CHRIST
(DEEMED TO BE UNIVERSITY)
BANGALORE | DELHI NCR | PUNE

# Notice for the PhD Viva Voce Examination

Ms Shanyukta Upadhyay, Registration Number: 2270155, PhD Scholar at the Department of Physics and Electronics, School of Sciences, CHRIST (Deemed to be University), will defend her PhD thesis at the public viva-voce examination on Saturday, 26 September 2026, at 10.00 am in Room No. 044, Ground Floor, R & D Block, CHRIST (Deemed to be University), Bengaluru - 560029, Karnataka, India.

| | | |
|---|---|---|
| **Title of the Thesis** | : | **Development of Low Dimensional Materials and Their Composites as Counter Electrode in Dye-Sensitized Solar Cell** |
| **Discipline** | : | **Physics** |
| **External Examiner - I** | : | **Dr Chandrabhas Narayana**<br>Professor<br>Chemistry and Physics of Materials Unit<br>Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR)<br>Jakkur, Bengaluru - 560064<br>Karnataka |
| **External Examiner - II** | : | **Dr Koteswara Rao Peta**<br>Associate Professor<br>Department of Electronic Science<br>University of Delhi<br>South Campus<br>New Delhi - 110021 |
| **Supervisor** | : | **Dr Manoj B**<br>Professor<br>Department of Physics and Electronics<br>School of Sciences<br>CHRIST (Deemed to be University)<br>Bengaluru - 560029<br>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–voce examination.

**Registrar (Academics)**

**Place:** Bengaluru
**Date:** 09 September 2026

# ABSTRACT

The energy crisis stands as the foremost issue globally, given that fossil fuels are undergoing swift depletion and their usage is a significant factor in the increase in the global average temperature. The depletion of fossil fuels for energy will drive the adoption of renewable energy sources, and initiatives have been undertaken to harness wind, biomass, geothermal, tidal, and solar energy. The disruption of oil shipments due to the Middle East war has tightened global energy supplies, driving up oil prices. All this has greatly affected the energy sector. Among these energy sources, solar energy stands out as the most viable option because of its clean, abundant, cost-effective, and pollution-free characteristics. Solar cells are clean energy devices that convert sunlight directly into electricity, offering a sustainable alternative to fossil fuels. The dye-sensitized solar cell (DSSC) has emerged as a significant energy generation technology owing to its simple processing, affordability, and uncomplicated manufacturing techniques in contrast with traditional solar cells. The counter electrode is an essential component of DSSCs, collecting electrons from the external circuit and facilitating redox reduction in the electrolyte. This process greatly affects the photovoltaic efficiency, durability, and overall cost of the devices.

This study provides a comprehensive overview of the impact of Transition Metal Dichalcogenide (TMD) composites combined with different types of carbon scaffolds, primarily rods (derived from Melamine, PANI, PEDOT: PSS and Nickel zeolites) and fibres obtained from (Jute, Cotton rope and cotton), as an efficient counter electrode material. In this study, the TMD material selected was molybdenum disulfide ($MoS_2$). This study encompasses comprehensive synthesis methods, the fabrication of DSSC devices, and their detailed photovoltaic and electrochemical evaluations. Prototypes were also developed with the best of these samples for the application of glowing LEDs. Doping is a powerful method for improving the properties of TMDs. By carefully selecting optimal metal combinations, multi-atom doping (from Cu and Pd) was performed to enhance electrocatalytic

properties and cell stability. With this multimetal-doped composite containing Cu, Pd, carbon nanofiber, and $MoS_2$, the maximum efficiency obtained is 7.77 %, making it a promising candidate for CE.

A Metal-Organic Framework (MOF) is a highly crystalline, porous substance composed of metal ions or clusters that are systematically arranged with an organic linker, forming extensive, multidimensional framework networks. Due to their significant surface area and adjustable pore structures, they serve as an outstanding foundational material for enhancing TMD materials. Prussian Blue Analogue (based on Ni and Mn metal legands) and Nickel zeolite-based frameworks were utilized with $MoS_2$ decoration as a counter electrode for the implementation of Bifacial DSSCs. Transmittance studies were conducted to verify the bifaciality of the solar cells, along with cell measurements under both front- and rear-illumination conditions. The maximum efficiency obtained was around 8.25% with the MnNi Prussian blue composite and $MoS_2$ under standard conditions (100

$mW/cm^2$ ).



**Keywords:** *Transition Metal Dichalcogenide, Carbon fibers, Dye sensitized solar cell, Bifacial cells, Electrocatalytic, Metal-Organic Framework*


**Publications:**

1. **Upadhyay, S.**, Rao, A. A., Narendhiran, S., Jafri, I., & Balachandran, M. (2023). Phosphorus-doped molybdenum disulfide as a counter electrode catalyst for efficient bifacial dye-sensitized solar cells. Materials Today Energy, 37, 101412, IF: 8.6, https://doi.org/10.1016/j.mtener.2023.101412
2. **Upadhyay, S.**, Narendhiran, S., & Balachandran, M. (2024). Exploring the Role of structurally modified Molybdenum disulfide composites with Prussian blue analogues as counter electrode catalysts for bifacial Dye-Sensitized solar cells. Solar Energy, 282, 112906, IF: 6.6, https://doi.org/10.1016/j.solener.2024.112906
3. **Upadhyay, S.**, Narendhiran, S., & Balachandran, M. (2025). Cotton-derived carbon fibers and $MoS_2$ hybrids for efficient I3- reduction in bifacial dye-sensitized solar cells. Carbon, 238, 120248, IF: 11.6, https://doi.org/10.1016/j.carbon.2025.120248
4. **Upadhyay, S.**, & Balachandran, M. Transparent Cu-Pd decorated $MoS_2$@functionalized carbon nanofiber composite counter electrodes: efficient bifacial dye-sensitized solar cell. Journal of Alloys and Compounds , 186168, IF: 6.3, 2 https://doi.org/10.1016/j.jallcom.2026.186168