

Report

National Summer School and Workshop on Semiconductor:

Hands on Training for Undergraduates

10th-19th July, 2024

From smartphones to space exploration, semiconductors are the backbone of modern innovation. With a firm grasp of semiconductor principles, individuals can contribute to India's technological progress in diverse sectors like electronics, telecommunication, renewable energy and many more. Recognizing the importance of this field and driven by the **India Semiconductor Mission**, launched by the **Government of India** for the establishment of science ecosystem, and also realizing that many undergraduate students find it challenging to grasp the complexities of semiconductors in the conventional academic environment, Shyam Lal College (SLC) conducted the '**National Summer school and workshop on Semiconductors**' from **10th-19th July, 2024** to provide young students with a unique blend of theoretical knowledge and practical skills in the field of semiconductors. **This summer school was organised by the Research & Development Centre and IQAC Shyam Lal College, University of Delhi, in collaboration with IUAC (Delhi), IIT (Delhi), Research Council (University of Delhi), and Miranda House.** Students from different colleges participated in this summer school and workshop.

The inaugural day commenced with a series of ceremonial activities, including the registration, arrival of guests, and a warm welcome ceremony involving lamp lighting, and Saraswati Vandana. **Dr. Niti Agrawal, the Convenor of the R&D Centre**, introduced the Summer School, outlining its objectives to pace up an environment of scientific temperament and collaborative research. The institutional highlights provided by **Prof. Kusha Tiwari, Director, IQAC, SLC** further promoted the collaborative spirit by showcasing the achievements and ongoing projects that involve multiple academic and research institutions. **Prof. Rabi Narayan Kar, Principal, SLC** floated the immediate aspiration of the College towards collaborative learning for a better future.

The event featured a notable address by **Prof. A. C. Pandey, Director, IUAC New Delhi, Chief Guest** for the event, emphasizing the pivotal role of collaborative research and development in advancing scientific knowledge and its practical applications. The keynote lecture delivered by **Prof. Mahesh Kumar, Senior Principal Scientist at CSIR and**

Professor at CSIR, focused on the emerging advancements in scientific research and their interdisciplinary applications. Dr. Kumar's insights into the convergence of various scientific fields provided a comprehensive understanding of how such integration can lead to pathbreaking innovations. His lecture emphasized the relevance of encouraging an interdisciplinary approach to research, which is vital for addressing contemporary global challenges. The afternoon session, led by **Prof. Amarjeet Kaur, Senior Professor at the Department of Physics & Astrophysics, University of Delhi**, explored into the significant advancements in Physics and Astrophysics and their broader implications. Prof. Kaur's lecture highlighted the transformative impact of advanced scientific research on education and its potential to inspire the next generation of scientists and researchers. The discussion on the latest technological advancements in Astrophysics served the thematic relevance in pushing the boundaries of human knowledge.

The first day of the Summer School successfully provided a comprehensive overview of how interdisciplinary scientific research and technological advancements that can address some of the most pressing challenges of our time. The emphasis on collaboration, innovation, and education set a strong foundation for the subsequent days of the summer school, promising a fruitful exchange of knowledge and ideas that will significantly contribute to the scientific community and society at large.

The Day 2 of Summer School was filled with excitement as our **one group of students visited to IIT Delhi and other group of students had hands on experience in the chemistry lab, SLC**. The campus buzzed with energy as they explored cutting-edge labs, interacted with top-notch professors, and experienced the vibrant academic environment firsthand. From witnessing research to engaging in stimulating discussions, the day was packed with unforgettable moments that left everyone inspired and eager for more. The program started with an interaction with the research scholars at **organic and hybrid solar cell lab at department of Energy Studies IIT Delhi**. The students of summer school were given basic ideas about current research in the field of solar photovoltaics. Organic and perovskites solar cells and their basic architecture were described by the respective instructors. In the second session students performed the hands-on training on sample preparation (sample cleaning through ultrasonification using IPA and acetone and finally UV cleaning).

In the first session at SLC, students of Group B were introduced to basic chemical terminology that they are going to use for the next few days. The details for synthesis of visible light driven

semiconductor based photocatalyst were explained to the students. Students learnt about the solvothermal method of synthesis of nanomaterial, elementary introduction of sulphides of copper, zinc ferrite, spinel structures, hierarchical structure, snowflakes structural material, organic pollutants, methyl orange dye and its toxic effects on environment. The aim of this session was to fabricate 3 D hierarchical snowflake shaped Cu₂S. Students performed the synthesis of above mentioned material smoothly. The session was conducted by **Dr Kanika Solanki, Dept of Chemistry, SLC**. In the second session, discussion involved Semiconductors and its role in modern electronic devices including Solar Cells. Detailed discussions were made on Dye sensitised solar cells (DSSCs) and its potential role as viable alternative to silicon based solar cells owing to its low fabrication cost and simple procedure. The discourse on DSSCs also entailed topics related to components and working principle of DSSCs. The session was conducted by **Dr Padma Dechan, Dept of Chemistry, SLC**.

On the third day of summer school students were given hands on training on fabrication of various layers (P3HT-PCBM and PEDOT-PSS) using spin coating technique at **IIT Delhi**. Finally in the second session of last day students were given training about the characterization of Thin film solar cells using UV-visible NIR and Photoluminescence spectroscopy. Lastly the students calculated the solar cell efficiency, fill factor, and IV characteristics using solar simulator. The session ends with a fruitful discussion with **Prof. Supravat karak**.

The other group of students had a **hand on practice in the chemistry lab, SLC**. The students learnt about incorporating magnetic characters to semiconductor hierarchical structures. In this process they have synthesized mixed oxides of zinc and iron with nano dimensions. They got to know about in-situ synthesis of zinc and iron oxide doped snowflake shaped copper sulphide. They have also performed the above mentioned experiment using solvothermal approach. The students were also introduced with the concept of centrifugation and working of centrifuge for separation of hierarchical structures. They have also learnt about the principles of partition and applied them in the washing of developed 3 dimensional architectures. They also got to know about degradation of organic pollutants using semiconductor based photocatalyst prepared by them in last two days. The next session has engrossed students with Hands on training on Fabrication of Dye Sensitised Solar Cells (DSSCs) using Porphyrin macrocycles. In the hands on training students learnt about the detailed fabrication process of dye sensitised solar cells. They fabricated two types of solar cells using two different porphyrin dyes which they first synthesized (followed by its purification using column chromatography) and then characterised using UV spectrophotometry. After the fabrication process, they measured the conductivity of

DSSCs using a millimetre. Voltage generated by the constructed cells were recorded by the students using both indoor and outdoor light sources. The students have appreciated the light harvesting capability of porphyrin dyes.

On Day 4 and 5, the same hands-on training was given to a different group of students.

On the sixth day of summer school, the students of national summer school visited **Inter University Accelerator Centre (IUAC)**. Giving National Summer School students a chance to experience a real-world laboratory setting was the main goal of the lab visit. The purpose of this visit was to improve their comprehension of experimental methods, scientific research procedures, and the real-world applications of their theoretical knowledge. The tour was packed with various things to do, like practical exercises where students could work on easy experiments under supervision. After that, students can interact with the researchers with Q&A sessions to talk about their current work and future plans.

At the Inter University Accelerator Centre the participants visited the thin film division facilities. They were given a brief exposure of thin film deposition using Physical Vapor Deposition (PVD) technique. Physical Vapor Deposition (PVD) describes a group of thin film deposition techniques that involve vaporizing a solid material in a vacuum, then depositing that material onto a substrate. They learned the deposition of Bismuth telluride thin film on sapphire substrate using RF sputtering technique. Bismuth telluride (Bi_2Te_3) is an efficient thermoelectric material, and fabricating Bi_2Te_3 thin films with good thermoelectric properties is a prerequisite to realizing the potential of these materials in microdevice application. The students were keen to observe and understand the working of Accelerators in Nuclear Science Division at IUAC where the scientist (Mr. Mohit) explained the working mechanism and addressed all the queries of students.

On the seventh day of the summer school, the learning journey continued at IUAC. The students were demonstrated the thermoelectric energy conversion using TE module made up of Antimony telluride. The students were also explained the basics of thermopower measurement. At last, the students performed the X-ray diffraction experiment on the deposited thin films of bismuth telluride.

The IUAC lab tour was a huge success, giving the students an exceptional look into the field of science research. All of the attendees were deeply impacted by the interactions with the scientists, hands-on activities, and exposure to cutting edge technology.

On Day 8, students compiled their report for the one week learning they had.

On Day 9, the participants visited the **Solid State Physics Laboratory (SSPL) under the Defence Research and Development Organisation (DRDO)**. The visit provided an in-depth knowledge about the advanced research and development activities conducted by the SSPL which includes areas like development of advanced semiconductor devices such as Gunn diodes, Schottky diodes, RF devices, and Monolithic Microwave Integrated Circuits (MMICs), development of detectors for applications like snow avalanche monitoring, landslides, chemical warfare, and health monitoring, Research into the development of highly sensitive nanosensors for various applications and many more. The young minds were also provided an exciting glimpse of various advanced instruments and technologies like SiC Technology Development, Bulk single crystal growth of SiC, SiC wafer fabrication and single polytype material development, Use of double-wall quartz chambers and diamond multi-wire cutting for wafer production etc. The students also paid a memorable visit to the characterization Labs Like X-Ray Diffraction (XRD), Atomic Force Microscopy (AFM), Raman Spectroscopy, Electron Microscope, X-Ray Photoelectron Spectroscopy (XPS), Secondary Ion Mass Spectrometry (SIMS), FT-IR and UV-Visible Spectroscopy and Stylus Profilometry. The inquisitive students received a nice explanations about various characterisation techniques from the scientists at the SSPL.

The ten days long “National Summer School & Workshop on Semiconductors” concluded on 19th July, 2024. In the first session, distinguished guest of the program, **Prof. R.K.Kotnala, scientist of Eminence, NPL-CSIR**, gave a vibrant talk on his remarkable invention of “hydroelectric cell”, a green energy device, it’s working principles and its potential as a viable alternative to current energy technologies.

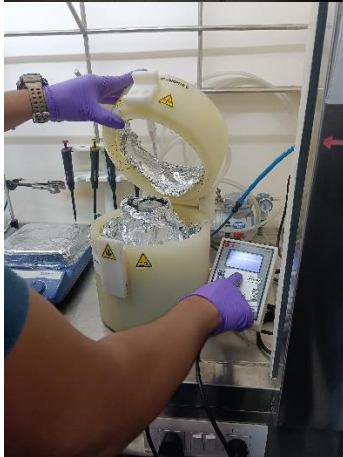
The Summer school and workshop on semiconductors **concluded with the Valedictory function. Prof. Raj Kishore Sharma, Dean Research, University of Delhi** graced the occasion as the chief Guest. The event continued with **the report presentation** on “National Summer School and Workshop on Semiconductors” by **Dr. Niti Agrawal, Convenor of Research and Development Centre, SLC**. The session was made a further success with a dynamic talk by Prof. Raj Kishore Sharma. In his talk, **Prof. Raj Kishore made a pressing note upon the vital role of semiconductors in modern electronic devices and applications including AI**. He motivated the young minds to come forward and contribute their potential role in the development of ever evolving semiconductor technologies and hence contribute

their significant and much needed role in the nation building process. The event was carried forward with **the certificate distributions to the participants of summer school and concluded with the vote of thanks.**

The summer school has ignited the young minds, setting them on a path towards bright academic and scholarly pursuits. The comprehensive curriculum and hands-on sessions have provided invaluable insights into the world of semiconductors. This collaborative atmosphere has further deepened the understanding and practical application of semiconductor technology towards a sustainable version of scientific temperament and Viksit Bharat. **The scholars deeply acknowledged the organisation of such an event especially to Prof. Rabi Narayan Kar (Principal, SLC), Prof. Kusha Tiwari (Director, IQAC, SLC), Dr. Niti Agrawal (Convenor, R&D Centre, SLC) and the entire organising team, who left no stone unturned for the successful accomplishment of the summer school and workshop on semiconductors**

Glimpses of the summer school and workshop on semiconductors







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