



# PRODUCT PREFERENCE GUIDE

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- C. Scintillation crystal Array

**锦虹晶体材料（上海）有限公司**

KINHENG CRYSTAL MATERIAL (SHANGHAI) CO., LTD.

TEL: +862160490170 Fax: +862163063530

[www.kinheng-crystal.com](http://www.kinheng-crystal.com)

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## A. Company profile:

Kinheng was founded by Mr. Wei LJ(Ph.D) who used to work in Chinese academy science about material science before his own business. There have two subsidiaries branch Kinheng crystal material(shanghai) co., Ltd. and K&HJJ Tech (Beijing) Co., LTd. in shanghai & Beijing for both International and domestic business.

We are committed to engineering and growing single scintillation crystal Materials. We have successfully developed and grown many scintillator materials including: NaI(Tl) ,CsI(Tl), CsI(Na) etc in the past few years. These crystals have been found widely used in high energy physics, nuclear medical imaging, Oil logging industry, Radiation detection instrumentation and environmental protection application etc.

Supported by Czochralski & Bridgman growth techniques, our precision mechanic, surface treatment and encapsulation to meet multi-application. Customization upon request is also available.

## Crystal growth:

At present we provide two kinds of growth method (Bridgman growth and Czochralski growth) crystal to meet different requests from low-end and high-end customers in market.

We wish to provide lowest price with highest standard quality materials to customers. Czochralski growth crystals are better in uniformity, energy resolution, counting rate, light output, appearance (especially for the long scintillator) and low afterglow.

We would be pleased to cooperate with you in your application. We continue to focus on enhancing "Technology, Innovation, Value" in high quality material science under regulation of ISO 9001:2008.

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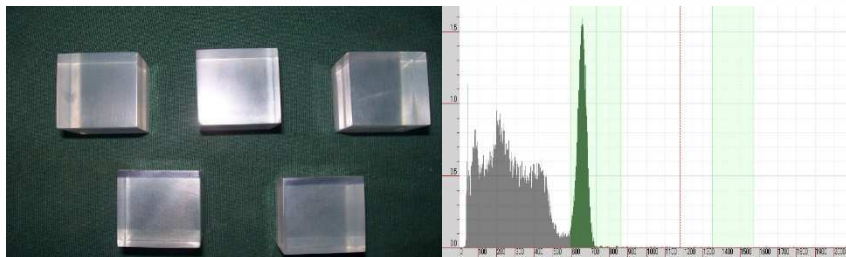
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**B: Scintillation crystal**
**1: CsI(Tl) scintillation crystal, CsI(Tl) scintillator**

CsI(Tl) crystal's Wavelength is 550nm which allows Si-photodiodes to be used to detect the emission. Scintillator-photodiode pair makes it's possible to diminish the size of the detecting assembly (Because of small size Si-PIN), high-voltage supply and magnetic shielding. The high radiation resistance (up to  $10^2$  Gy) allows CsI(Tl) to be used in radiation detection, X ray imaging and high energy physics application area. Special treatment ensures obtained CsI(Tl) scintillators with a low afterglow which makes excellent performance in security inspection and nuclear imaging. Our Czochralski method growth technique to meet different high end application.

**Properties:**

Density [g/cm <sup>3</sup> ]	4.51
Melting point [K]	894
Thermal expansion coefficient [K <sup>-1</sup> ]	$54 \times 10^{-6}$
Cleavage plane	none
Hardness (Mho)	2
Hygroscopic	Slightly
Wavelength of emission maximum [nm]	550
Lower wavelength cutoff [nm]	320
Refractive index at emission maximum	1.79
Primary decay time [μs]	1
Afterglow (after 6ms) [%]	0.5 - 5.0
Light yield [photons/MeVγ]	$52- 56 \times 10^3$
Photoelectron yield [% of NaI(Tl)] (γ rays)	45


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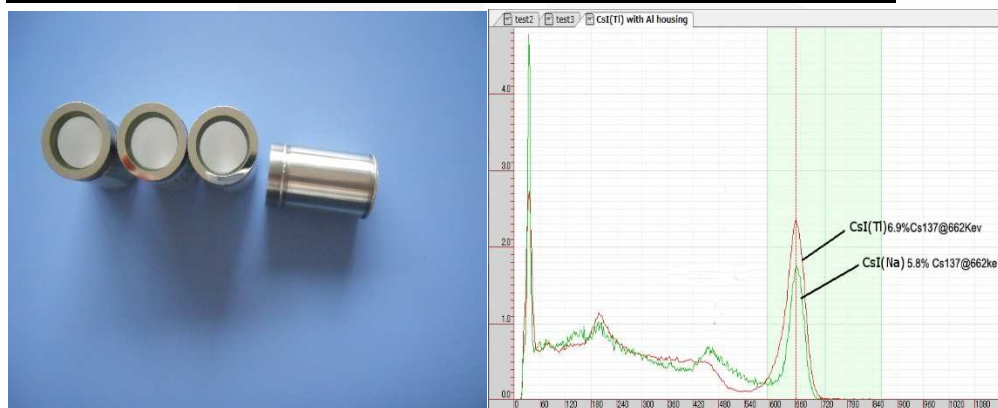


## 2. CsI(Na)scintillation crystal, CsI(Na) scintillator

CsI(Na) is another widely used material nowadays. It's High light output (85% of NaI(Tl)), emission in the blue spectral region (in coincidence with the maximum sensitivity range of the most popular PMT with bialkali photocathodes). Lower hygroscopicity in comparison with NaI(Tl) to make this material alternative for NaI(Tl) in many standard applications. The temperature dependence of light output can be 80°C max. The decay time of CsI(Na) depends on the dopant concentration, it's an excellent material in oil logging industry.

### Properties:

Density [g/cm <sup>3</sup> ]	4.51
Melting point [K]	894
Thermal expansion coefficient [K <sup>-1</sup> ]	54 x 10 <sup>-6</sup>
Cleavage plane	none
Hardness (Mho)	2
Hygroscopic	yes
Wavelength of emission maximum [nm]	420
Lower wavelength cutoff [nm]	300
Refractive index at emission maximum	1.84
Primary decay time [μs]	0.63
Light yield [photons/MeVγ]	38-44x10 <sup>3</sup>
Photoelectron yield [% of NaI(Tl)] (γ rays)	85



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### 3. NaI(Tl)scintillation crystal, NaI(Tl) scintillator

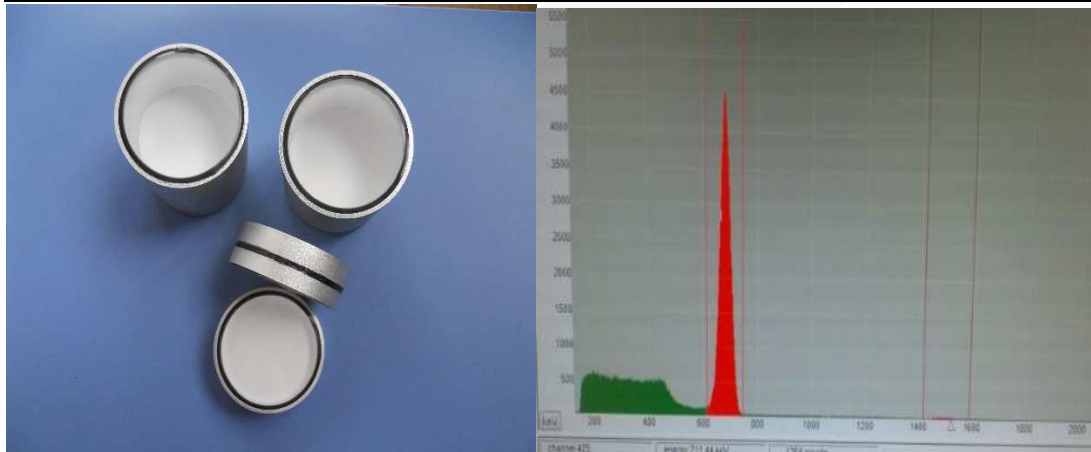
NaI(Tl) is the most widely used scintillation material because of its Performance/price rate. NaI(Tl) is used in nuclear medicine, environmental measurements, geophysics, medium-energy physics, Radiation detection etc. It has high light output, convenient emission range (in coincidence with maximum efficiency region of photomultiplier (PMT) with bialkali photocatodes), large-size growth and lowest price rate compared to other scintillation materials. As it's easy to be hygroscopic, NaI(Tl) must be sealed in Al housing encapsulation. Available welding SS housing encapsulation to make the crystals to resist the high temperature application.

Customized sharp of NaI(Tl) scintillator:

End-Well, Cubic sharp, side open well. Cylinder.

#### Properties:

Density [g/cm <sup>3</sup> ]	3.67
Melting point [K]	924
Thermal expansion coefficient [K <sup>-1</sup> ]	47.4 x 10 <sup>-6</sup>
Cleavage plane	(100)
Hardness (Mho)	2
Hygroscopic	yes
Wavelength of emission maximum [nm]	415
Refractive index at emission maximum	1.85
Primary decay time [μs]	0.25
Temperature coefficient of light yield	0.3% K <sup>-1</sup>
Light yield [photons/MeV γ]	38 x 10 <sup>3</sup>



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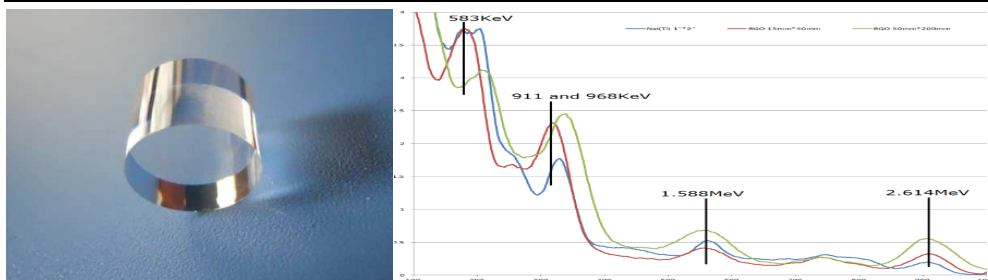
## 4. BGO Scintillation crystal, BGO scintillator

BGO ( $\text{Bi}_4\text{Ge}_3\text{O}_{12}$ ) is an oxide type scintillation material. It has high atomic number and density. BGO has good property including strong mechanical strength, non-hygroscopic, no cleavage. Extreme high density 7.13 g/cm<sup>3</sup> which makes these crystals very suitable for the detection of natural radioactivity.

BGO detectors are characterized by high energy resolution in the energy range 5 - 20 MeV, a relatively short decay time. Its parameters remain stable up to the doses of  $5 \times 10^4$  Gy. Due to these features, BGO crystals are used in high-energy physics, spectrometry and radiometry of gamma-radiation, positron tomography nuclear medical imaging industry.

### Properties:

Density [g/cm <sup>3</sup> ]	7.13
Melting point [K]	1323
Thermal expansion coefficient [C <sup>-1</sup> ]	$7 \times 10^{-6}$
Cleavage plane	none
Hardness (Mho)	5
Hygroscopic	no
Wavelength of emission max. [nm]	480
Lower wavelength cutoff [nm]	320
Refractive index @ emission max	2.15
Primary decay time [ns]	300
Light yield [photons/keV]	8-10
Photoelectron yield [% of NaI(Tl)] (for $\gamma$ -rays)	15 - 20
Temperature response	-1.2%/C
Neutron capture cross-section	1.47b
Afterglow @ 20ms	150ppm



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## 5. LYSO:Ce scintillation crystal, LYSO:Ce scintillator

LYSO:Ce is a new inorganic scintillation crystal with excellent performance. Its advantages of high light output, fast decay time, good radiation hardness, high density, high effective atomic numbers, high detection efficiency of Gamma rays, non-hygroscopicity and stable physical & chemical properties. It's considered as an inorganic scintillation crystal material of best overall performance. It has been used in nuclear physics, nuclear medical imaging (Especially in CT, PET, SPECT), high-energy physics and geophysical exploration.

Properties:

Crystal system	Monoclinic
Density(g/cm <sup>3</sup> )	7.15
Hardness(Mohs)	5.8
Refractive index	1.82
Light output (Relative to NaI)(%)	65~75
Decay time (ns)	≤47
Peak wavelength (nm)	410
Anti-radiation (rad)	1×10 <sup>8</sup>



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## 6. LSO(Ce) scintillation crystal, LSO(Ce) Scintillator

LSO(Ce) ( $\text{Ce:Lu}_2\text{SiO}_5$ ) crystal is a new kind of inorganic scintillation material, of which advanced property including high light output, short decay time, excellent radio resistance, high density, high effective atomic number, high detection efficiency against Gamma ray, non-hygroscopicity and stability etc. It's widely used in Nuclear physics, nuclear medical imaging (PET), high energy physics, geologic survey etc.

Properties:

Crystal system	monoclinic
Point group (/m)	2
lattice constant; Å	a=14.254、b=10.241、 c=6.641、 $\gamma=122.20$
Space group	C2/c
Melting point (°C)	2070
Density (g / cm <sup>3</sup> )	7.3~7.4
hardness (Mohs)	5.8
refractive index	1.82
Light output (Comparing NaI(Tl))	75%
Decay time (ns)	<40
Wavelength (nm)	410
Radio resistance (rad)	>1×10 <sup>8</sup>



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## 7. YSO(Ce) Scintillation crystal YSO(Ce) Scintillator

YSO(Ce) has excellent property including high light output, short decay time, excellent radio resistance, high density, more Effective atomic number, high detection efficiency again Gamma ray, non-hygroscopic, stable etc.

Properties:

Crystal System	monoclinic
Space group	C62h
Melting point (°C)	1980
lattice constant; Å	a=1.250、b=0.672、 c=1.042、 $\beta=102^{\circ}68'$
Density (g / cm <sup>3</sup> )	4.44
Light output (Comparing NaI(Tl))	120%
Decay time (ns)	70



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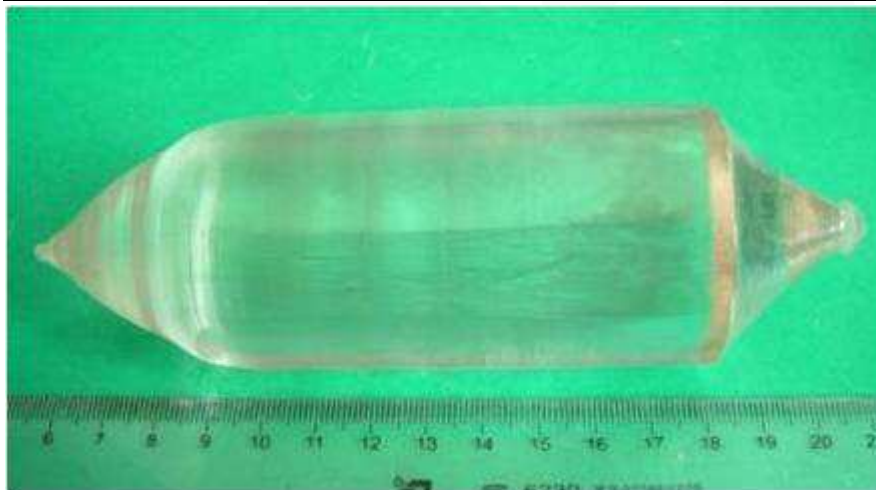


**8. YAP(Ce) scintillation crystal, YAP(Ce) scintillator**

YAP(Ce) is a fast scintillation crystal with good mechanic strength and chemically resistant property. Its high mechanical strength enable precise machining, entrance windows can be made with a very thin aluminum layer deposited on the surface of the crystal. YAP(Ce) scintillators have very low energy secondary X-ray emissions, it's desirable for imaging applications. YAP(Ce) detectors are used for gamma and X-ray counting, electron microscopy, electron, X-ray imaging screens and tomography systems.

**Properties:**

Crystal system	Orthorhombic
Density	5.3(g/cm <sup>3</sup> )
Hardness(Mohs)	8.5
Light output(Photons/MeV)	15000
Decay time(ns)	30
Wavelength(nm)	370



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## 9. Yb:YAP Scintillation crystal, Yb:YAP Scintillator Yb:YAG Scintillation crystal, Yb:YAG scintillator

Yb:YAG is a fast scintillation crystal, its decay time is 0.8ns. It's mainly used in fast particle imaging, Positron annihilation spectrum measurement and Yb<sup>3+</sup> neutrino detection because of its good mechanic strength and excellent Physical and chemical property.

### Properties:

Crystal	Yb:YAP	Yb:YAG
Crystal system	Orthogonal	Cubic
Density	5.3	4.5
Hardness	8.5	8
Light output(Photons/Mev)	1000	800
Decay time(ns)	0.7	0.8
Wavelength(nm)	330	330



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## 10. LuYAP:Ce Scintillation Crystal, LuYAP:Ce Scintillator

Ce:LuYAP which raised from lutetium aluminate, it has excellent characteristics including short decay time, high light output, high density which has high resists on gamma ray. Ce:LuYAP are widely used in PET application. It's an excellent material to increase the time, energy and space resolution in future.

Properties:

crystal system	orthorhombic
density (g/cm <sup>3</sup> )	7.44
hardness (mohs)	8.5
light output (photons/mev)	12000
energy resolution(FWHM)	≤7.5%
decay time(ns)	≤20
center wavelength	380



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## 11. CWO Scintillation crystal, CWO scintillator

CWO ( $\text{CdWO}_4$ ) is an excellent scintillation detector materials, it has good scintillation property including X-ray absorption coefficient, high density, high luminous efficiency, short afterglow and irradiation damage resistance. It has very important application value in these nuclear medical X-ray CT, container inspection industry.

Properties:

Density (g.cm <sup>-3</sup> )	7.90
Radiation length(cm)	1.06
Decay constant(us)	20us/5us
Emission peak(nm)	470/540
Light yield(%NaI(Tl))	38
Melting point(°C)	1272
Hardness(Mho)	4-4.5
refractive Index	2.3
Hygroscopicity	None
Cleavage	(101)



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## 12: PWO Scintillation crystal, PWO Scintillator

PbWO<sub>4</sub> crystal has Fast decay time, High density, Radiation hardness, high irradiation intensity and other characteristics. It's excellent material in high energy physics and nuclear medical.

Properties:

Density (g.cm-3)	8.28
Radiation length(cm)	0.92
Decay constant(us)	6ns/30ns
Emission peak(nm)	440/530
Light yield(% NaI(Tl))	0.5
Melting point(°C)	1123
Hardness(Mho)	/
refractive Index	2.16
Hygroscopicity	None
Cleavage	(101)



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## 13: YAG(Ce) Scintillation crystal, YAG(Ce) Scintillator

YAG(Ce) has high light output, medium strength mechanical & excellent physicochemical properties, it's a fast scintillator with a relative light yield of 21% of NaI(Tl), it can be used for light particle detection, Alfa particle detection, gamma ray detection, electronic detection imaging (SEM), high resolution microscopic imaging and other fields.

Properties:

Crystal system	Cubic
Density	4.5(g/cm <sup>3</sup> )
Hardness	8 (mohs)
Melt point	1970°C
Light output(Photons/Mev)	15000
Decay time(ns)	80
Wavelength(nm)	530



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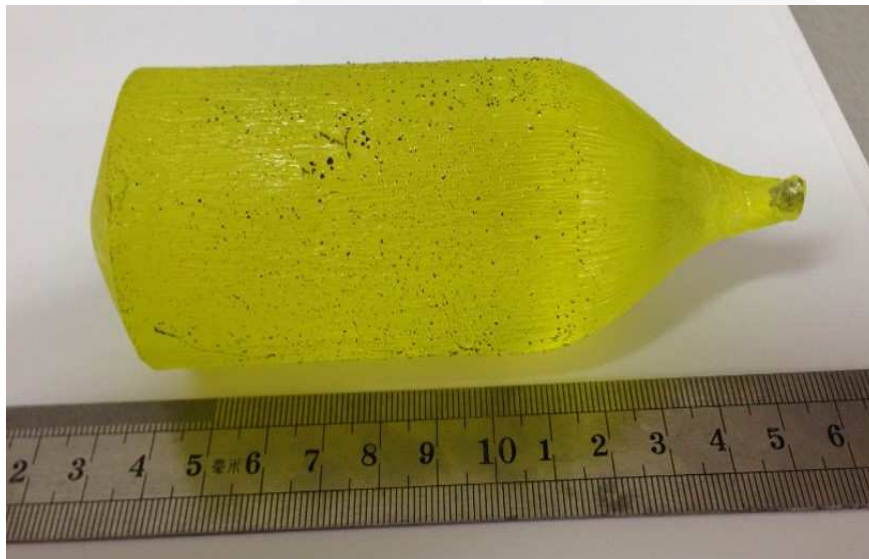


## 14. GAGG(Ce) Scintillator, GAGG(Ce) Scintillation Crystal

GAGG(Ce) has best light output in all series of oxide crystal. Besides, it has good energy resolution, High density, non-selfradiation, Non- hygroscopic. It's widely used in PET, PEM, SPECT, CT , X-ray &Gamma ray detection.

Properties:

Crystal system	Cubic
Density (g/cm <sup>3</sup> )	6.7
Light output (Photons/MeV)	50000
Energy resolution(FWHM)	≤6%
Decay time(ns)	≤88
center wavelength	520



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## 15. Pr: LuAG scintillation crystal, Pr: LuAG Scintillator

Pr:LuAG ( $\text{Pr:Lu}_3\text{Al}_5\text{O}_{12}$ ) has high density, high light output, fast decay time, good energy resolution etc Which can be used in Fast particle imaging, TOF-PET, PEM etc.

Properties:

Crystal system	Cubic
Density (g/cm <sup>3</sup> )	6.7
Hardness (Mohs)	8
Light output (Photons/MeV)	20000
Energy resolution(FWHM)	≤5%
Decay time(ns)	≤20
center wavelength	310



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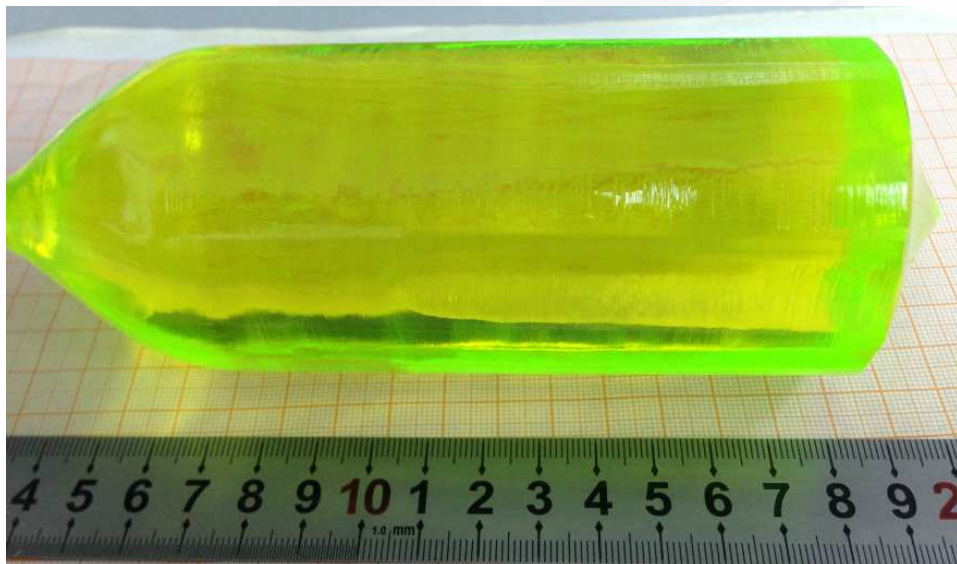


## 16. Ce:LuAG Scintillation crystal, Ce:LuAG scintillator

Ce:LuAG is a relatively dense and fast scintillation material, it has good properties including high density, fast decay time, high temperature resistance, chemical and good mechanic strength, It's widely used X ray imaging.

Properties:

crystal system	Cubic
density (g/cm <sup>3</sup> )	6.73
hardness (mohs)	8.5
light output (photons/mev)	15000
energy resolution(FWHM)	6.5%
decay time(ns)	70
center wavelength	530



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## 17. CeF<sub>3</sub> scintillation crystal, CeF<sub>3</sub> Scintillator

CeF<sub>3</sub> is an excellent inorganic scintillation crystal. It's good for application in various high energy physics experiments.

Properties:

Density(g/cm <sup>3</sup> )	6.16
Melting Point(°C)	1443
Refractivity	1.62
Radiation length (cm)	1.68
Emission peak (nm)	340(slow);300(fast)
Decay constant (ns)	30((slow);8(fast)
Light output [NaI(Tl)=100%]	8.6
Density(g/cm <sup>3</sup> )	6.16



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## 18. CaF<sub>2</sub>:Eu scintillation crystal, CaF<sub>2</sub>:Eu Scintillator

CaF<sub>2</sub>:Eu is an attractive radiation detection material because it's inert, non-hygroscopic, shock resistant. CaF<sub>2</sub>:Eu scintillation detector was constructed to identify whether energy dependent differences in (n,p) and (n,alpha) cross sections could be exploited to distinguish fission neutrons from DD neutrons in an active interrogation system. Experimentally, the charged particles are difficult to distinguish from the significantly larger number of gamma-rays produced in (n,gamma) reactions. In addition, modeling results show that fission neutrons produce only slightly higher charged particle production rates than D-D neutrons.

Properties:

Density [g/cm <sup>3</sup> ]	3.18
Melting point [K]	1691
Thermal expansion coefficient [C <sup>-1</sup> ]	19.5 x 10 <sup>-6</sup>
Cleavage plane	<111>
Hardness (Mho)	4
Hygroscopic	no
Wavelength of emission max. [nm]	435
Lower wavelength cutoff [nm]	395
Refractive index @ emission max	1.47
Primary decay time [ns]	940
Light yield [photons/keV <sub>γ</sub> ]	19
Photoelectron yield [% of NaI(Tl)] (for γ-rays)	50



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### 19. BaF<sub>2</sub> Scintillation crystal, BaF<sub>2</sub> scintillator

BaF<sub>2</sub> shows good optical transmission over wide spectrum range, which can be used as UV-IR windows in 0.15μm~12.5μm. It also presents excellent scintillation properties, which is widely used in high energy physics, nuclear physics and nuclear medical instruments, and etc. It is regarded as the fastest scintillators so far. As the fast component can be used to measure time precisely and obtain good time resolution, it has been pursued as a promising scintillator in the research of positron annihilation. It shows excellent radiation hardness up to 10<sup>6</sup> rad or even more. All these properties make BaF<sub>2</sub> crystal's application in nuclear detection involving very high counting rates and severe radiation.

Properties:

Transmission range (μm)	0.15~12.5
Transmittance	>90% (0.35~9μm, 3mm)
Refractivity(2.58μm)	1.4626
Reflection Loss at 2.58μm	6.8%(both faces)
Radiation length(cm)	2.06
Emission peak (nm)	310(slow);220(fast)
Decay constant(ns)	620(slow);0.6(fast)
Light output[Nal(Tl)=100%]	20%(slow);4%(fast)
Knoop hardness (kg/mm <sup>2</sup> )	82 with 500g indenter
Solubility at 23°C(g/100gH <sub>2</sub> O)	0.17
Cleavage plane	(111)
Density (g/cm <sup>3</sup> )	4.89
Melting Point (°C)	1280



**锦虹晶体材料（上海）有限公司**

KINHENG CRYSTAL MATERIAL (SHANGHAI) CO., LTD.

TEL: +862160490170 Fax: +862163063530

[www.kinheng-crystal.com](http://www.kinheng-crystal.com)

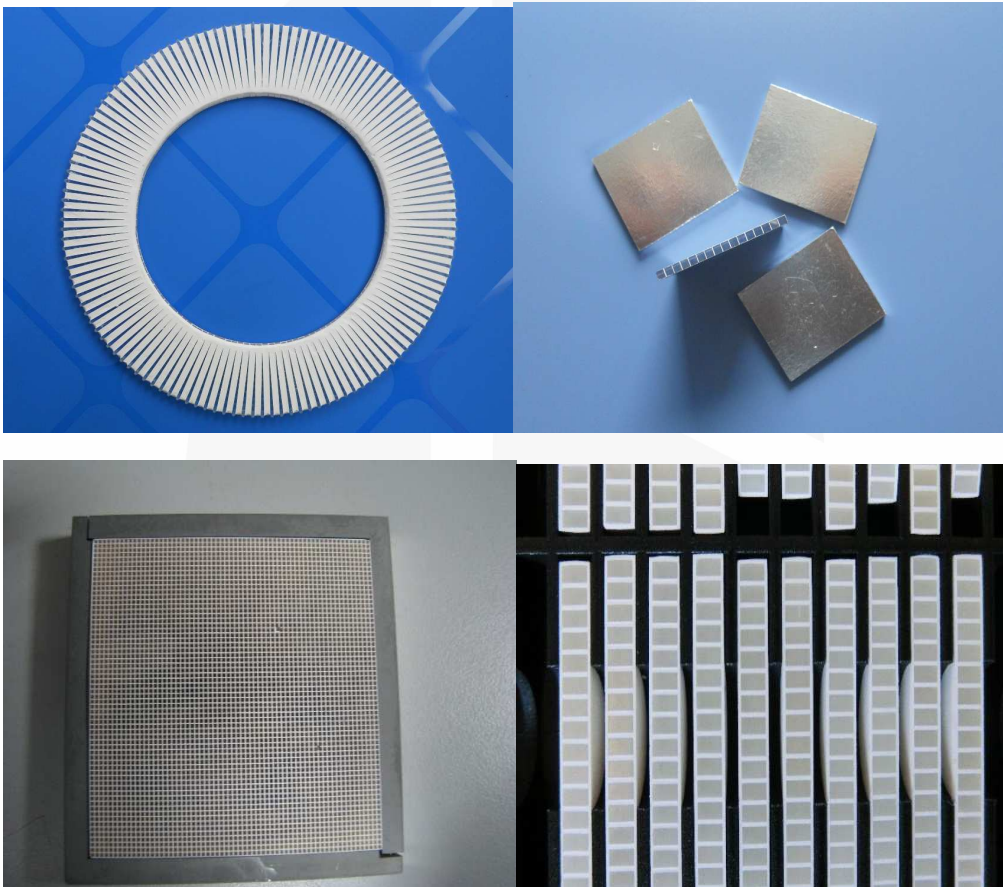
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**C: Scintillation crystal array**

We can provide following array by customization, 1-D Line array, ring array, cubic  $4 \times 4$ ,  $8 \times 8$ ,  $16 \times 16$  array etc. Its application in medical imaging (PET, SPECT), Small animal PET, Security inspection, container checking.

1. CsI(Tl) line array
2. BGO Array
3. LYSO(Ce), LSO:Ce array
4. YSO:Ce array
5. GAGG:Ce array



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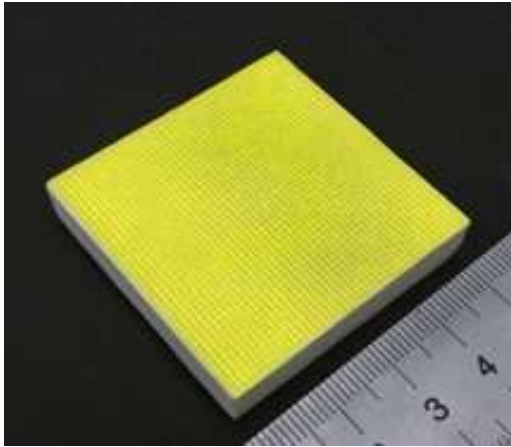
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