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Product Brief

High-efficiency Ceramic Scintillating Crystals and Crystal Arrays

Highlights

- Superior light output efficiency
- Two to three times higher light output than Cadmium Tungstate
- Fast decay times and reduced afterglow
- Nearly transparent crystals
- High X-ray stopping ability

Description

Toshiba has developed a new family of ceramic scintillators that have both high light output efficiency as well as high light transmittance. These new ceramic scintillators are ideal for use in various non-destructive industrial product inspection applications, as well as in security and surveillance applications to thwart terrorist threats or other illegal activities. The scintillators are made of polycrystalline Gadolinium Oxysulfide (GOS) crystals with dopants of either Praseodymium (Pr), Terbium (Tb) or Europium (Eu) determined by the requirements of the application. This new family of GOS crystals offers unusually high x-ray-to-light conversion efficiency with afterglow intensities as low as 0.1% at 3 milliseconds. Additionally, these high-performance GOS scintillators are different from more traditional scintillating materials because they do not contain any hazardous materials, and therefore, do not present any health concerns or require any special handling requirements.

Why GOS Crystals and Arrays

The new Toshiba GOS ceramic scintillating crystals and crystal arrays are very efficient in converting invisible X-rays to visible light rays, which can then be collected and digitized by a variety of data acquisition techniques and transmitted to real-time displays. These real-time displays enable industrial entities worldwide to more quickly, efficiently and economically monitor 100% of their product output to ensure that products shipped to their customers are consistently of high quality and within specification.

Interest in these systems extends beyond non-destructive inspection applications. Governmental Agencies worldwide are now finding these systems appropriate for security, counter-terrorism and as a means for detecting a variety of illegal activities including the smuggling of goods and human trafficking.

Praseodymium doped gadolinium oxysulfide phosphor powder, used in scintillating screens produced by Toshiba for many years for medical diagnostic applications, has long been recognized as a material that has a high fluorescence efficiency and short fluorescence decay time under x-ray excitation. More recently, it was realized that this same basic material could be made into a translucent ceramic scintillator by a manufacturing technique known as Hot Isostatic Pressing (HIP). This process, which simultaneously applies high pressure uniformly from all directions at high temperature, initiates the ceramic sintering and densification process of the phosphor powder, resulting in a fired ingot of gadolinium oxysulfide that exceeds 99% of theoretical density, without requiring the addition of impurities, which can cause undesirable light scattering in the final crystals. Light scattering can easily result when intentionally introduced impurities, such as sintering aids, with different refractive indexes than the ceramic host grains locate themselves at the grain boundaries. These hot isostatically pressed ingots are then sliced into individual crystals and assembled into multiple crystal arrays of a size specified by the customer.

The size of the Toshiba GOS crystal arrays is ultimately determined by the overall size of the photodiode detector to which the array will be matched. Light reflectors made of white polyethylene terephthalate films (PET) are placed between scintillator segments to efficiently collect emitted light and to prevent cross talk between adjacent segments. With

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the use of an adhesive, these scintillator segments are joined together to form a scintillator block, which the customer in turn mounts directly to their photodiode arrays.

The decision as to what type of GOS crystals should be used in the arrays is determined by the customer and dependent upon the application and what imaging characteristics of the crystals are considered most important. As is often the case, there are performance trade-offs that must be considered when deciding which type of GOS crystal array to select. As can be seen in the table below, for a given amount of x-ray energy input, the praseodymium doped GOS crystals provide approximately twice the light output of the most popular traditional single crystal type scintillator, with approximately the same decay time and afterglow. However, if light output is the more important characteristic, then either terbium or europium doped GOS crystals, which respectively provide 2.5 and 3.5 times the light output of the more traditional cadmium tungstate scintillator may warrant serious consideration, even though the decay time and amount of afterglow for each is higher.

Characteristics of Toshiba GOS Ceramic Scintillators

	Toshiba	Toshiba	Toshiba	Tradition AL
Material	**GOS: Pr**	**GOS: Tb**	**GOS: Eu**	**CdWO4**
	Ceramic	**Ceramic**	**Ceramic**	**Single Crystal**
Emission Maximum (nm)	*512*	*545*	*630*	*480*
Relative Output (a.u.)	*2*	*2.6*	*3.4*	*1*
Decay Time (µs)	*3 µs*	*1 ms*	*1 ms*	*5 µs*
Afterglow at 3 ms (%)	*< 0.1*	*1.0*	*~ 3.0*	*< 0.1*

For more information about Toshiba's GOS crystal scintillators and array capabilities and to discuss your specific application, please contact us.

www.Toshiba.com/taec

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