Advertisement for Incubation of Technology

Title of the technology	Handheld gamma spectrometer based on Caesium iodide (CsI) single crystal

Current state of Technology

- ✓ Basic principles observed?
- ✓ Technology concept formulated?
- ✓ Experimental proof of concept?
- ✓ Technology validated in lab?
- ✓ Demo system available? (with limited functionality)

General Information

The CsI:Tl single crystal has many advantages over conventional NaI:Tl crystals including higher density, better efficiency, lesser hygroscopic etc. Therefore the gamma spectrometers based on CsI:Tl single crystals are widely used for radiation detection and isotope identifications. However all the current systems used at various places of department, industries and academics are imported only. Therefore the development of a novel single crystal growth equipment (a modified Bridgman technique) and the process to grow single crystal of CsI:Tl up to 50 mm diameter and 60 mm length was carried out in CTS, TPD, PG. A portable USB powered gamma-ray detectors was also fabricated and used in various applications of the department. With the addition of advance electronics and user customized interface, the applications of these detectors can be extended further.

Features/Specification of system

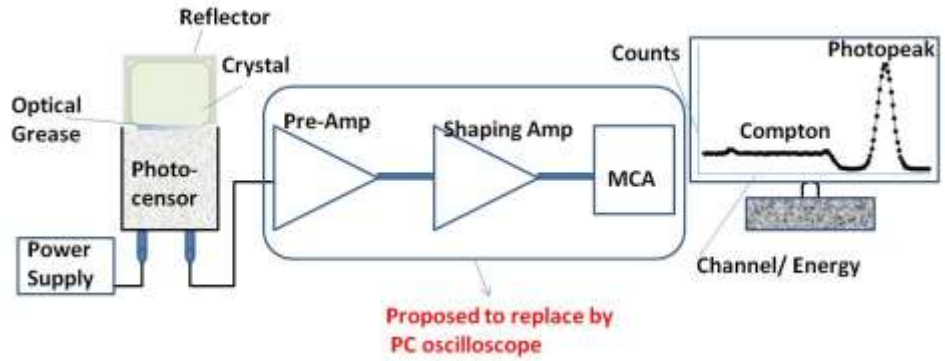
Crack free and transparent crystals of CsI:Tl, up to 2 inch diameter and 2 inch length, has been successfully grown with almost 100% confidence and repeatability. The current gamma spectrometer based on 2 inch X 2 inch CsI:Tl single crystal can be powered by USB and by using the imported multichannel analyser and available software , pulse height spectrum can be measured to identify the radioisotope having gamma energies up to 2 MeV. The energy resolution is about 7% at 662 keV gamma energy.

Properties	**Values for Current System**	**Values for Target System**
Crystal size	50 mm x 50 mm	50 mm x 50 mm
Energy resolution	7% @662 keV	7% @662 keV
Photomultiplier Tube (PMT)	Only specific 14 Pin, 51 mm dia, 10 stages,	**Any manufactured with any Pin structure**
Photocathode	Bialkali	Bialkali
Peak efficiency	30%	30%
Gain	10^6	10^6
Dark current	<3 nA	<3 nA
Timing Resolution	16 ns	**2 ns**

Voltage for max A/lm	1150 V	1150 V
Input power	min; 5 V, max; 15 V	min; 5 V, max; 15 V
Temperature coefficient	0.5%/deg C	0.5%/deg C
Digitizer Bandwidth	62.5 MHz	**250/500 MHz**
Sampling rate	upto 100 MS/s	**500 MS/s to 1 GS/s**
Power	USB powered	**USB powered , 12 V adaptor, User specified**
Software platform	Windows (No code for user specific applications)	**Linux, Open source code**
Channels	Maximum 8k	**user defined -32 k to 32 k**
Resolution	12 bit	**upto 12 bits**
Sensitivity	-----	**10 mV/div to 4V/div**
Output	Pulse height spectrum (Not User defined)	**User defined; Raw pulse, pulse height spectrum, counting mode and communication through USB and Ethernet etc.**
Numbers of detectors connected	One	**2/4**

Working of the System (with schematic block diagram)

The radiation detectors can work in both current and pulsed mode. The current mode measures an average signal above specific threshold for counting applications while pulse mode record individual event and therefore useful for the spectroscopy. Single crystal scintillators have the advantage of the best uniformity along with higher atomic density which leads to a well-defined photo-peak corresponding to full energy deposition. The radiation detector based on single crystal scintillator generates a specific pulse height voltage signal for a particular energy to identify the radio-isotope. The high density and effective atomic number of single crystal ensures the better efficiency and sensitivity in comparison with other detectors based on gas ionization etc. The energy required to create charge carriers is also lesser in comparison with the gas ionization and therefore provide better sensitivity for counting applications also.



Applications of the System

Departmental: Department of nuclear energy use gamma spectrometer at numerous places including the extensive use at Front end and back end fuel cycles. Starting from the uranium exploration and mining, gamma spectrometers are essential for fuel fabrication, processing, nuclear reactors, burn up measurements, Hull monitoring, fuel reprocessing, waste management etc. The environmental monitoring for radiations also requires the sensitive gamma spectrometers based on single crystal scintillators.

Industrial: The gamma spectrometers are extensively used in various industries for gamma scanning, flow detection, quality checks, gauging, exploration etc.

Academic: The gamma spectrometer is required for the basic research experiments in nuclear physics and to teach the concept of radiation detectors to students as well.

Picture/Photo of the System –

Fig.Pulse height spectrum of a single and four coupled portable gamma spectrometer radiation detectors using CsI:Tl crystal (MCA in these detectors are imported and can be replaced by indigenous ones)

Whether the parent product/ technology/ process is patented: No

If yes, provide the details –Not applicable

Deliverables – Portable gamma spectrometer with user specified software

Justification for Incubation – In spite of having numerous applications of gamma spectrometer, there is not a single manufacture nationally to fabricate the gamma spectrometer. The imported system does not provide any user specified software to use the setup in multiple applications. We already have the expertise in growing single crystals of CsI:Tl, which are widely used for various spectrometer. Recently we have used the detectors based on these crystals by processing the raw pulses only which can be recorded using economic PC oscilloscopes. With the help of incubation, a general algorithm with the possibilities of user specified inputs along with the user specified mechanical designs can be incorporated to develop more versatile yet portable and economic gamma spectrometers.

Facility and Infrastructure requirements:

Facility and Infrastructure to be provided by Incubatee:

Manpower/ expertise Mechanical and software expertise for fabrication of the radiation detector, Basic experience of working in the field of radiation detection applications, chemicals handling, furnaces and vacuum operation
Machinery and Equipment Enough space for the installation of at least 3 Bridgman furnaces, crystal cutting and polishing machine, glass blower facility for fabrication of quartz crucibles, material handling facility Data acquisition electronics
Others A few standard radioactive sources to qualify the developed detectors
Any special requirements for plant, industry, location utilities, handling storage, safety etc. Enough space for the installation of at least 3 Bridgman furnaces, material handling facility, chemicals handling, furnaces and vacuum operation, A few standard radioactive sources to qualify the developed detectors

Note: As per in-house technology incubation policy, the incubatee should be a licensee of the existing technology. Alternatively, the applicant will be required to take the license of the existing technology before entering incubation agreement.

If interested in Incubation, kindly ***download -> fill -> scan -> send*** the application form to -

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