Notice for the PhD Viva Voce Examination

Mr Bibin John (Registration Number: 1881304), PhD scholar at the School Sciences, CHRIST (Deemed to be University) will defend his PhD thesis at the public viva-voce examination on Tuesday, 7 February 2023 at 2.00 pm in the Syndicate Room (Room No. 802), Ground Floor, Auditorium Block, CHRIST (Deemed to be University), Bengaluru - 560029.

Title of the Thesis	**:**	**Growth and Characterization of Sb2Se3 and SnSe2 Crystals for Photovoltaic Applications**
Discipline	**:**	**Physics**
External Examiner (Outside Karnataka)	**:**	**Dr Cyriac Joseph** Professor School of Pure & Applied Physics Mahatma Gandhi University P D Hills Kottayam-686 560 Kerala
External Examiner (Within Karnataka)	**:**	**Dr N Shanthi** Professor and Head Department of Physics School of Science JAIN (Deemed to be University) J C Road, 1st Cross Bengaluru - 560027 Karnataka
Supervisor	**:**	**Dr Kunjomana A G** Professor (Rtd) Department of Physics and Electronics School of Sciences CHRIST (Deemed to be University) Bengaluru – 560029 Karnataka

The members of the Research Advisory Committee of the Scholar, the faculty members of the Department and the School, interested experts and research scholars of all the branches of research are cordially invited to attend this open viva.

Registrar

Place: Bengaluru
Date: 31 January 2023

ABSTRACT

Tremendous development in crystal growth technology led to the production of good quality samples for the design and fabrication of optoelectronic devices. As naturally available solids exhibit undesirable characteristics, the present research work deals with the artificial synthesis and characterization of defect free binary layered chalcogenide materials (LCMs) for photovoltaic (PV) applications. Antimony selenide (Sb_2Se_3) and tin diselenide ($SnSe_2$) have gained special attention in the PV industry due to their eco-friendly, sustainable, and non-hazardous nature as well as the salient features such as moderate melting temperature, *p*-type conductivity with direct transition, optimum band gap and high absorption coefficient. Therefore, cost-effective synthesis was implemented to engineer bulk Sb_2Se_3 and $SnSe_2$ crystals for the enhancement of optoelectronic parameters. Horizontal normal freezing (HNF), the facile and inexpensive melt growth technique was employed to explore the suitability of cleaved samples. Most of the vapor phase synthesis methods, especially, the chemical vapor deposition (CVD) deteriorates material quality, which adversely affects the physical properties due to the presence of contamination or foreign elements. But, the physical vapor deposition (PVD) process is favorable, as it offers feasible instrumentation and yields stoichiometric specimens with supreme quality and fine-tuned characteristics. The PVD method could provide the evolution of various habits under high vacuum, if the processing protocols are critically controlled in a growth chamber. Even though research work has been published on Sb_2Se_3 and $SnSe_2$ samples prepared by other techniques, an economically viable approach by physical means for harvesting stoichiometric crystals, which enable versatile optical properties, has not been developed so far. A possible growth mechanism to explain the formation of crystals was proposed and discussed based on the Kossel-Stranski-Volmer (KSV) model. The phase identification, chemical homogeneity and microstructural evolution of the samples have been investigated by utilizing different sophisticated characterization tools like PXRD, EDAX, XPS, optical microscope, SEM, and TEM. Thermogravimetric analysis was performed for accessing the phase transition and thermal characteristics. Vickers microhardness tester was employed to probe the mechanical characteristics of the samples and Hall effect experimental setup was utilized to examine their transport properties. The optical measurements were carried out by UV-Vis-NIR and PL spectrometers. The results obtained were analyzed systematically to assess the suitability of harvested products for photovoltaic applications.

Keywords: physical vapor deposition (PVD), horizontal normal freezing (HNF), morphology, supersaturation, supercooling, physical properties and photovoltaic applications.

Publications:

1. **Bibin John**, A. G. Kunjomana and Teena Mathew "Vapor deposition and enhancement of optoelectronic properties of $SnSe_2$ platelets," *Journal of Materials Science: Materials in Electronics* (Springer), 2022. (**IF: 2.779**)
2. **Bibin John**, A. G. Kunjomana and Teena Mathew "Enhancement of structural, mechanical and optical properties of vapor grown Sb_2Se_3 whiskers," *Journal of Materials Science: Materials in Electronics* (Springer), 2022. (**IF: 2.779**)
3. **Bibin John** and A. G. Kunjomana, "Facile synthesis of novel antimony selenide nanocrystals with hierarchical architecture by physical vapor deposition technique," *Journal of Applied Crystallography*, (Wiley) vol. **52**, p. 312, 2019. (**IF: 3.304**)