NCPRE

NewsLetter

September 2020 Edition

NCPRE *Profile*

The National Centre for Photovoltaic Research and Education (NCPRE) at IIT Bombay is one of the leading PV research center in the country. It was launched in 2010 with funding from the Ministry of New & Renewable Energy (MNRE) of the Government of India, soon after the launch of India's National Solar Mission. The broad objectives of NCPRE are to provide R&D and education support for India's ambitious 100 GW solar mission. NCPRE has 29 faculty members and over 120 research staff and students across 9 Departments at IIT Bombay. State-of-the-art laboratory facilities, with over 200 equipment spread across 12 laboratories, have been set up which are accessible to all researchers and Industries. The Centre is involved in both basic and applied research activities.

These research activities include silicon solar cell fabrication and characterization, new materials for PV devices, energy storage and batteries for PV, development of power electronic interfaces for solar PV systems, and module characterization and reliability. NCPRE has a strong programme of industry outreach. It undertakes projects and consultancy in its areas of expertise. It also provides services for characterization and measurements. NCPRE periodically conducts workshops and hands-on training in the field of photovoltaics for industry as well as academia.

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Investigator, Chief Editor

Dr. Diksha Makwani,
Sr.Executive officer, Sr.Editor

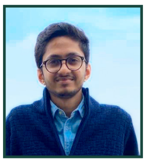
Priya Sinsinwar,
Ph. D. Student, Editor

Aakash Ahuja,
Ph. D. Student, Co-editor

Associate Editors

Sonali Bhaduri,
Ph. D. Student

Ruchita Korgaonkar,
Ph. D. Student



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Jr. Research Fellow

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Jr. Research Fellow

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Sr. Technical Assistant

Manoj Kawale,
Designer

Dipali Khedekar,
Technical Assistant

Design of Smart Transformer-less Hybrid 5 KVA Solar Photovoltaic System

The increasing energy demand and depletion of conventional energy resources has rendered to move towards energy harvesting from the renewable energy resources (RESs). The solar photovoltaic (PV) technology is gaining momentum rapidly and the residential rooftop PV system is an effective solution which can cater the household demands as well as supply the surplus power to the ac grid. The inverter system is called hybrid because it can operate in both standalone and grid connected mode. The system is called "smart" because of its capability of LVRT (Low Voltage Ride Through), voltage regulation and islanding detection.

The conventional full bridge inverter can be operated in either unipolar or bipolar modes of operations. But the unipolar pulse width modulated (PWM) technique introduces a common mode voltage which periodically charges and discharges the parasitic capacitor of the PV panel and hence lead to circulation of leakage current. On the other hand, the bipolar PWM technique eliminates the common mode voltage and thereby limits the leakage current to very low value. Still small leakage current flows because of the parasitic capacitances around the MOSFET; although the value of this leakage current is very small. Unipolar PWM technique has other advantages such as output voltage has twice the switching frequency output and hence smaller filter size and magnetic core loss. But all these advantages are overlooked because of the presence of common mode voltage.

The proposed topology uses H bridge inverter with bipolar modulation techniques because of the reason explained above. The dc-dc converter used with PV and battery is a bidirectional boost converter. Bidirectional boost converter uses common ground configuration and therefore leakage current is almost negligible. In addition, the battery and PV converters are in cascaded.

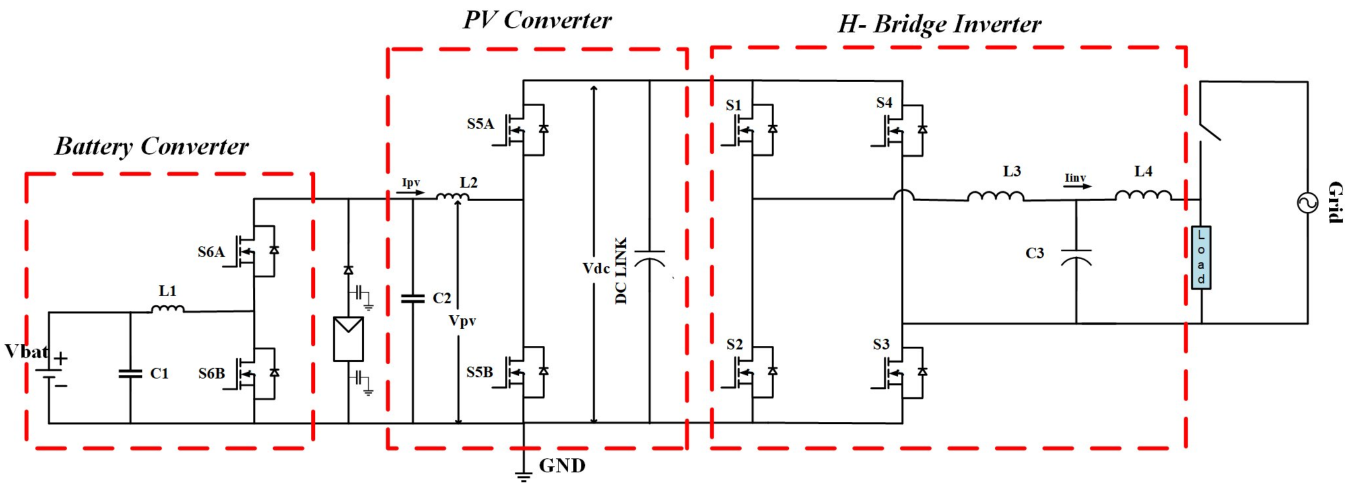


Figure: Block diagram of the proposed converter topology.

bgf@ee.iitb.ac.in

Auxiliary Power Supply for Grid Connected Hybrid PV Inverter System

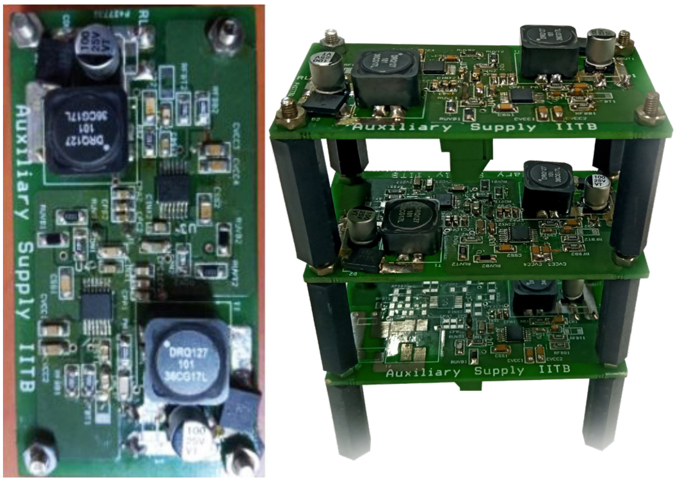
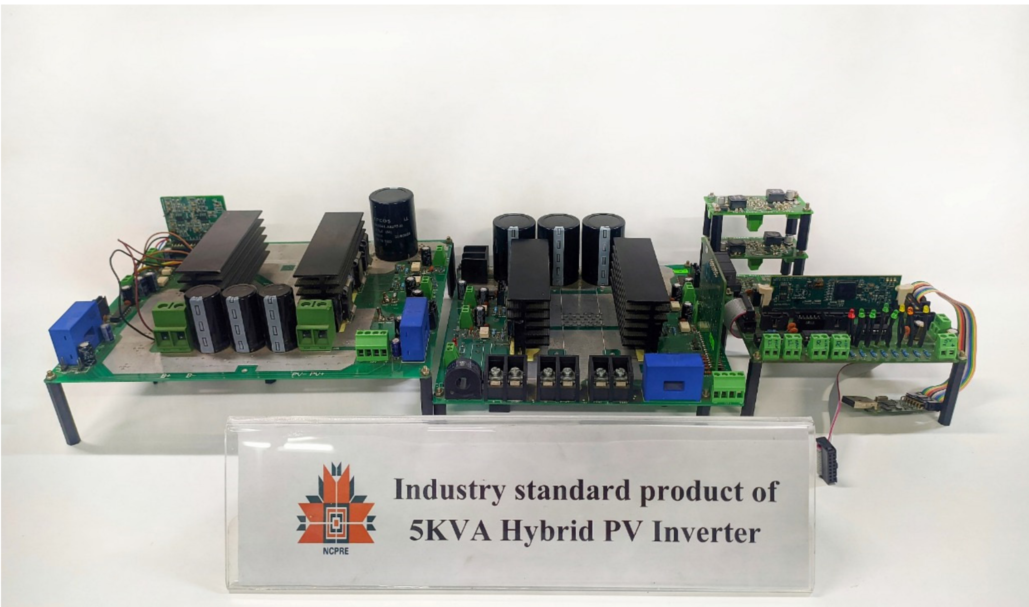


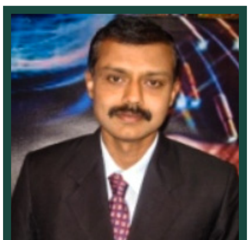
Figure: Fabricated Power Supply PCB, consisting of two isolated converters mounted on single board.

Designing a Grid-connected PV Inverter System requires multiple numbers of auxiliary power supplies for gate drivers, sensors, relays, cooling fans, DSP, etc. which are meant to be low cost, simplified, reliable and efficient.

Traditionally for such application flyback converters are employed to generate isolated supply. Flyback topology typically uses asymmetrical turn's ratio transformer and an opto-coupler or a tertiary winding is required for reference feedback voltage. This makes it a bulky solution with a high number of component count subsequently increases BOM cost.

An isolated synchronous buck converter also known as "Flybuck" converter is a solution over this dilemma.This topology is a "synchronous buck" converter with a coupled inductor and a schottky diode for rectifying secondary side output voltage. The number of turns is ideally equal at both primary and secondary winding, connecting an opto-coupler or tertiary winding transformer is not required. As the secondary side output voltage can be regulated by primary side output voltage which results in the reduction of size, components, and cost.





Prof.
B. G. Fernandes

Dr.
Rajesh Farswan

Priya Sinsinwar

Alok Giri

bgf@ee.iitb.ac.in

Novel Bidirectional Z-source DC Circuit breaker

DC distribution is gaining attention due to its energy efficiency, high reliability and flexibility in connecting renewable distribution generation. With the emerging distributed energy resources and semiconductor technologies, DC distribution is selected for the applications such as low voltage micro grid, datacenters, naval ships, etc. The major concern while deploying DC grid is the design of protection under various fault conditions. Unlike AC systems, there is absence of natural current zero crossing during breaker operations in DC systems. Also, fault propagates faster in the DC system, so the protection device should be really fast. The circuit breakers that can be used for protecting DC systems are as follows:

1. Electromechanical circuit breaker: These are traditionally used in AC system. That can also be used for DC system after de-rating. It clears the fault in 2 to 3 cycles i.e. 60 msec.

2. Hybrid circuit breaker: Hybrid circuit: Hybrid circuit breakers are used for both AC and DC system protection. It is, basically, an integration of both electromechanical and solid state circuit breaker. Its fault clearance time is around 2 msec to 30 msec and current commutation process is really complex.

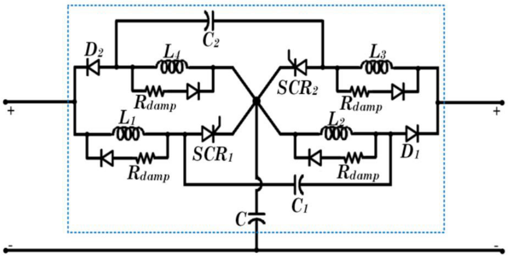


Figure: Bi-directional Z-source circuit breaker (Bi-ZSB)

3. Solid state circuit breaker: It uses the semiconductor device as the main switch, hence known as solid state circuit breaker. Its fault clearance time is less than 1 msec, which is faster than any other breaker.

Solid state circuit breakers commonly employ fully controlled device such as IGBT, as a main line switch. Hence, the occurrence of fault needs to be sensed and turn off command is to be provided to the switch using an external control unit, in order to clear the fault. However, use of sensors and external control unit makes system more complex.

Z-source circuit breaker is a type of solid state circuit breaker which uses SCR as the current breaking element. SCR turns ON when triggered through gate pulses and it turns OFF when the current through it falls below its holding current. Thus, no turn off command is required for SCR commutation. The Z-source breaker topologies make use of passive elements to achieve current zero crossing in power line, which assists the commutation of SCR. Therefore, Z-source circuit breaker can isolate fault without use of any sensing circuitry, unlike other solid state CBs and is capable of isolating the fault in tens of microseconds.

Z-source circuit breaker can be used to protect DC systems such as micro grid, data centers, EV battery system and naval ships. In such applications, power flows in both directions. These systems require circuit breakers which are capable of isolating the fault during either direction of power flow. Bi-directional Z-source breaker (Bi-ZSB) as shown in figure is designed and developed for similar applications. For forward direction of power flow, combination of inductors (L_1 & L_2) and capacitors (C_1 & C) are utilized to turn off SCR1 during fault condition. Similarly, for reverse direction of power flow, combination of inductors (L_3 & L_4) and capacitors (C_2 & C) are utilized to turn off SCR2 during fault condition. The novel circuit breaker is designed and developed for 380V, 16A. It isolates the fault within 300 microseconds.

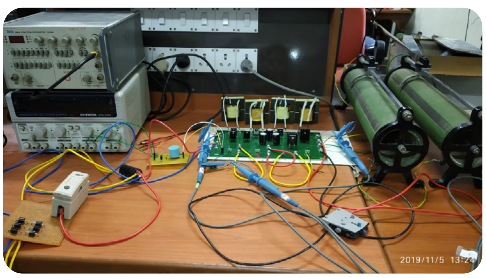
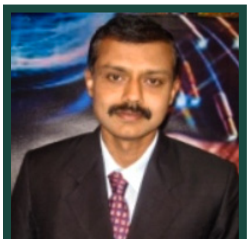


Figure: Breaker Testing Setup



Prof.
B. G. Fernandes

Dr.
Swati Sawaliya

Vibha Surwade

bgf@ee.iitb.ac.in

Towards GaN

For decades, Si has dominated the semiconductor market due to its abundance and low cost. Almost every circuit has some Si based component. Power Electronic circuits are no exception. To this date, most converters use Si transistors as switches. More than 60% of the space on a converter circuit board is occupied by bulk capacitors and magnetic components. Because these components transfer energy every second, their size depends on the operating frequency. Si fails to provide considerable size reduction in high power circuits because it struggles to operate efficiently at high frequencies (>100kHz). Hence, Si-based high-power solutions tend to be bulky. This is where GaN steps in.

GaN enables efficient operation at high frequencies (>100kHz) which means that the size of magnetic components can be decreased allowing for power efficient high-power density circuits. GaN based converters are more compact, dissipate lesser heat and pack more power per unit volume than their Si-counterparts. The BLDC driver under development at IIT-B uses GaN transistors to operate at higher frequency because at high frequencies, the current ripple and hence the amount of DC-Link capacitance required decreases. This means that smaller film capacitors can be used instead of bulky electrolytic capacitors. With GaN transistors, the team was able to increase the operating frequency to 4x that of initial prototype and get 50% theoretical reduction in DC-Link capacitance and 40% lesser losses per switch.

Owing to higher operating frequency, lesser losses and easier thermal management, the team was able to decrease the power stage size to 1/3rd that of the Si-based prototype. This allowed them to design modular half bridge cards (daughter boards). 3 such daughter boards when plugged into a motherboard (which carries DC-Link capacitors) complete the power stage of the BLDC driver. This plug-n-play features makes the motor driver highly modular. In case of a failure in any of the phases, the corresponding daughter board can be simply pulled out and replaced like a Lego block. This modularity facilitates easy debugging, quicker maintenance and shorter downtime.

Si vs GaN Technology (100-650V range device)

Criteria	Si	GaN	Reason
Operating Temp	Lower	Higher	GaN has higher Bandgap than Si
Operating Freq	Lower	Higher	GaN device has lower C_{ISS}, C_{OSS} meaning faster turn-on, turn-off and lower switching losses
Device Size	Bigger	Smaller	GaN has higher critical elec. field, which means for same breakdown voltage, GaN device can be much smaller ($V_{BR} = 0.5*w_{drift}*E_{crit}$)
RDS-ON	Higher	Lower	Higher electron density and much smaller drift region in GaN
Device Parasitic	Higher	Lower	Instead of Au bond wires, modern GaN devices have a “laminated structure” interconnected with thick Cu-filled vias for terminal connections
Cost	Lower	Higher	Fabrication Complexity

Figure:Power stage of driver with 3 daughter cards and DC-Link capacitors installed

Prof. B. G. Fernandes

Pushkar Chaudhari

Pranit Pawar

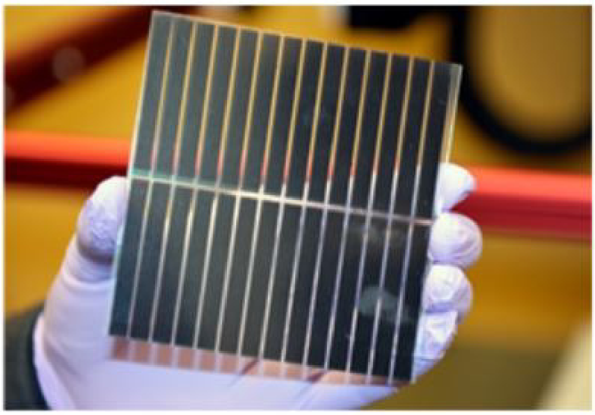
bgf@ee.iitb.ac.in

Can Perovskite replace Silicon Solar Cells: *Challenges and Strategies!*

The recent advancement in the efficiency of Perovskite Solar Cells (PSCs) from 3.9% to 25.5% in a decade has brought the spot light of PV community on these wonder materials. Now, the efficiency of PSCs is comparable to crystalline Silicon solar cells, there are efforts to make this technology commercially viable due to inherent understanding the use of small energy budget to prepare these cells. It is agreed in community that, this technology has less energy payback and financial payback then current technology. Furthermore, the tunable bandgap of lead halide perovskite makes a suitable candidate for the Si/Perovskite tandem solar cell with an opportunity to increase energy generation yield without affecting much on production cost. However, researchers still don't know understand fully how does lead halide perovskite works so well despite of ion migration, defects sort of challenging known problems, which are hindering its stability aspects and preventing it to enter in commercial level. At, NCPRE, the Thin-film group is trying to address some of these concerns via device and photo-physics with these wonder materials.

In a recent review article, Prof. Kabra's group explained the different kinds of imperfection and discussed their impact on the charge carrier transport in the PSCs through optical studies. The imperfections such as heterogeneity at different length scales, static vs dynamic disorders, defects in the bulk, at the surface, grain boundaries, and at the interfaces of the solution-processed hybrid metal halide perovskite semiconductor are known to be detrimental for the solar cell performance. These imperfections influence the voltage losses and charge transport by the formation of undesirable non-radiative channels. The photo-generated charge carriers recombine via these non-radiative channels and hamper the performance of perovskite solar cells (PSCs). Scientists are aiming to decode the nature of these defects by having a better understanding of their origin and developing novel engineering techniques for the passivation of defect states. Finally, this review provides an insight into the defect dynamics and passivation strategies that allow us to understand the nature of defects and helps in the development of future trends in passivation methods.

a)



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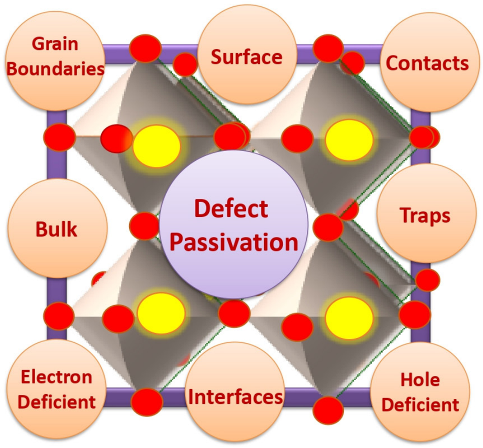


Figure: a) Perovskite solar cells (image credit: OIST) b) Schematic representation for passivation of bulk defects, surface & grain boundaries defects, and interlayer defects for the thin film based PSCs.

Link: https://iopscience.iop.org/article/10.1088/1361-6463/abb487

Dr. Singh
(Project Research Scientist)

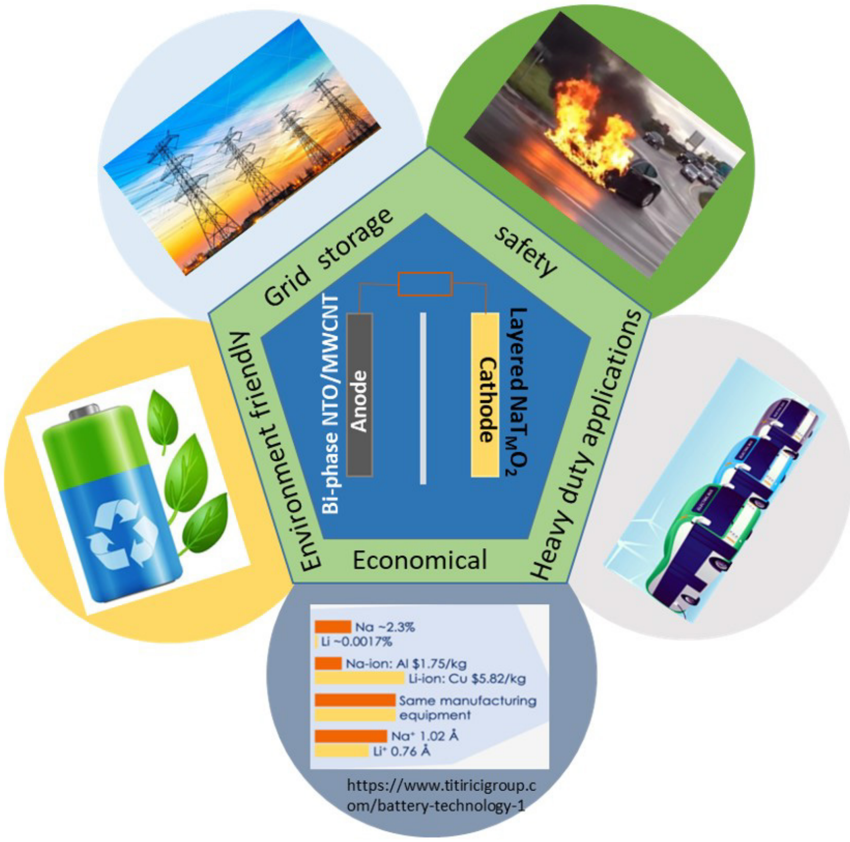
Prof. Kabra
(PI- Thin Film Head)

Laxmi
(Research Scholar)

dkabra@iitb.ac.in

Towards the development of fast, stable, health/environment friendly and sustainable Na-ion batteries

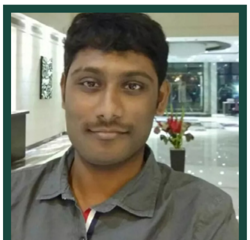
Currently Li-ion batteries dominate the market share, powering electronic gadgets and electric vehicles world over, due to their high energy density and design flexibility. However, the scarcity of Li-reserves and rapidly increasing demand for Li-ion batteries for widespread applications strongly defy sustainability. Accordingly, the need for developing less expensive and sustainable alternatives has directed the focus towards the upcoming Na-ion battery system; especially in countries like India, which is third largest producer of sodium.



However, there are certain bottlenecks associated with the Na-ion battery system. One among them is the availability of a safe and electrochemically stable anode material; since graphite, the work-horse anode material in 'conventional' Li-ion batteries, does not work for Na-ion batteries. A popular potential anode material is hard carbon, but which possesses issues concerning safety and irreversibility. The other bottleneck is the absence of a cathode material which promises high energy density, exhibits 'long-term' electrochemical stability and possesses stability upon exposure to air/water. Against these backdrops, the NCPRE research team working under Prof. Amartya Mukhopadhyay have addressed both the above issues by leading to the development of a 'bi-phase' Na-titanate based anode material and compositionally/structurally engineered high Na-containing 'layered' Na-T_M-oxide (T_M => transition metal) based cathode material. The 'bi-phase' Na-titanate based anode possesses a 'safe' operating potential, exhibits very long-term stability upon repeated discharge/charge and allows for extremely fast charging/discharging, so much so, >80% of its Na-storage capacity can be accessed in < 3 minutes. At the cathode front, our newly developed Na-T_M-oxide not only exhibits very good long-term cyclic stability, but also inherently possesses excellent stability against degradation in the presence of moisture/water (unlike other variants); thus enabling electrode preparation via the health/environment-friendly and cost-effective aqueous route, which, in itself is a significant development for the Na-ion battery system.


Prof. Amartya Mukhopadhyay


Anagha Pradeep


Bachu Sravan Kumar

amartya_mukhopadhyay@iitb.ac.in

Understanding Leakage Currents in PV Modules

Solar Photovoltaic (PV) modules in PV plants are connected in series to form strings as it is economical to evacuate power at higher voltages and lower currents. As the frames of PV modules and the metallic structures on which they are mounted are grounded, the electrical cell circuitry in some modules in a PV plant would experience a high voltage with respect to the frame.

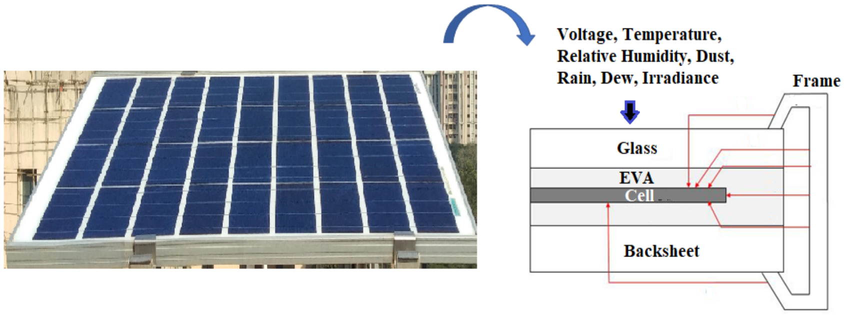


Figure : Leakage current paths in a module

This results in the flow of leakage current through the various module layers such as front glass, encapsulant, and backsheet (as shown in the figure above). The leakage current is critical when the reliability and normal operation of the PV plant is concerned. For example, the inverter only functions when the insulation resistance (voltage divided by the leakage current) is higher than a minimum threshold. The leakage current has also been correlated to the Potential Induced Degradation (PID) in PV modules. When the cell circuitry is at a negative potential with respect to the frame/ground, the sodium ions from the glass move towards the cells. Some of these ions get trapped in certain defects (stacking faults) in the solar cells, thus resulting in localized shorting (shunting) of the P-N junction. On a considerable scale, this can lead to a significant reduction in the shunt resistance of the PV module, which leads to power loss due to PID.

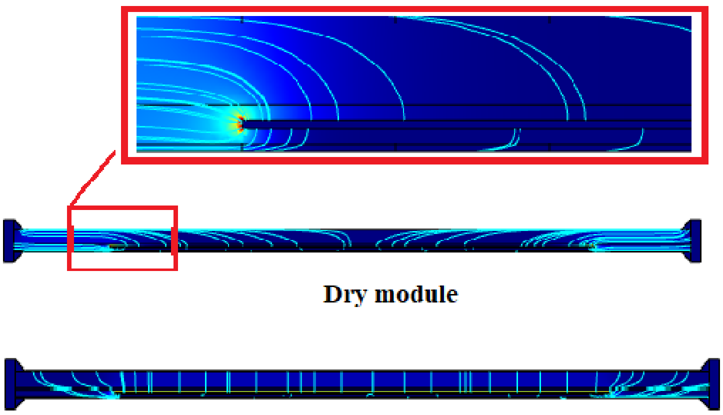


Figure : Electric field distributions in a dry and wet module

Glass has the lowest resistivity (and highest thickness) among the materials used in PV modules, followed by EVA. Thus, the majority of the leakage current flows through the glass and EVA (as shown in the adjacent figure). The leakage current takes the shortest path and is concentrated in the region of EVA and glass between the cell and the frame. Thus, the use of high resistivity glass or encapsulant is an effective strategy in reducing the leakage current in PV modules. In addition to the materials, the leakage current strongly depends on the module temperature, as it exponentially increases with the temperature.

Moreover, it has been observed that the leakage current increases considerably when the module is wet (during the events of rain or dew). The root cause behind this increase is a change in the orientation of the electric field in a wet module, which leads to an increase in the effective area through which the current can flow, and not the ingress of water inside the module. Thus, the leakage current in PV modules depends on various system and environmental factors and also on the materials, the properties of which can be altered to reduce the module leakage current.

Prof. Narendra Shiradkar

Prof. S V Kulkarni

Anagha E R

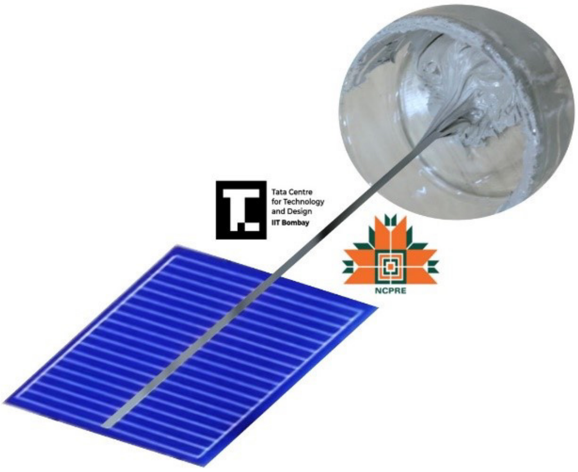
naren@ee.iitb.ac.in, svk@ee.iitb.ac.in

Perfecting the current to build for the future: *Silver Pastes for Current and New Generation Silicon Wafer Solar Cells*

With the rapidly increasing solar PV installations in the country, it is expected that within the next several years, solar PV will become a significant contributor to India's power requirements. Atmanirbhar Bharat Abhiyan is providing a significant push to developing raw materials and components within the country. In line with the Abhiyan, we have been working towards the development of PV grade silver paste used in the manufacturing of silicon solar cells. At the present solar cell production output, India imports around 50 tons/year of silver paste worth around INR 500 – 700 Crores per year.

Besides silver powder, the silver paste typically contains organic additives to make it screen printable and a customized glass powder in minor amounts which helps to etch the silicon nitride anti-reflection coating (ARC) during firing at elevated temperatures. The nature and amount of organic additives have to be highly customized to achieve a flow behaviour (rheology of paste) such that current collection grid lines of fine width can be printed on the ARC deposited silicon wafer. Etching the ARC layer, the glass powder also plays a crucial role in precipitating fine silver particles at the interface of the wafer and paste to develop the desired electrical contact.

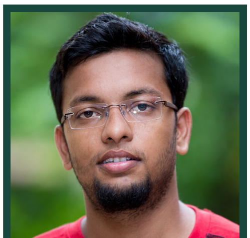
Utilizing our experience in materials synthesis and designing of the flow behaviour of slurries and pastes, we initiated the work on the development of silver pastes. In the past 2-3 years, we have developed our silver powders, glass powder of suitable composition and formulated screen printable pastes. The NCPRE facilities were utilized to screen print as well as fire the wafers in both batch and continuous furnace to fabricate the solar cells. Till date, the best performing cells with our paste yielded 15% photo-conversion efficiency. Efforts are currently underway to establish the silver paste composition for the presently most popular industrial configuration of mono-crystalline p-type silicon wafers for Al-BSF and PERC architecture. Once pastes with superior repeatable performance are obtained, the knowledge would be applied to develop pastes for the emerging n-type silicon wafers solar cell technologies such as the HJT TOPCon followed by bifacial architectures also. We would be happy to receive any inputs from the industry towards the work being carried out on paste development and at a suitable time also seek their assistance in the evaluation of the pastes.



Prof.
Parag Bhargava

Dr.
Ashok Kumar Sharma

Shiwani Pareek



Mueed Ahmad

pbmatsc@gmail.com

Spectroscopic Ellipsometer

Figure : SE-2000 spectroscopic ellipsometer installed in NCPRE Si solar cell fabrication lab.

SE-2000 is a Spectroscopic Ellipsometer capable of spectroscopic measurements covering a large spectral range from ultraviolet to near-infrared within a few seconds. The analysis software is able to determine the thickness and optical constants (refractive index and extinction coefficient) of coatings in single (up to ~ 100 µm) or multi-layer stacks. The tool has the capability to rotate the goniometer arm from 12^o to 90^o, which allows it to measure the properties of the film deposited of various substrates (glass, PET foil, etc.) in addition to Si. The tool can automatically focus the sample under measurement, which reduces the error due to manual focusing. There are two different chucks provided based on the substrate type; normal chuck can measure the film properties on polished Si, glass, PPE foil, and textured multicrystalline Si, and solar stage for the measurement on textured mono-Si samples. In addition to the point measurement of thickness and optical constants, it can also perform the 2-D mapping of these parameters. The tool can not only measure the thickness and optical parameters of monolayer film but also it can also measure the parameters on multilayer films stacked on the substrate. 2D mapping and stack measurement capabilities are restricted only for normal chuck. However, the solar chuck can provide results for point measurement only. The tool has inbuilt models/libraries for the wide range of materials including oxides, glasses, III-V compounds, II-VI compounds, metals, plastics, organics, silicides, silicon, and its compounds. These all specifications enable the usage of the tool to a wide variety of substrates and films (single as well as stacks).

Pi_ncpre@ee.iitb.ac.in

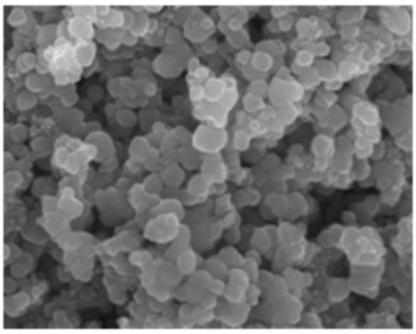
Performance evaluation of dye sensitized solar cell fabricated with ZnS modified TiO_2 photoanode

-A project carried out, at NCPRE under PUMP, by Vikash Kumar (User), Dr Ajay Bansal (Principal Investigator) Dr. Renu Gupta (Co-principal Investigator) Dr. B. R Ambedkar National Institute of Technology, Jalandhar (Punjab).

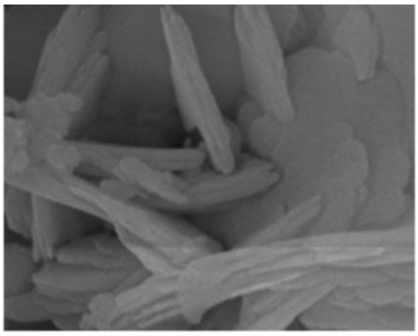
I feel very privileged to have the opportunity to work at NCPRE in the prestigious institute, IIT Bombay. My project entitled "Performance evaluation of dye sensitized solar cell fabricated with ZnS modified TiO_2 photoanode" was approved under Photovoltaic Users and Mentorship Programe (PUMP) at NCPRE, IITB. The project was supported with all the necessary Chemicals, testing facility and TA/DA. This kind of initiation is not only promoting research in the field of photovoltaic but also providing access to sophisticated lab facilities for carrying out research projects with innovative ideas. I am grateful to Dr. Diksha Makwani and Dr. Dinesh Kabra for providing me all the work facility. I am thankful to all the scientific and technical staff of NCPRE for their support. Also thank to all the office staff especially, Ms Ashwini Bangera, Sr. Project Assistant, NCPRE IIT Bombay for their timely help.

Vikash Jaiswal

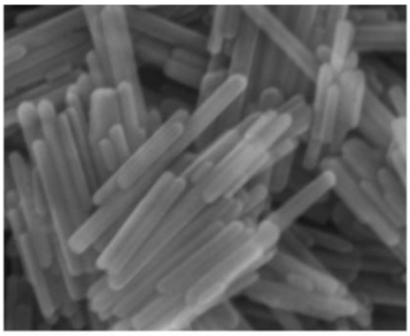
In this work, the photovoltaic efficiency of DSSCs fabricated with different nanostructures of TiO_2, ZnO and ZnS have been studied. The TiO_2 was synthesized by solgel method, ZnO was prepared by hydrothermal route and ZnS was synthesized by alocohothermal method. The synthesized nanostructures were subjected to characterizations by field emission-scanning electron microscopy (FE-SEM), energy Dispersive X-Ray Spectroscopy (EDS), X-ray diffraction (XRD), and X-ray photoelectron spectroscopy (XPS). Further, the synthesized nanostructures were used as photoanodic material for the preparation of photoanode. The photoanodes were sensitized with different organic and inorganic dyes. The cells were fabricated using sensitized photoanode, electrolyte and pencil graphite based counter electrode. The performance of the cells was investigated by measuring the photoconversion efficiency using I-V characteristics instrument under simulated solar light ($100 mW/cm^2$). These results indicated that modification of the TiO_2 and ZnO photoanode by ZnS can play a major role in maximizing the photo conversion efficiency.



TiO_2 nanoparticles



Zinc sulfide nanoflowers



Zinc oxide nanorods

Dr. Ajay Bansal

Professor
Department of Chemical Engineering
Dr. B R Ambedkar National Institute of Technology
Jalandhar, Punjab-144011
e-mail: bansala@nitj.ac.in

Dr. Renu Gupta

Associate Professor
Department of Chemical Engineering
Dr. B R Ambedkar National Institute of Technology
Jalandhar, Punjab-144011
email: bansalr@nitj.ac.in

Publications

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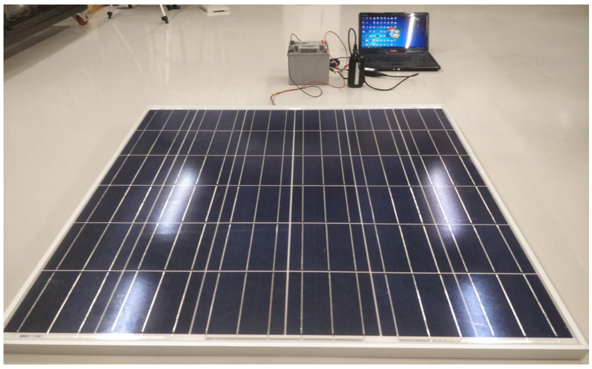
Is Poor Electricity Connection Hampering Your Experience of Online Education? Read This!



COVID-19 pandemic has caused lecture delivery to shift to online mode for several institutes across the world. Some students are facing disruptions in remotely attending the online lectures due to unreliable / intermittentelectricity connection. The National Centre for Photovoltaic Research and Education (NCPRE) at the Department of Electrical Engineering, Indian Institute of Technology Bombay (IITB) has prepared a comprehensive instruction manual to address this issue.

This manual provides some reasonably low cost Do It Yourself (DIY) solutions to provide an alternative solution to students to charge their smartphones / laptops using their existing chargers. The solutions in this manual are presented in such a way that the students themselves can choose the most appropriate system for their needs procure the components, and perform assembly and basic maintenance of the systems.

Use of solar panels for providing electricity for off-grid applications is not new. There are several instructional videos / websites available that describe various kinds of small, solar PV + battery based off grid systems. However, the sizing and bills of materials of these systems needs to be optimized for the specific end-use application. The manual, we have proposed systems that are useful for charging the laptops twice a day.

Design Philosophy: Our motivation is to provide system designs that would provide the bare-bones, essential functionality to meet the goal at the lowest possible cost. This is important because the students are expected to purchase the components for these systems on their own. Also, we targeted a service life of 1 year for the systems.

Since its launch on September 22, 2020, this manual has been shared with various engineering colleges in India affiliated with AICTE and it has received over 11,500 reads by October 1, 2020.

For more details please follow the link: https://bit.ly/2FUu9zs

Prof. Narendra Shiradkar

Kedar Deshmukh (Senior Research Fellow)

Achievements

Dr. Shivam Singh is a Project Research Scientist at National Centre for Photovoltaic Research and Education (NCPRE), Indian Institute of Technology (IIT) Bombay, Mumbai. Before joining NCPRE, he worked as a Research Associate at the Department of Physics, IIT Bombay. He did his Ph.D. at Department of Physics, NCPRE, IIT Bombay, India, in the research group of Prof. Dinesh Kabra. Among approximately 120 students pursuing their PhD in the Physics Department of IIT BOMBAY, where Dr. Shivam Singh has won the "Award of Excellence in PhD 2020" from IIT Bombay. His research interest focuses on the understanding of photo-physics of metal halide perovskite semiconductor, fabrication of perovskite based optoelectronic devices (perovskite solar cells and light emitting diodes) to understand the charge transport properties, recombination dynamics, electronic states and element analysis studies. Currently, he is working on fabrication of semi-transparent perovskite solar cells for tandem application.

Link for Google Scholar: Dr. Shivam Singh

https://scholar.google.com.au/citations?user=2QqVe7gAAAAJ&hl=en

Dr. Shivam Singh

Indo-UK workshop on Soiling: *Effect of soiling and mitigation strategies*

The Indo-UK PV Soiling workshop is being organised during October – November 2020. The joint workshop is supported by the Department of Science and Technology and the British Council. Accumulation of dust (also called soiling) on photovoltaic (PV) modules is recognised as a serious challenge to the economic viability of PV deployment in many of the sun-belt countries, including India. This meeting will bring together experts in the field looking at various aspects of soiling to discuss topics ranging from economic impact of soiling loss, dust mitigation strategies, effect of robotic cleaning, reliability and development of anti-soiling coatings, etc. We will have speakers from academia and the industry which will enable us to bridge the gap between the two sectors. This, we hope, will bring forth new collaboration between India and United Kingdom to come up with solutions to make solar PV an economical and reliable source of energy.

You are requested to confirm your participation by registering using the link given below. Participation fee- free of cost. If you have any queries regarding the same, please email us at **sonalibhaduri@iitb.ac.in.** You will receive the link to the workshop a couple of days before the event.

Click here to register!

You can also scan the QR code on a phone or tablet to access the registration form.

International Conference on Perovskites for Energy Harvesting: *from Fundamentals to Devices*

The International Conference on Perovskites for Energy Harvesting: from Fundamentals to Devices **(PERENHAR)** is organised in an online mode under nanoGe (A platform with established technical expertise in conducting series of online conferences on Energy research). It will take place from 19th to 20th November, at 08:00 UTC / 13:30 h India Standard Time (IST) / 09:00h CET-Berlin-Paris.

It is widely known by now that metal halide perovskites have been a relatively new entrant in the photovoltaic arena, the high efficiencies achieved over a short span of time have turned the spotlight on them and a similar trend is being observed for light-emitting-diodes. This meeting will bring together experts in the field looking at various aspects of these materials to discuss topics ranging from the fundamental properties of the materials involved, their use in optoelectronic devices and beyond like piezoelectric nanogenerators. We will cover the aspects of materials, device engineering for improved efficiency and advanced characterization techniques. This, we hope, will bring forth the advances made as well as the problems that still limit their applications to a wider community.

Our plenary speakers are Prof. Sir Richard H. Friend, UCAM, UK, Prof. Prashant V. Kamat, Notre Dame, USA, Prof. D. D. Sarma, IISc Bengaluru and Prof. Henry J. Snaith, Oxford, UK and we expect additional distinguished speakers from various institutes/universities across India.

Chasing dreams *Prof. Amartya Mukhopadhyay*

Having worked with ceramic materials during my Masters (at IIT Kanpur) and PhD (at the University of Oxford), looking primarily into the structural and mechanical aspects, I was keen on taking the knowledge forward towards another application of such materials. That opportunity arrived when I got to focus on electrode materials for Li-ion batteries during my post-doctoral stint at Brown University and I was very happy to grab the opportunity. Of course, at that time I did not realize that Li-ion batteries and electrochemical energy storage per se would assume so much importance in the present-day world, but got very interested in the associated science and, in particular, the materials-electrochemical perspectives.

Having gained experience in working on different aspects associated with Li-ion batteries and the associated interest towards the same, I was determined to continue my research in this area upon joining IIT Bombay as a faculty member (almost 9 years back). I was also keen on expanding the domains in the context of research on electrochemical energy storage systems/technologies per se. While doing so, it becomes essential to keep the interests of the nation in mind. In this context, despite still continuing to work on various aspects associated with the Li-ion battery system, I started venturing into battery chemistries, beyond the Li-ion system. It was apparent that considering the vast resources of Na(-precursors) present in India, as opposed to nearly no Li-source, it is the Na-ion battery system that needs a good look into and developed to substitute for the Li-ion battery technology for some of the applications in the Indian contexts.

This is where the support and motivation from NCPRE needs to be acknowledged, since it helped working with the Na-ion battery chemistry, unravelling the science/sub-mechanisms, addressing the bottlenecks and taking it forward towards the development of Na-ion battery systems.

On this note, I would like to thank the highly dedicated research scholars and post-doctoral researchers of my group, who have been successful towards addressing various issues, coming-up with new insights (often aided by operando experiments) and progressing towards the development of high performance, stable, safe and environment friendly alkali metal-ion battery systems (including, Li-/Na-/K-ion and solid-state battery systems).

Prof. Amartya Mukhopadhyay

amartya_mukhopadhyay@iitb.ac.in

NCPRE houses state-of-the-art Solar PV research facilities which is being used by Industry and Academia in India

Contact details:

NCPRE website: www.ncpre.iitb.ac.in

Email: ncpre@iitb.ac.in/ pi_ncpre@ee.iitb.ac.in

Phone: 022-25764475/79/80

Acknowledgments

- Ministry of New and Renewable Energy (MNRE) for financial support to NCPRE
- IIT Bombay for infrastructural support
- All faculty, Students and Staff at NCPRE