Our Research at IIT-Madras

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Ph.D. (2013)–Swiss Federal Institute of Technology (EPFL)
Postdoc. (2014-16) – University of California Berkeley &
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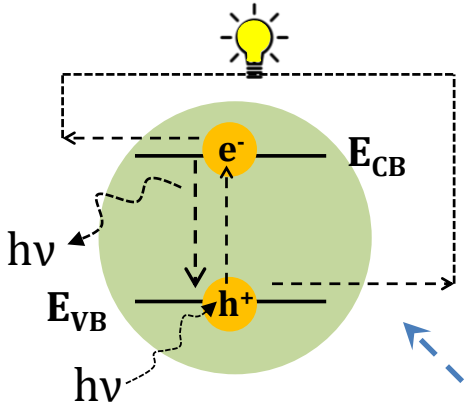
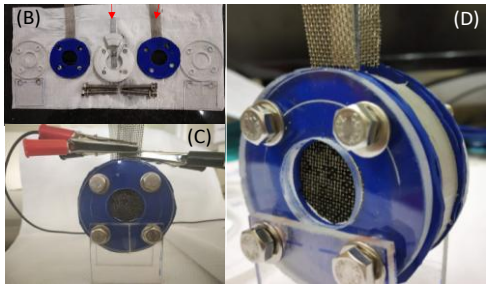
Perovskites solar cells
Light emitters

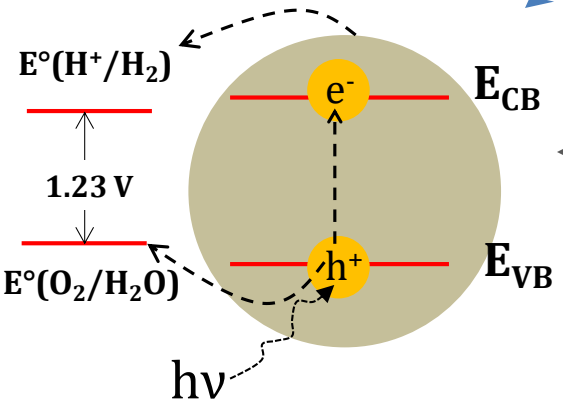


Metal-air batteries for EVs



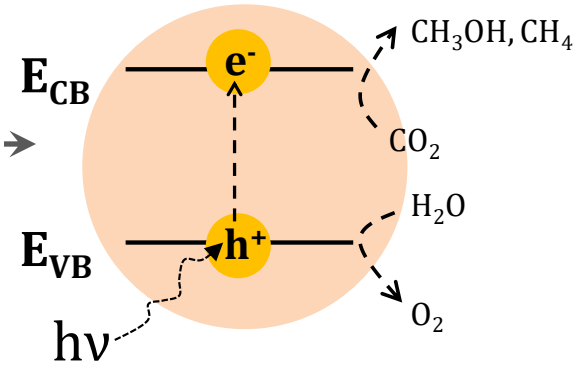
Lithium-ion batteries
operational safety

(Photo) Electrochemistry



$H_2O \rightarrow H_2$ (Water splitting to generate Hydrogen)

Solar Fuels



$CO_2 \rightarrow CH_3OH, CH_4$
Carbon dioxide recycling

My Research Group

Principal Investigator: Dr. Aravind Kumar Chandiran
Postdocs (6): Dr. A. Tamilselvan, Dr. S. Arun Kumar, Dr. B. Prerna, Dr. S. Mohan, Dr. S. Alamelu, Dr. Abinash Das
Ph.D.(13): Maruthi Mala, Puneet Siwach, Poonam Sikarwar, Phani Chandra, Sivaram Prasad, Muhammed Hamdan, Akhil Kongara, Jigar Halpati, Gunjan Kapadia, P. Govardhan, Shubham Rajput, Abhishek Anand, Manasa Manoj.
M.S.(1): Nitharshni R.G.
Project Associates (6): Indraja Konneri, Indu Bala, Shweta Shinde, S. Nandhini, P. Alagammai, S. Keerthana *(UG/M.Techs not included)*

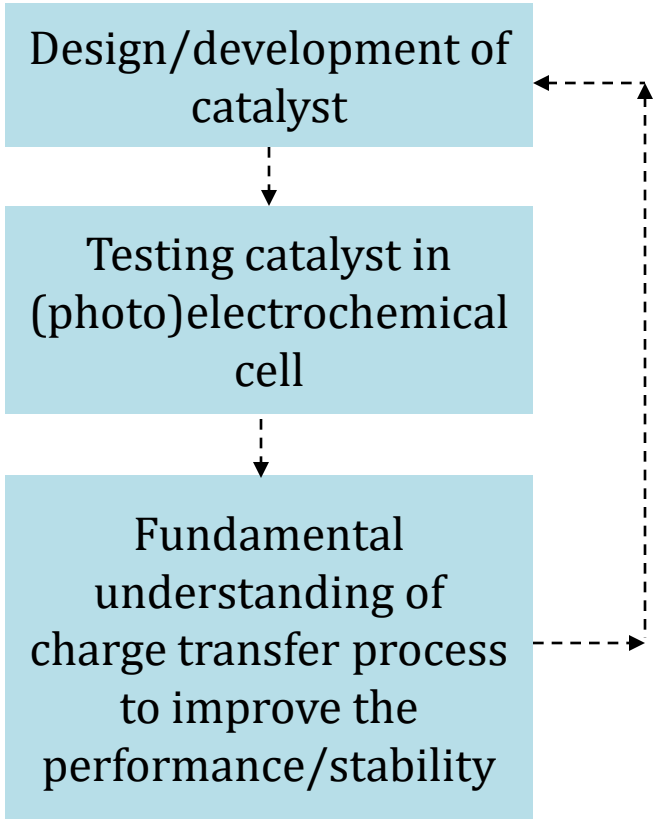
Our Funding Agencies/Partners

DEPARTMENT OF BIOTECHNOLOGY
Ministry of Science & Technology

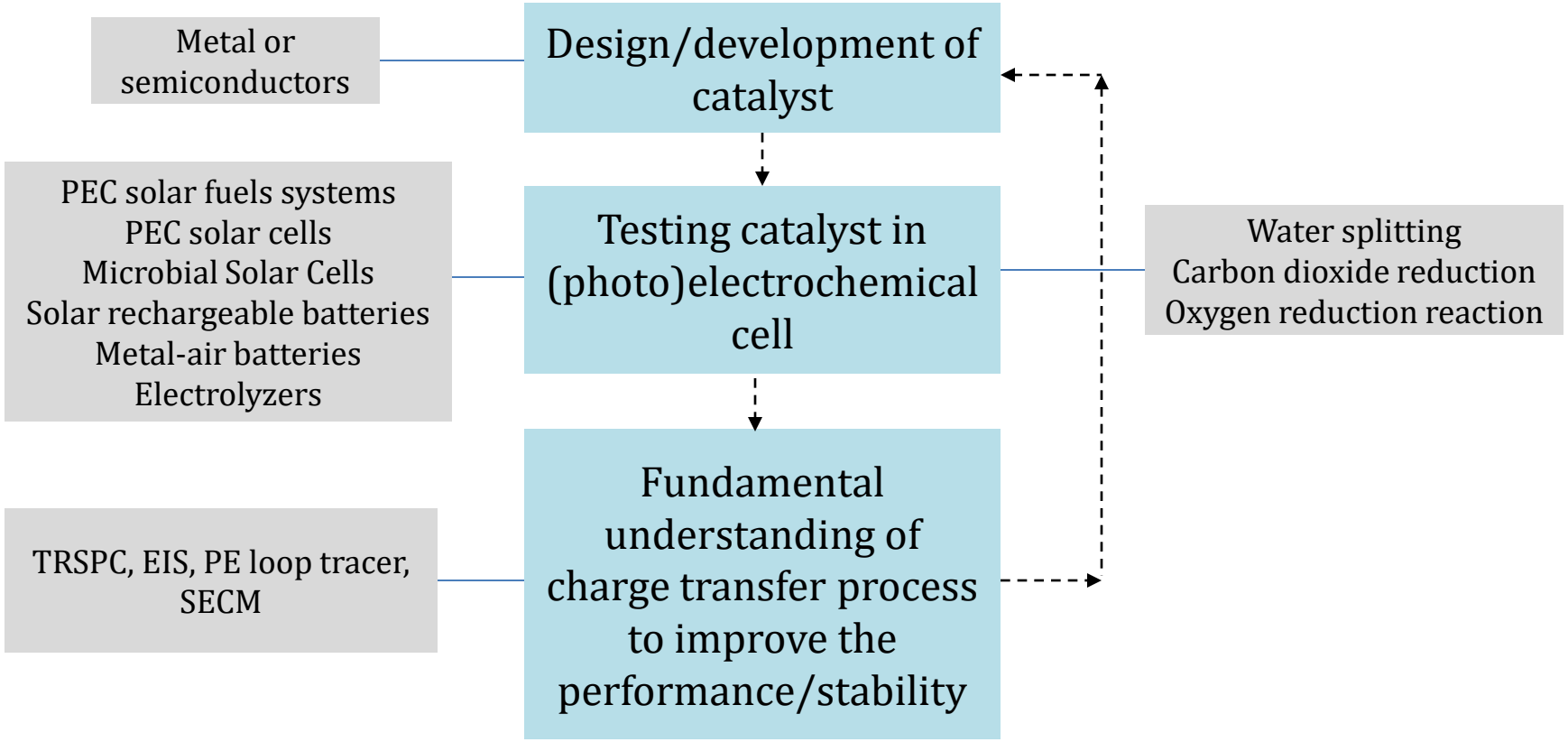
सत्यमेव जयते
Department of Science and Technology (DST)
DST
NANOMISSION

IMPACTING RESEARCH INNOVATION AND TECHNOLOGY

Our Research Strategy



Our Research Strategy



National/International Accolades

October 2021 - INSA Medal for Young Scientists
(Indian National Science Academy)

October 2021 - American Chemical SocietyEnergy & Fuels Rising Star
(only 2 Indians listed)

November 2021 - NASI Young Scientist Platinum Jubilee Award
(National Academy of Sciences, India)

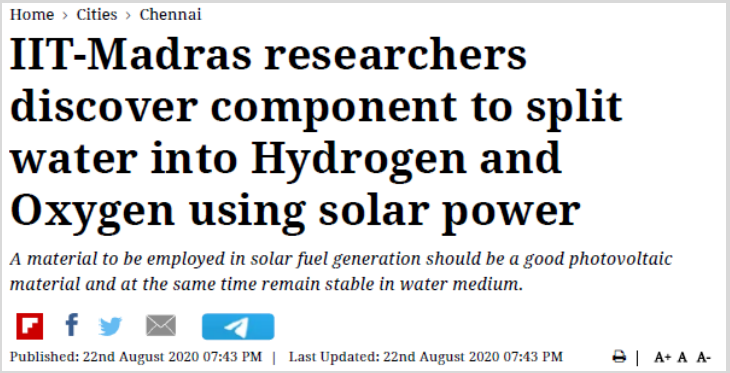
March 2021 - DST SERB Technology Translation Award
(Science & Engineering Research Board, GoI)

NDA/MoU with our lab at IIT Madras

Key Outcomes

Discovered the most stable semiconductor for solar water splitting

We discovered the **world's most stable semiconductor (Cs_2PtI_6)** that is stable even in strong acids and bases (XRD patterns below). Demonstrated successful solar water splitting.



Home › Cities › Chennai

IIT-Madras researchers discover component to split water into Hydrogen and Oxygen using solar power

A material to be employed in solar fuel generation should be a good photovoltaic material and at the same time remain stable in water medium.

Published: 22nd August 2020 07:43 PM | Last Updated: 22nd August 2020 07:43 PM | A+ A A-

The Indian Express – 22 August 2020

CHENNAI

IIT Madras researchers discover new material to split hydrogen and water using solar power

SPECIAL CORRESPONDENT

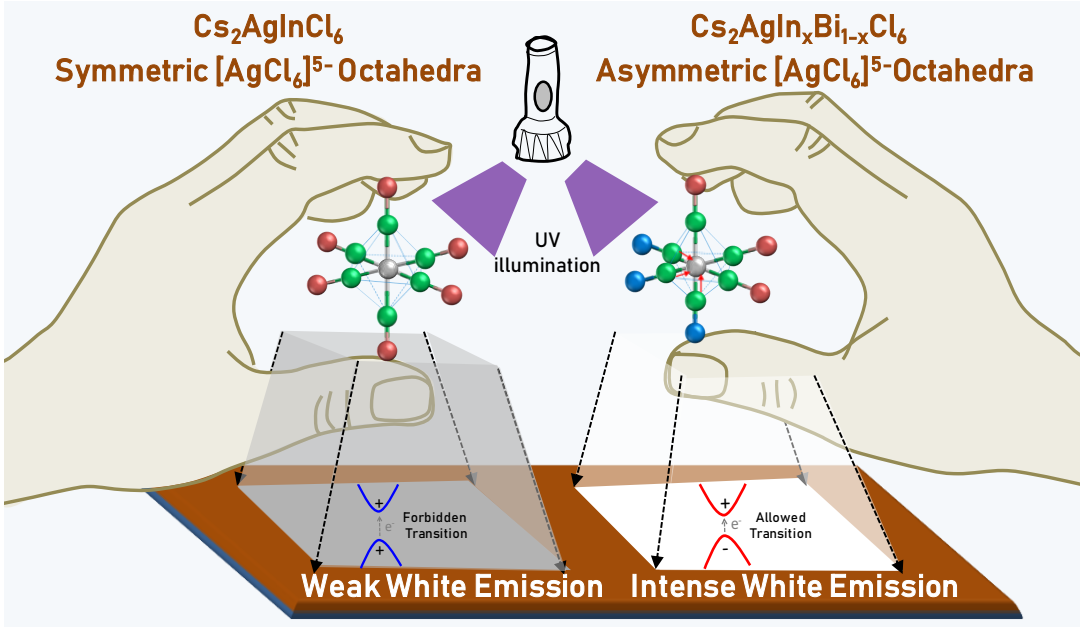
CHENNAI, AUGUST 21, 2020 17:08 IST
UPDATED: AUGUST 21, 2020 17:08 IST

The research is expected to bring the conversion and storage part in a single system, which would reduce the cost per kWh of solar energy, a press release said

The Hindu – 21 August 2020

Angewandte Chemie International Edition, 2020, DOI: 10.1002/anie.202000175
ACS Applied Materials and Interfaces, 2021, DOI: 10.1021/acsami.0c22654

Invented ambient stable bright white light emitting semiconductor



Science and Technology

FROM THE LABS

White light LEDs

| Updated on August 29, 2021

Conventional LED materials do not emit white light — specialised techniques, such as blue coating, are used to produce white light. Globally, there is a look-out for materials that can emit white light straightaway.

Now, researchers at IIT-Madras have developed a white-light emitter for use in LEDs. A team comprising professors Aravind Chandiran, Ranjit Nanda, Tamilselvan Appadurai, Ravi Kashikar, Poonam Sikarwar and Sudhadevi Antharjanam has been working on crystalline materials called 'halide perovskites' for various applications due to their extraordinary opto-electric

The Hindu Business Line, 29 August 2021

Indian Patent ID#1906: Appl. No. 201941046554; PCT Application No. PCT/IN2020/ 050951

WON DST-SERB TECHNOLOGY TRANSLATION AWARD

communications materials

ARTICLE

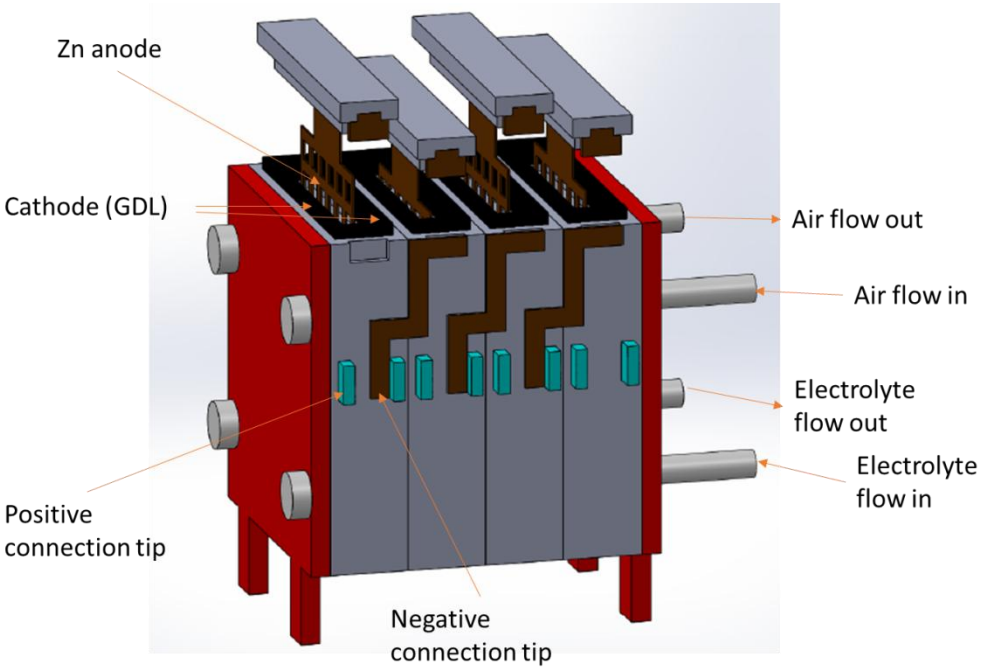
https://doi.org/10.1038/s43246-021-00172-9 OPEN

Check for updates

Manipulation of parity and polarization through structural distortion in light-emitting halide double perovskites

Tamilselvan Appadurai[1], Ravi Kashikar[2], Poonam Sikarwar[1], Sudhadevi Antharjanam[3], Birabar Ranjit Kumar Nanda[2,4,5]✉ & Aravind Kumar Chandiran[1,6]✉

Batteries for Electric Vehicles



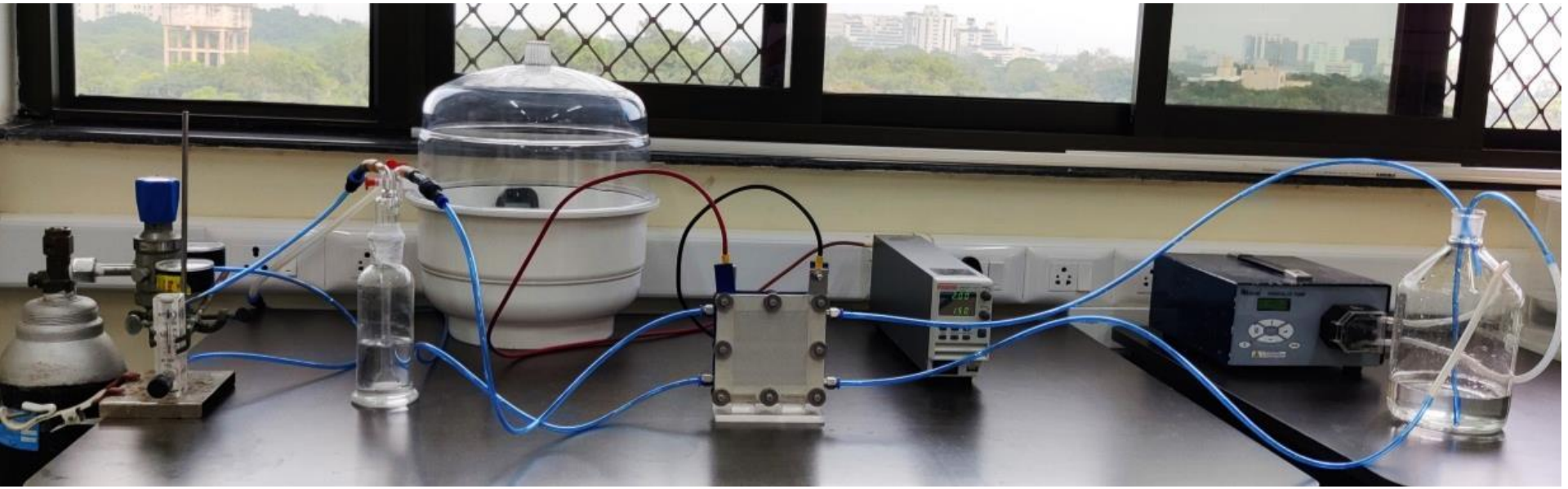
Mechanically rechargeable zinc-air batteries/pack for EVs

USP of our indigenous EV battery technology

-Ultrafast recharging (<10 minutes)
-Use of local resources
-Performance tuned for intra-city/short-range EVs/ stationary energy storage

(patenting in progress)

Large Area CO_2 Electrolyzer



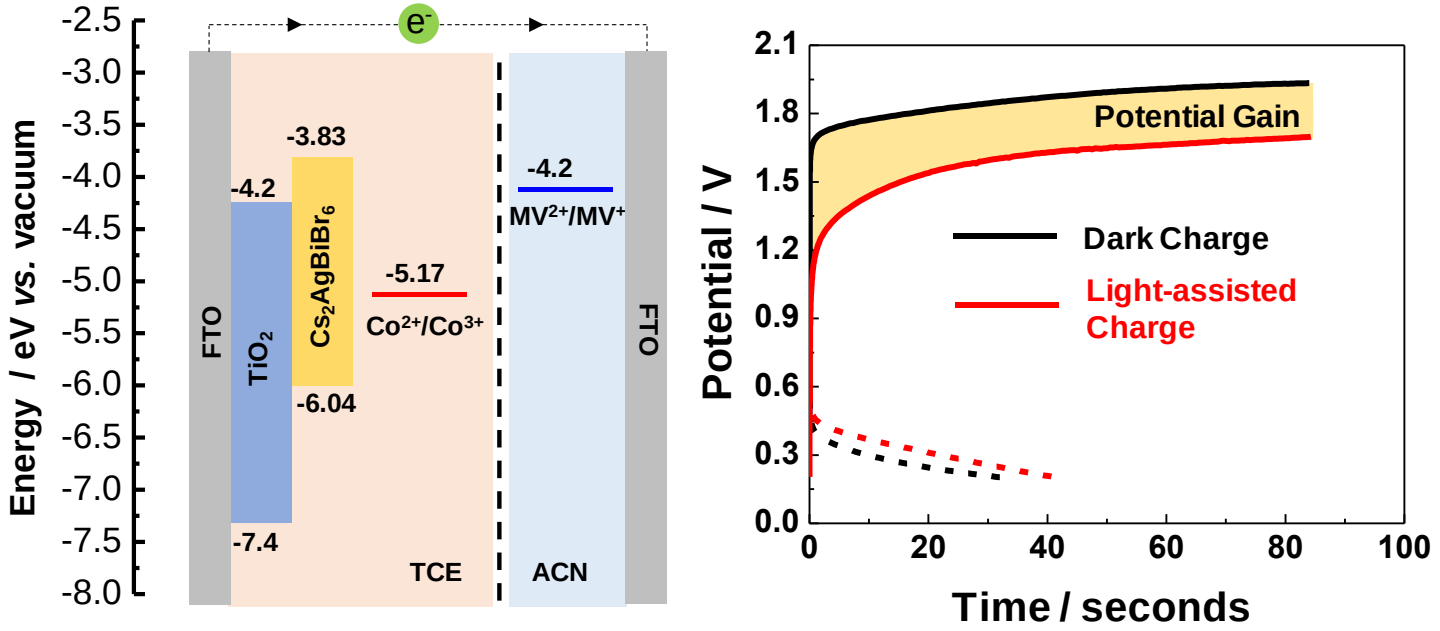
USP of our CO_2 electrolyzer

- Produces syngas ($CO+H_2$) from carbon dioxide
- Electrolyzer uses solar power for syngas production

w/Prof. Raghuram Chetty

Direct Solar Energy Storage in Redox System

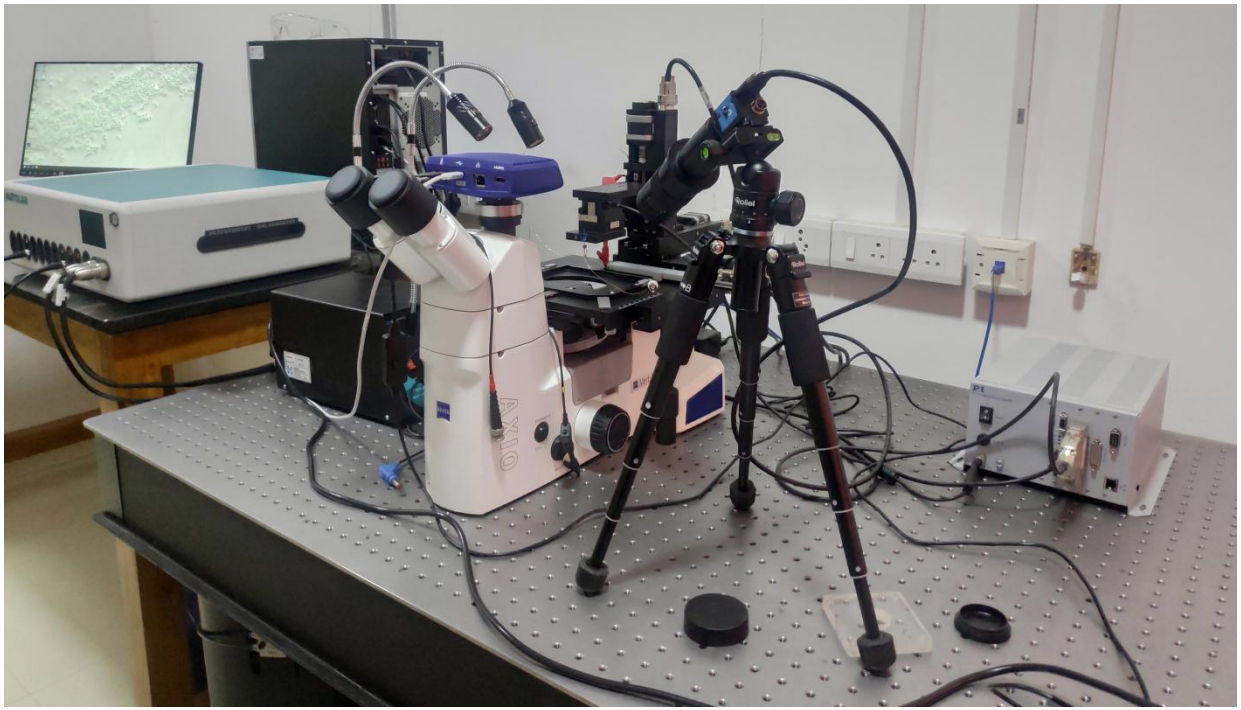
A rather fundamental research. Harvesting and storing solar energy is achieved in a single device.

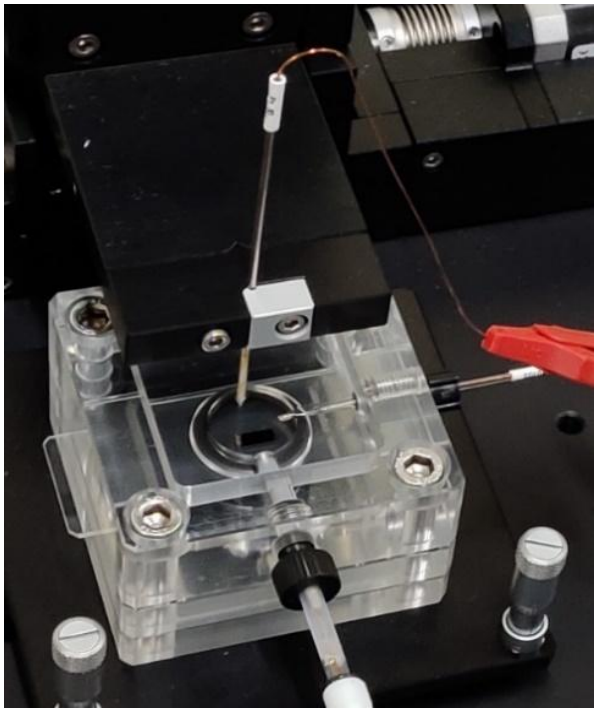


Solar energy storage in $Cs_2AgBiBr_6$ halide double perovskite photoelectrochemical cell. *ChemComm*, 2020, DOI: [10.1039/D0CC02743J](https://doi.org/10.1039/D0CC02743J)

Our facilities

Scanning Electrochemical Microscope (SECM)

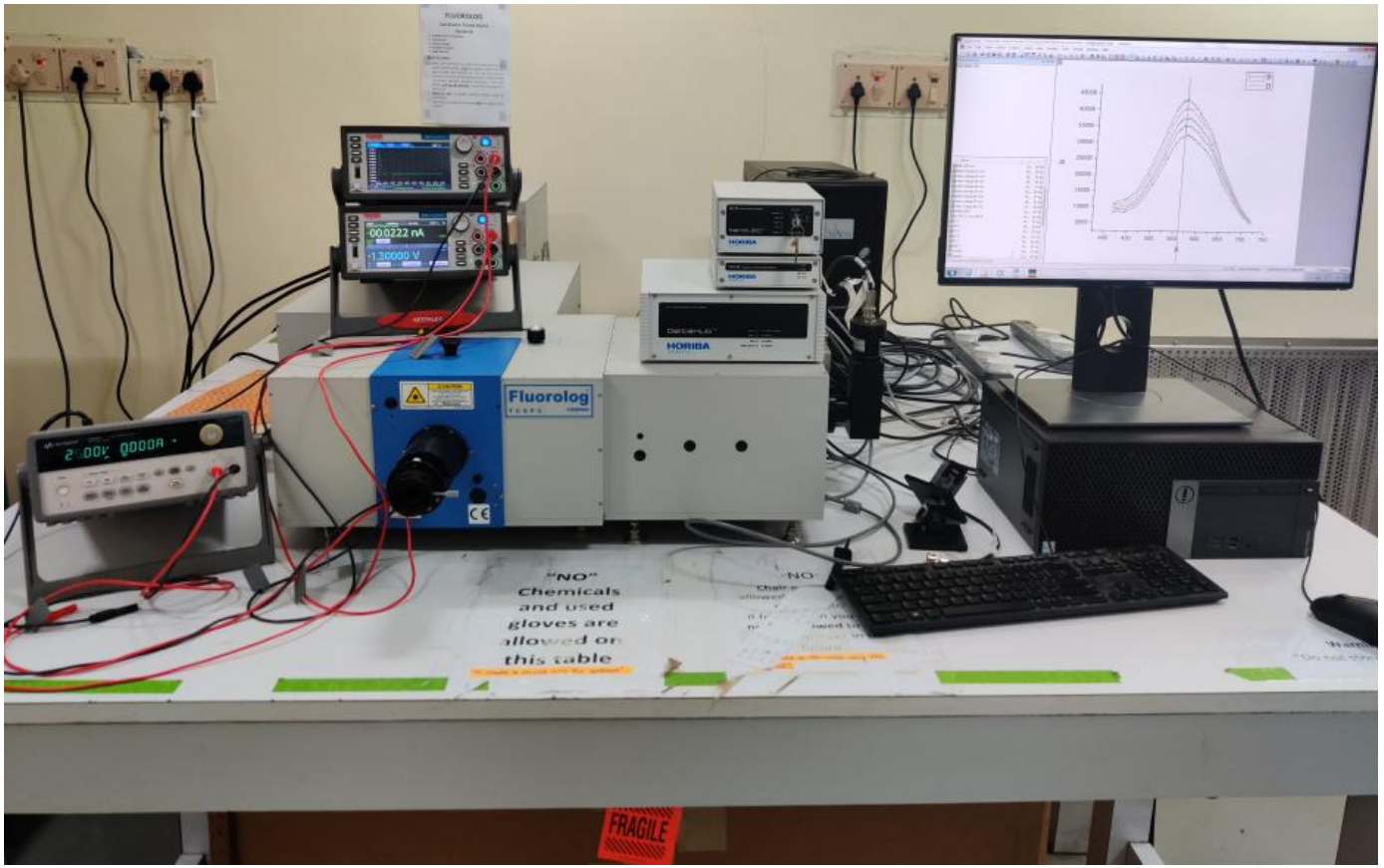




Advanced SECM Integrated with Inverted Microscope

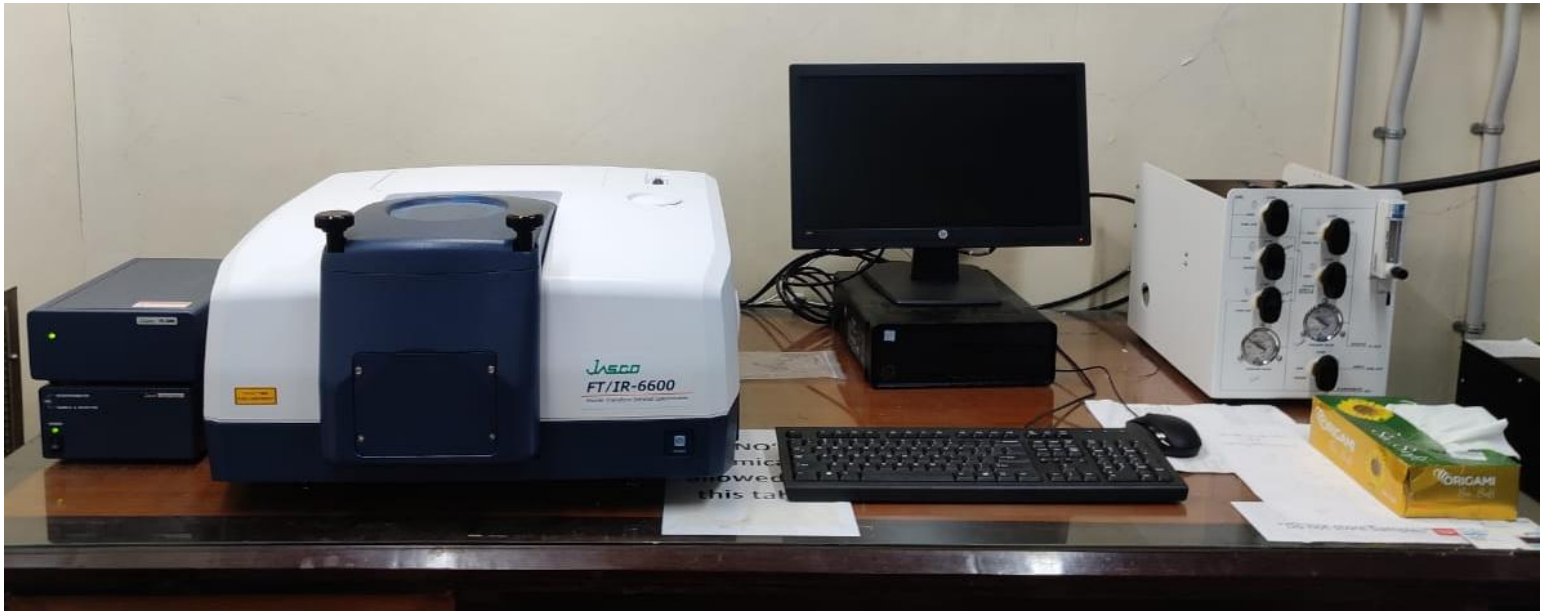
Autolab/Sensolytics Scanning Electrochemical Microscope

Spectrofluorometer



Horiba Spectrofluorimeter – with 5 laser diode sources – capable of steady state and time-resolved photoluminescence measurements between 190 nm and 900 nm. Time resolution - ~ 30 ps.

Far- and Near-IR Spectrometer



Jasco Far-IR and Near-IR spectrometer with ATR Setup
Capable of operating between 6000 cm-1 and 50 cm-1 in high vacuum mode.

Ferroelectric Test Station

aixACCT Ferroelectric test station for photoferroics. Capable of polarizing upto 10kV and can operate at maximum switching frequency of 1MHz.

Major Characterization Facilities in our Lab

Versastat 3 electrochemical work station with EIS setup.

Shimadzu UV-Vis-NIR (190 nm to 1400 nm) spectrophotometer fitted with integrating sphere for solids, films and powders.

40 Channel High Current Battery Cyclers

Photoelectrochemical workstation (home made) for solar fuel studies.

Photovoltaic station (home made) for solar cell characterization.

Spectroelectrochemical work station (home made) and external quantum efficiency analyser for solar cell and solar fuel systems characterization.

Characterization/Fabrication/Synthetic Facilities in our Lab (partial list)

Schlenk line for air free chemical synthesis

HHV Dual source thermal evaporator for solar cell fabrication (BRNS funded; ~ Rs 13 lakhs)

Hydropneovac Inert atmosphere glove box for solar cell fabrication (IIT Madras funded; ~ Rs 10 lakhs)

Buchi rotary evporator

Remi Centrifuge

Homemade manual screen printer

Keithley DC power supply and Electronic load

Keithley sourcemeter for electrochemical deposition of films (3 Nos)

High temperature tubular furnace (2 Nos)

Hot air ovens (3 Nos)

Holmarc spin coater for thin film fabrication

Delta Electronika high voltage DC power supply for electrophoretic deposition

High temperature hot plate for solar cell fabrication

Neware 8-channel battery cycler

To be added in next few months

(i) Impedance analyser with dielectric spectroscopy fitted with cryostat and furnace– capable of operating between 32 MHz to few μHz – Temperature range : -195 °C to 800 °C
(ii) Piezoforce Microscope for analysing ferroelectric domains

Thank You!