OPTICA
Advancing Optics and Photonics Worldwide

Optics for Energy

NEWSLETTER

CONTENT

MARCH., 2026_VOL8

WE NEED YOUR CONTRIBUTION

Make your research more visible

Send us your recent publication.
We promise
to make a comprehensive review
for a broad audience

Give us a shot from your camera

Submit any light-highlighting photo
whether from your lab,
or a sparkle of light that captured your
eyes.

Share your story

Inspire others with your story

Click and drop

FOREWORD

Mission and Goals

The groups aims is to connect professionals and students in optics and energy through: Technical events ,Educational webinars, Networking activities, Social media engagement.
MUCH MORE would be possible with your contributions!

Meet the team

Chair
Dr. rer. Nat. Banafshe Zakeri
HySON Institute
zakeribanafsheh@yahoo.com

Vice Chair
A/Professor. Georgios Arnaoutakis
Hellenic Mediterranean University
arnaoutakis@hmu.gr

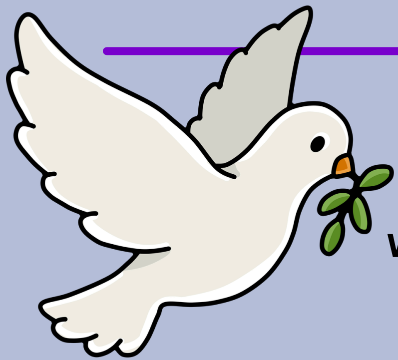
Event Officer
M.Sc. Idris Adeshina Sulaimon
Institut National de la Recherche Scientifique (INRS)
sulaimonidris61@gmail.com

Social media Officer
M.Sc. Rodgers Mutugi Gichuru
Multimedia University of Kenya (NIOL)
roycerodgers2@gmail.com

Webinar Officer
Prof. Ahmed Morshed
Ain Shams University
ahmed_morshed@eng.asu.edu.eg

OPENING MESSAGE

By Banafshe Zakeri



As scientists, we have more power than we think for bringing peace to the world!

It was late, near midnight, and I was still watching the news. It has become my routine since the war in Iran began, the country I happily left 11 years ago. But now, watching it burning like a phoenix, hoping for a rebirth, I can't help but cry. Connections are undeniable! I know I'm not the only one in the world who watches a war from afar while desperately worrying for her family! There has always been war and people who give their lives for ..., for what?! When it all started! Who was the inventor of war? Connections, perhaps, are the major problem! We make the concept of connection superficial; we tend to connect more often with people who share our attitudes and lifestyles, and disconnect with those who aren't in our zone! And disconnections make the gap between us so huge that one day we see the other side as an enemy!

You might think, I'm on the wrong page, why do I write it here for scientific readers! Yet, I think there is also something to point out regarding this topic within our beloved scientific societies. I've seen it many times: the boundaries for collaboration, the unspoken word of "outsiders", the unshared knowledge under the tag of confidential treatment of our scientific results! Whether we accept it or not, science is involved in every war happening around the world, perhaps not directly, but every time we closed our eyes and walked away while we supposed to speak out; When the commercialization and nationalization of science became bolder than its humanitarian side; When the fighting for being right about our theories, methods, etc, instead of a respectful dialogue turned normal! Not to forget also what the theoretical physicist *Stephan Hawking* warned us about: *"technology has advanced at such a pace that this aggression may destroy us all by nuclear or biological war."*

I think, as scientific societies, we have more power than we think for bringing peace to the world, to remove the boundaries, to stop disconnecting based on attitudes instead of actions, and start connecting, not only with those who share our values but also with those who don't but are willing to hear respectfully. Just as the nature of science itself, unlimited and without boundaries, so should be the frame of mind of those who walk in this path.

THE “NEXT BIG THING” IN ENERGY!

Optics investment trends relevant to energy

In an interesting market report in Optics and Photonics News (OPN, January 2026), the “Next big Thing”, defined as a familiar household topic or the newest and biggest trend that everyone talks about and wants a piece of, was discussed. Using the “follow the money” guideline, that is, identifying trends in public and private funding sources for optics and photonics, some trends in investing technologies relevant to optics were found. Among them, fusion energy received a considerable increase in funding.

What is fusion energy?

As the word fusion indicates, it’s about combining light atoms (hydrogen) to create energy, which is the opposite process of fission used for producing nuclear energy by splitting heavy atoms (uranium). The fusion reaction powers the sun as the ultimate source of energy. While its extremely high temperature provides enough energy for nuclei to overcome their mutual electrical repulsion, its immense gravity produces extreme pressure, confining the nuclei within a small space and increasing the chances of collision. This environment, in which light elements can fuse and yield energy, is provided by plasma in a star just as in a fusion device. The tokamak is an experimental fusion device with a fusion plasma confined by strong magnetic fields (Fig. 1).The energy produced by the fusion of atoms in the plasma is absorbed as heat in the walls of the vessel.

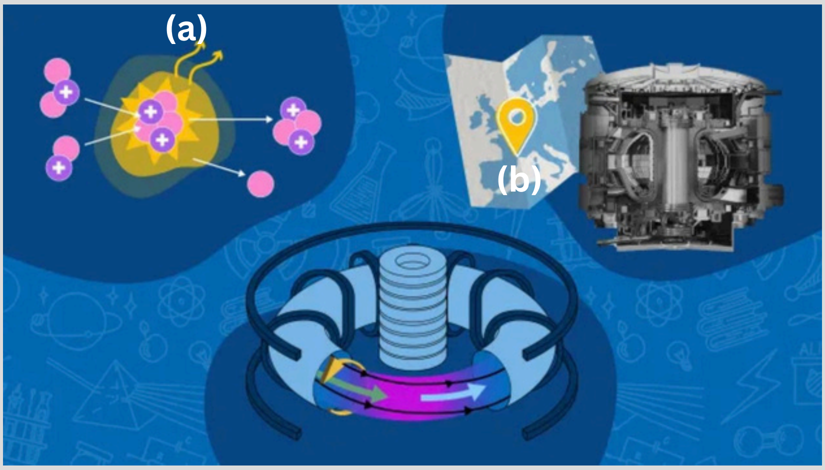


Fig.1: (a) Nuclear fusion of hydrogen’s isotopes to produce energy, (b) magnetic confinement (Tokamak) as magnetic fusion device, source: International Atomic Energy Agency (IAEA).

Fusion energy is clearly a safer and cleaner energy than its nuclear counterpart because it produces no high-level, long-lived radioactive waste. According to the 2025 statistical review of world energy, however, the contribution of fusion energy, together with all types of renewables, was reported as only 5%, which is the amount for nuclear energy contribution alone (Fig. 2)! So, why does it contribute less to energy production than nuclear energy? The challenge is producing the extreme conditions, gravity (confinement) and temperature on Earth! Energy gain in large-scale, producing more energy than used to initiate the reaction, is not only a challenge for scientists but also for engineers.

ITER - "The Way"

ITER is one of the most ambitious energy projects in the world, with an experimental campaign in southern France. The world's largest tokamak is built through the collaboration of 34 nations to produce fusion energy based on the same principles that power the sun and the stars. They investigate the concept of burning plasmas, that is, plasmas in which the energy of produced helium by the fusion reaction is enough to eliminate the need for external heating. Moreover, there are engineering challenges in integrating technologies essential for a fusion reactor.

Optics and the future of fusion energy

A potential alternative to magnetic confinement is inertial confinement using high-power lasers. Small hydrogen-isotope pellets are compressed and heated to the degree of initiating nuclear fusion and producing clean energy. The intense heating of the capsule surface creates a micro-implosion of the fuel, and, as a result, the pellet's surface layer is ablated and explodes. The inertia created by this process keeps the fuel confined long enough for fusion reactions to take place.

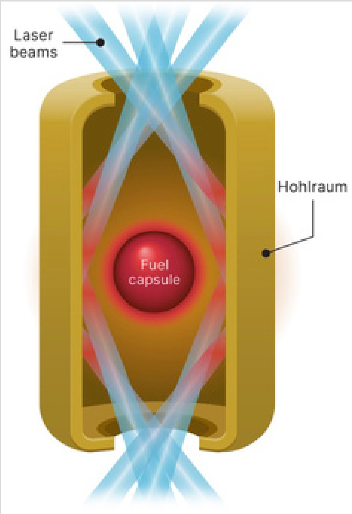


Fig.2: Laser illumination scheme, "Inertial Confinement Fusion Scaling and Future Designs", University of Rochester, Laboratory for Laser Energetics

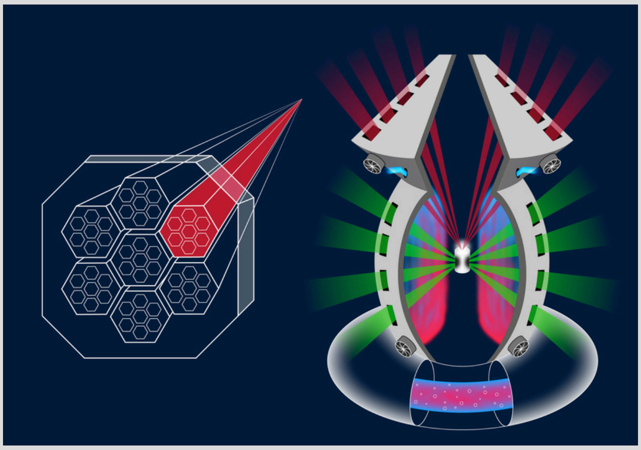


Fig.3: Components of a beam combination system, HB11 Energy

The ignition, the point at which fusion becomes completely self-sustaining, is achieved when capsules release around 30 times more energy than they absorb. To improve cost efficiencies and maximize resiliency, thousands of commercial lasers can be combined to achieve the required energy levels.

HIGHLIGHTING RESEARCH

Hybrid Ag nanowire electrochromic films for energy-efficient optics

Motivation and Overview

Electrochromic (EC) materials enable electrically controlled modulation of optical transmittance and reflectance, which is central to energy-saving technologies that regulate solar heat gain and daylight. PEDOT:PSS is a widely used organic EC polymer, but its relatively high sheet resistance limits switching speed and operating voltage. Dr. Atkinson investigates how AgNW diameter, length, and concentration influence the optoelectronic performance of hybrid AgNW/PEDOT:PSS films and devices.

The central concept is in the formation of dual electron transport pathways: one through the polymer matrix and another through a percolating metallic nanowire network. This hybrid architecture improves charge transport, accelerating ion-electron coupling during redox switching thereby enhancing optical modulation applicable in smart windows and switchable elements

Structural design and Fabrication

Hybrid films were fabricated by mixing ethanol-diluted PEDOT:PSS with AgNWs for a controlled geometry, followed by Mayer-rod coating and thermal annealing. The annealing step removes insulating surfactants and welds nanowire junctions, forming a transparent conductive network embedded in the electrochromic polymer. Figure 1 and 2 (schematic and microscopy) illustrates the fabrication flow and shows an optical micrograph of the percolated AgNW/PEDOT:PSS film. The image shows a uniform nanowire mesh that maintains optical transparency while providing low-resistance conduction paths. The nanowire network acts as a subwavelength conductive scaffold with thin (30 nm) and long (88 μm) nanowires that minimizes optical scattering and absorption losses while maximizing electrical percolation, an essential trade-off for transparent energy devices.

Jon Atkinson
Postdoctoral Fellow,
University of Toronto
https://doi.org/10.1364/OE.535426

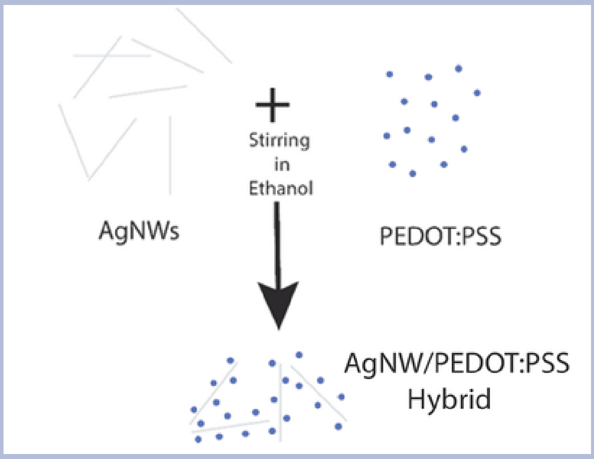


Figure 1: Schematic of the fabrication

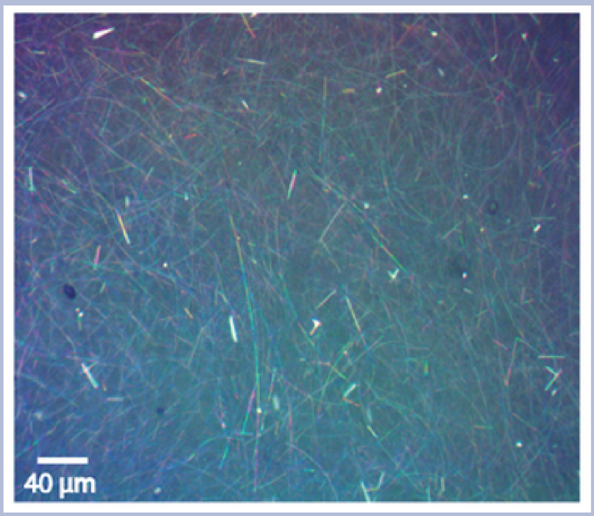


Figure 2: Microscope Image of the hybrid film

Optical metrics and electrochromic theory

The study quantifies color and transmittance modulation using Standard Electrochemical (EC) metrics. The perceived color change in CIELAB space is

$$\Delta E = \left[\left(L^*_{red} - L^*_{ox} \right)^2 + \left(a^*_{red} - a^*_{ox} \right)^2 + \left(b^*_{red} - b^*_{ox} \right)^2 \right]^{1/2}.$$

where subscripts denote reduced and oxidized states. Coloration efficiency (CE), a key figure of merit for energy devices, is defined as

$$CE = \frac{\Delta OD}{Q \times A},$$

with ΔOD the change in optical density, Q the injected charge density, and A the active area. High CE corresponds to large optical modulation per unit charge, which directly relates to lower power consumption. Electrochemical behavior is characterized using cyclic voltammetry (CV) and chronoamperometry (CA). The optimized geometry (30 nm diameter, 88 μm length, 3.0 mg/ml) yielded sharp redox peaks, reduced turn-on voltage (~−1.1 V), and faster switching, reflecting improved carrier transport and interfacial kinetics.

Optimization of nanowire geometry

Diameter effects

Smaller diameters enhance optical performance by reducing light blocking and scattering. Although thicker nanowires can lower sheet resistance further, they degrade transmittance contrast. The 30 nm wires provide the best balance between conductivity and optical clarity, crucial for energy-efficient glazing where visible transparency must be preserved.

Length effects

Longer nanowires reduce junction resistance and increase percolation efficiency. The 88 μm wires produce the lowest sheet resistance and highest transmittance modulation. Optically, extended wires form fewer junctions per conduction path, decreasing resistive losses without significantly increasing optical extinction.

Concentration effects

Increasing nanowire concentration lowers sheet resistance but reduces the fraction of active electrochromic polymer. A concentration of 3.0 mg/ml is identified as optimal, maximizing coloration efficiency while maintaining strong optical contrast. Excessive loading diminishes electrochromic capacity because metallic regions do not contribute to color change.

Conclusion

The optimized hybrid AgNW/PEDOT:PSS electrochromic films provide a versatile platform for energy-focused optical technologies. Their combination of high transparency, low electrical resistance, and low-voltage switching enables efficient dynamic control of light and heat across multiple applications, such as smart windows, adaptive photovoltaic regulation, low-power reflective displays, and dynamic thermal management coatings. The improved coloration efficiency allows significant optical modulation with reduced electrical energy input, directly supporting energy savings.

Publication Review

Infrared-Reflective Ultrathin-Metal-Film-Based Transparent Electrode for High-Efficiency Solar Cells

by

George Perrakis, Anna C. Tasolamprou, George Kakavelakis, Konstantinos Petridis, Michael Graetzel, George Kenanakis, Stelios Tzortzakis & Maria Kafesaki

https://doi.org/10.1038/s41598-023-50988-3

This work explores the design and optimization of ultrathin-metal-film-based transparent electrodes (MTEs) for thin-film solar cells, particularly perovskite solar cells (PSCs). The research demonstrates that MTEs, composed of low-resistivity metals like silver (Ag) and dielectric layers, can achieve high optical transparency (>91%) in the visible spectrum, low optical loss (~2.9%), and efficient infrared (IR) reflection (~70%). These properties significantly enhance solar cell performance by reducing heat load and improving power conversion efficiency (PCE).

Enhanced Optical Performance

MTEs suppress visible light reflection through destructive interference, achieving broadband transparency. The optimized design reflects harmful UV, NIR, and SWIR radiation while maximizing thermal radiation in the mid-infrared (MIR) atmospheric transmission window.

Improved Efficiency

Integration of MTEs in PSCs results in a photocurrent density (J_{ph}) > 25 mA/cm² and PCE > 20%, surpassing conventional transparent conductive oxide (TCO) electrodes. The optimized multilayer structure reduces device heat load by 177.1 W/m², lowering operating temperatures by up to 9°C compared to conventional PSCs.

Material and Layer Optimization

The study highlights the importance of encapsulation layers, such as TiO_2, SiO_2, Al_2O_3, and HfO_2, for achieving optimal light interference and broadband response. The number and thickness of layers, see Fig.1 were optimized using advanced modeling techniques, including genetic algorithms and local optimization methods.

Thermal Management

MTEs act as efficient IR filters, reducing heat generation and enhancing radiative cooling, see Fig.2. This improves the operational stability and reliability of PSCs, especially under outdoor conditions with high temperatures and low wind speeds.

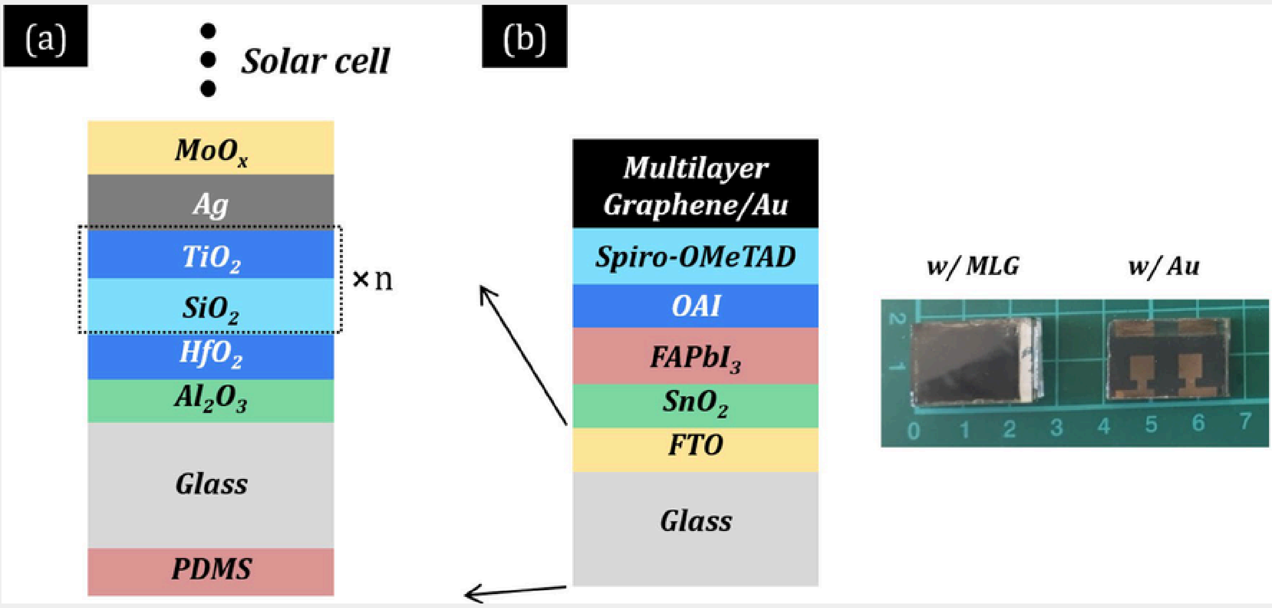


Fig.1: (a) The designed ultrathin-metal-film-based multilayer transparent electrode (b) Geometry of the thin-film PSCs

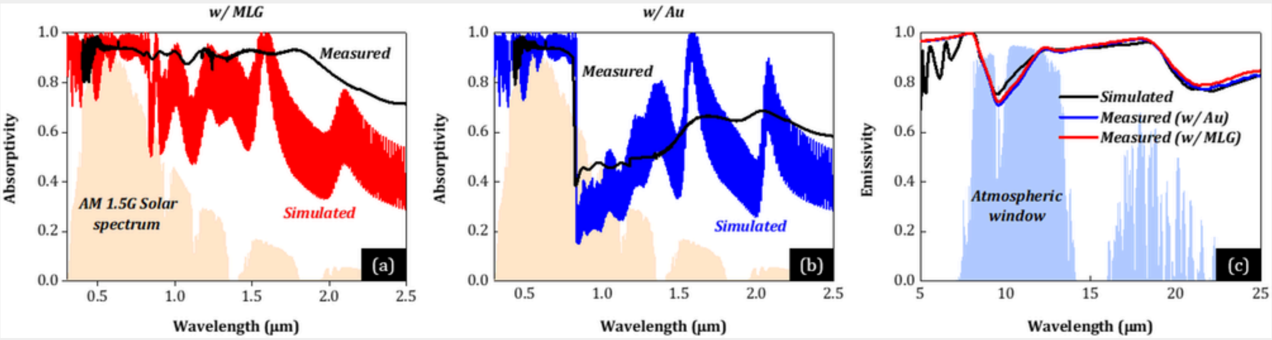
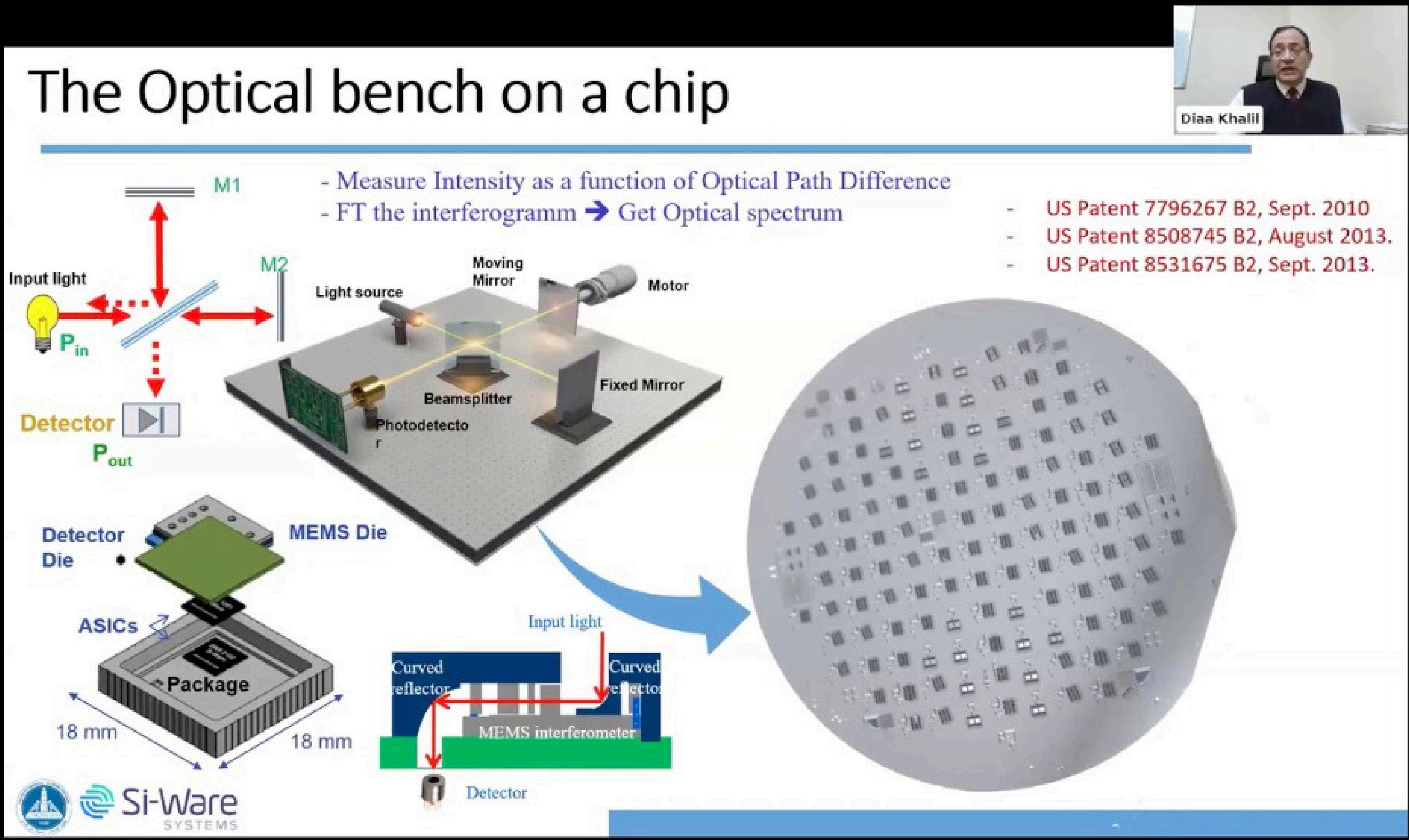


Fig.2: (a, b) Experimentally measured (black) and simulated (red and blue) solar absorptivity spectra of the two PSC samples. (c) Simulated (black) and experimentally measured (red and blue) thermal emissivity spectra of the two PSC samples

Conclusion

The work provides a pathway for integrating MTEs into high-efficiency optoelectronic devices, including solar cells, smart windows, light-emitting diodes, and displays. The findings challenge the conventional belief that compact metal films are unsuitable for high-efficiency solar cells, demonstrating their potential through careful design and optimization.

This work sets a foundation for advancing solar energy technologies, particularly in the development of cost-effective, high-performance, and thermally stable solar cells.

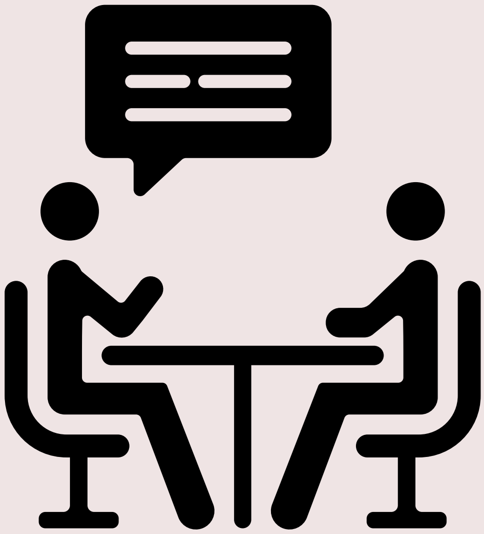


Integration optics provides micro scale optical components (lenses, mirrors, guides, etc) that are self-aligned on the substrate and can be actuated. In an interesting webinar at Optics for Energy TG, Prof. Diaa Khalil from faculty of engineering at Ain Shams University presented his interesting research on miniaturized FTIR MEMS spectrometer for detecting energy-related gases. He introduced the concept of MEMS optical bench, through which a compact spectral sensor is realized to monitor multiple gaseous components using a single device. The device is an open-path Fourier-transform infrared (FTIR) gas analyzer based on a mid-infrared (MIR) MEMS spectrometer, produced using MEMS technologies. This unique product gained the Prism award in the Photonics West conference 2014. The device was deployed inside a district-scale climatic chamber to demonstrate its capabilities in monitoring the gaseous components produced by a car engine. Preliminary results of laboratory-scale measurements intended to assess the potential of the proposed spectral sensor to screen gaseous compounds are presented.

Watch the full webinar

Upcoming

Coming Soon

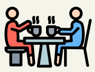


“Career Focus” Interview
with *Saroj Mishra*
Founder and Entrepreneur

Be our next speaker

Drop your abstract **here**

We aim for some new series in 2026;



Coffee chat

Right communications facilitate making efficient connection. Join for these coffee chats to find your future partners, mentor, ...

This would be no official event, but a friendly chat between professionals and students.

Welcome to my lab...

A recording series to show you what's happening inside research labs.

We will find research group with relevant research area and visit them to record a glimpse of what they are working on for you..

Please make a short time and respond to this survey. It will help us in orienting the activities and topics based on your needs and interests.

Communication and Engagement

DISCUSSION

[Click here to join](#)

INFORMATION SHARING

[Click here to join](#)

[Click here to join](#)

EVENT UPDATES

email (TGactivities@optica.org)