Melting Point	2113K
Density	6.64g/cm^3
Specific Heat	0.57J/g.k (295K)
Thermal Conductivity	5.1W/m.k
Thermal Expansion	$8.2x10^{-6}k^{-1}$ (295K), $11x10^{-6}k^{-1}$ (973K)
Dielectric Constant（ε_r）	22.7(291K/1MHz), 21.7(90K/10kHz)
Dielectric Loss（tgδ）	$7.47x10^{-5}$ (90K/10kHz)
Mohs Hardness	6.5
Growth Method	Czokralski
Color	None or Light yellow (if needed)

Substrate Specifications

Standard Size	Φ2″, Φ1″, 20x20, 10x10, 10x5, 10x3mm, or customer design
Thickness	0.5mm，1.0mm
Thickness Tolerance	±0.02mm or ±0.005mm for special order
Polish	one or two sides
Orientation	[100], [110], [111]
Orientation Accuracy	±0.5°
Edge Orientation Accuracy	2°（or 1°for special order）
Cut with Special Tilt Angle	available (tilt angle: 1°—45°)
Micro Roughness Ra	≤5Å（5μm×5μm）

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$LiGaO_2$

The lattice parameter of Lithium Dioxogallate ($LiGaO_2$) crystal can match with the Gallium Nitride film very well. The mismatch coefficients are 0.2% only for $LiGaO_2$ much smaller than that of the common used substrates such as [0001] sapphire (14%), [100] MgO (3%), [0001] SiC (3.5%). The Gallium Nitride film is a very important material for blue, violet, UV and white LED. A substrate material that matches the film to be grown well is very important to get a nice GaN epitaxial film.

Basic Properties

Substrate	$LiGaO_2$
Crystal Structure	mm2, Orthorhomnic
Cell Parameter	a = 5.402Å, b = 6.372Å, c = 5.007Å
Melting Point	1858 K
Density	4.187 g/cm^3
Thermal Expansion (x10^{-6}k^{-1})	α_a=11.8, α_b=12.5, α_c=3.7 (300K) α_a=15.5 , α_b=20.5, α_c=25.2 (1100K)
Dielectric Constant (1kHz, Room Temperature)	ε_a = 7.0, ε_b= 6.5, ε_c= 8.3
Mohs Hardness	5
Growth Method	Czockralski

Substrate Specifications

Standard Size	Φ20, 20x20, 10x10, 10x5, 10x3mm or customer design
Thickness	0.5mm, 1.0mm
Thickness Tolerance	±0.02mm or ±0.005mm for special order
Polish	one or two sides
Orientation	[100], [110], [111]
Orientation Accuracy	±0.5°
Edge Orientation Accuracy	2°（or 1°for special order）
Cut with Special Tilt Angle	available (tilt angle: 1°－45°)
Micro Roughness Ra	≤5Å（5μm×5μm）

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$LiAlO_2$

The lattice parameter of Lithium Aluminium Oxide (γ) ($LiAlO_2$) crystal can match with the Gallium Nitride film very well. The mismatch coefficients is 1.4% only for $LiAlO_2$, much smaller than that of the common used substrates such as [0001] sapphire (14%), [100] MgO (3%), [0001] SiC (3.5%). The Gallium Nitride film is a very important material for blue, violet, UV and white LED. A substrate material that matches the film to be grown well is very important to get a nice GaN epitaxial film.

Basic Properties

Substrate	$LiAlO_2$
Crystal Structure	422 Tetragonal
Cell Parameter	a = 5.1687Å, c = 6.2676Å
Melting Point	1973 K
Density	2.615 g/cm³
Thermal Expansion	α_a= 7.1x10^{-6}k^{-1}, α_c= 15x10^{-6}k^{-1} (393-973K)
Hardness	6.5（Mohs）
Growth Method	Czockralski

Substrate Specifications

Standard Size	Φ20, 20x20, 10x10, 10x5, 10x3mm or customer design
Thickness	0.5mm, 1.0mm
Thickness Tolerance	±0.02mm or ±0.005mm for special order
Polish	one or two sides
Orientation	[100], [110], [111]
Orientation Accuracy	±0.5°
Edge Orientation Accuracy	2°（or 1°for special order）
Cut with Special Tilt Angle	available (tilt angle: 1°－45°)
Micro Roughness Ra	≤5Å（5μm×5μm）

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GGG

Gadolinium Gallium Garnet ($Gd_3Ga_5O_{12}$) is a magneto-optical and microwave substrate. It is the best substrate material for infrared optical isolator (1.3μm and 1.5μm), which is a very important device in optical communication. It is made of YIG or BIG film on the GGG substrate plus birefringence parts. Also GGG is an important substrate for microwave isolator and other devices, its physical, mechanical and chemical properties are all good for the above applications.

Basic Properties

Molecular Form	$Gd_3Ga_5O_{12}$
Crystal Structure	Cubic, m3m, Garnet
Cell Parameter	a = 12.383 Å
Melting Point	2098K
Density	7.08 g/cm^3
Specific Heat	0.3812J/g·k
Thermal Conductivity	7.05W/m·k
Thermal Expansion	9.18x10^{-6}k^{-1}
Dielectric Constant（ε_r）	12.11
Mohs Hardness	6
Growth Method	Czockralski

Substrate Specifications

Standard Size	Φ25, Φ20, 20x20, 10x10, 10x5, 10x3mm or customer design
Thickness	0.5mm, 1.0mm
Thickness Tolerance	±0.02mm or ±0.005mm for special order
Polish	one or two sides
Orientation	[100], [110], [111]
Orientation Accuracy	±0.5°
Edge Orientation Accuracy	2°（or 1°for special order）
Cut with Special Tilt Angle	available (tilt angle: 1°－45°)
Micro Roughness Ra	≤5Å（5μm×5μm）

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