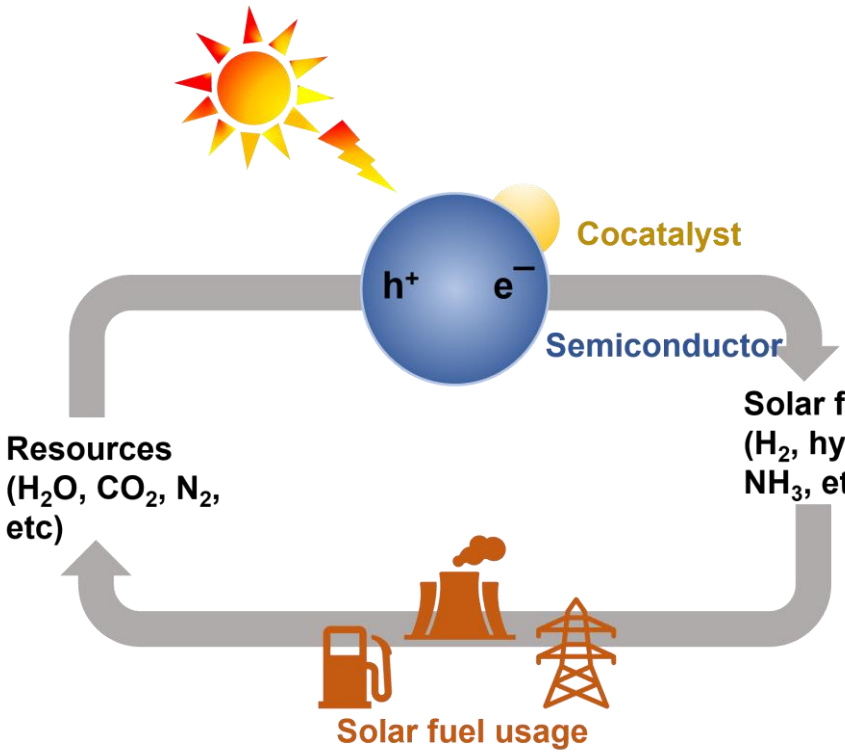
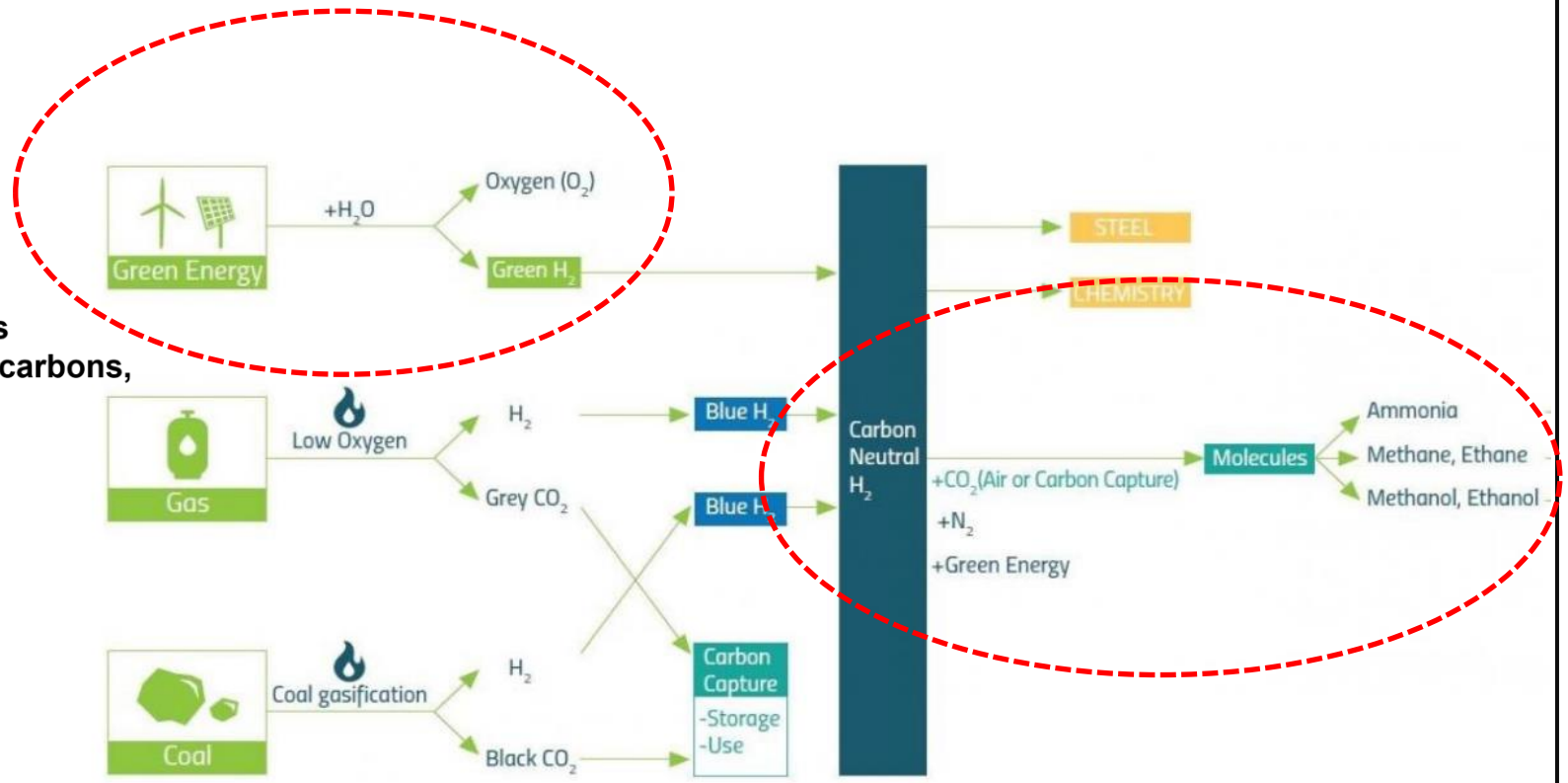
Solar Fuels Research at IMO-IMOMEC

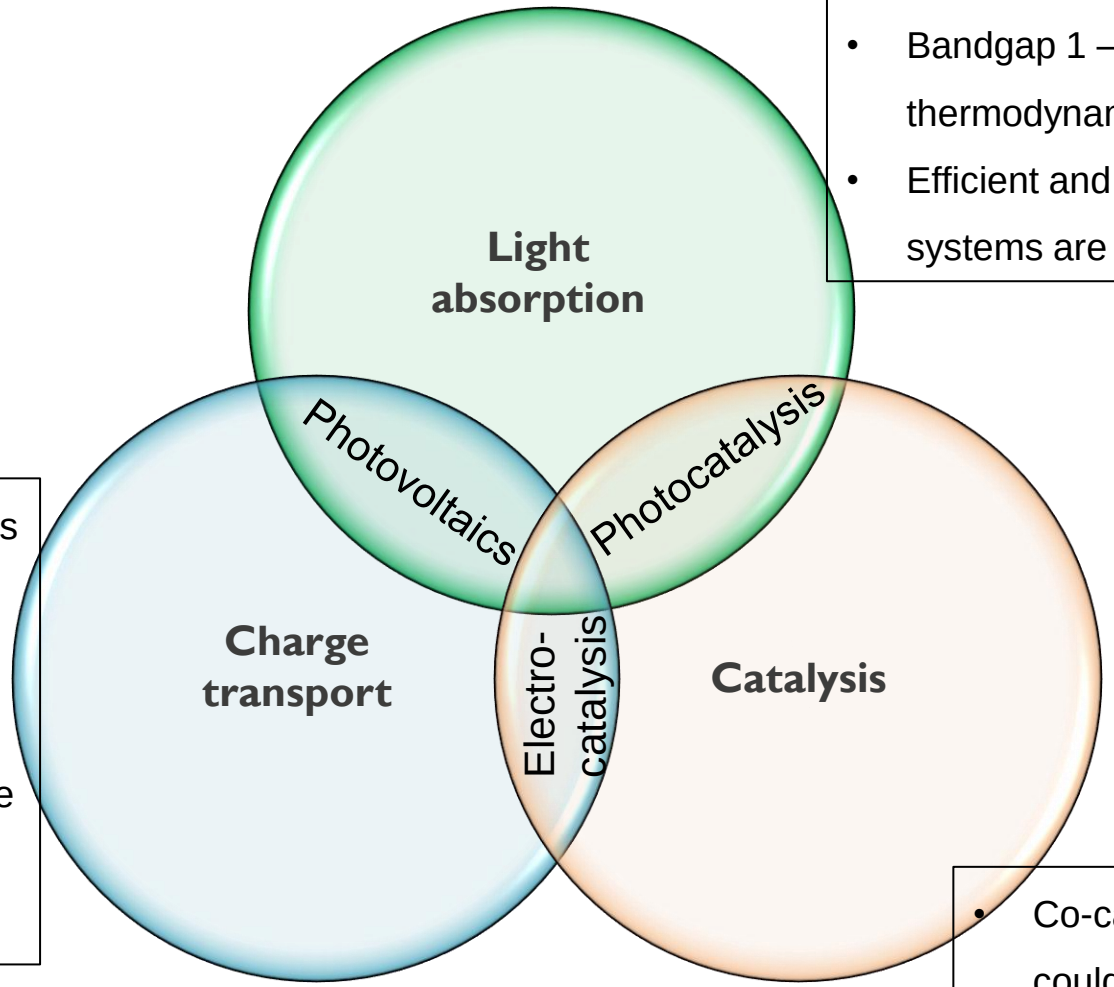


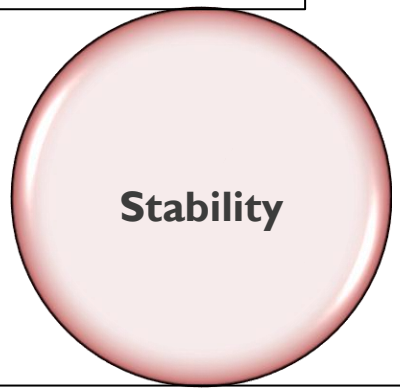
Approaches on solar fuels at imo-imomec



Solar Fuel research elements @ imo-imomec

- e^- and h^+ are generated here
- Bandgap 1 – 2 eV, due to high thermodynamic uphill for specific reactions
- Efficient and wide-spectrum absorption systems are to be developed





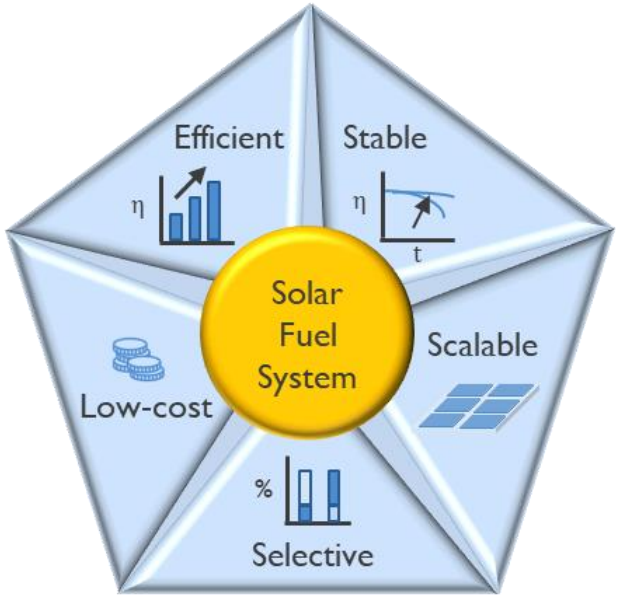
- e^- and h^+ carrier selectivity is vital to facilitate proper elementary reactions
- Interface (solid-solid and solid-liquid) charge exchange layers are required as its a multi-state system

- Aqueous and operational stability is vital to the technology

- Co-catalysts should be engineered as they could selectively determine the end products
- Catalyze the sluggish kinetics of reactions

Materials for solar fuels: Thin films and Porous Diffusion Electrodes

Material selection criteria of imo-imomec



Preparation Processes

Sulfurization/selenization

Tube furnace

Rapid thermal annealing

3

3

Sputtering/Evaporation

As explored materials in our lab: Cu_2Se, $Cu(In,Ga)(S,Se)_2$, Cu_3BiS_3, Sb_2S_3, MoS_2

As explored materials in our lab: Cu/ZnO, Cu_2O, ZnO

Deposition, solution, and scale-up facilities

35x35 cm² Linear Sputtering and Co-evaporation cluster tool

Thermal evaporator

30x30 cm² slot die coating

30x30 cm² picosecond laser scribing

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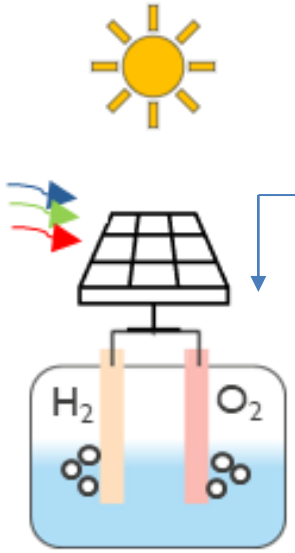
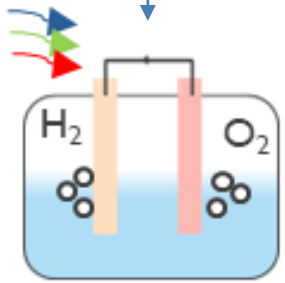
Device fabrication facilities @ imo-imomec

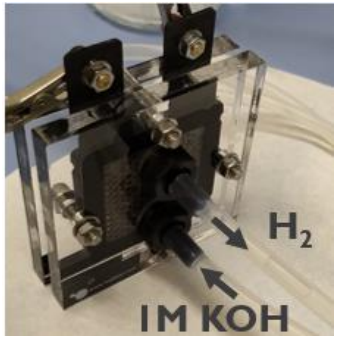
Solar Fuel devices



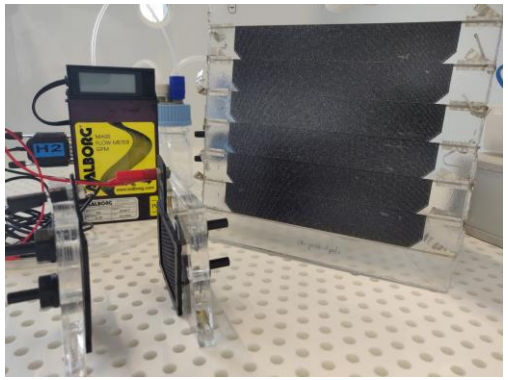
PV-Electrolysis cell



Photoelectrochemical cell



Electrochemical flow cell

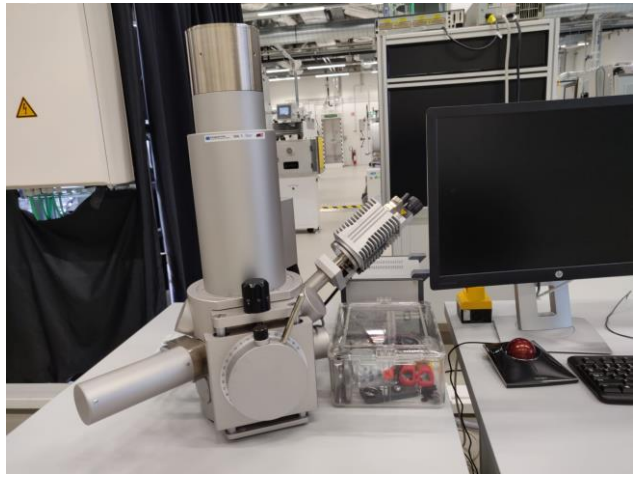


Solar cell-PEC flow cell assembly

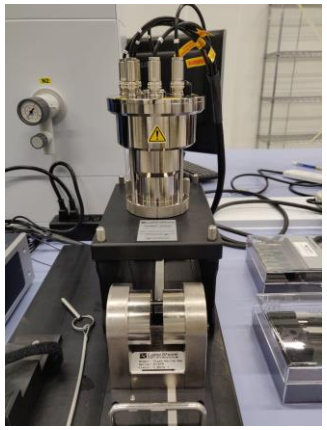
PEC cell with electrodes

Designated Electrochemical workstation

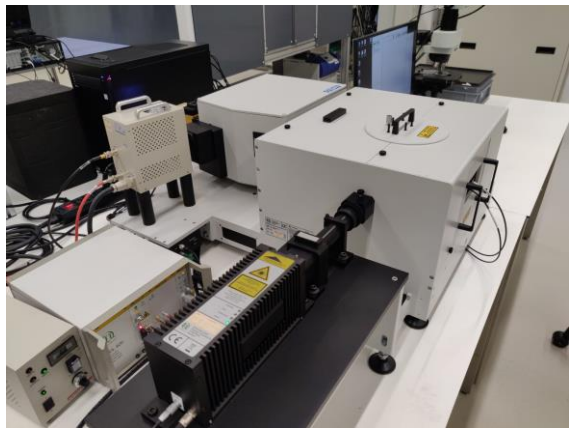
Characterization facilities @ imo-imomec



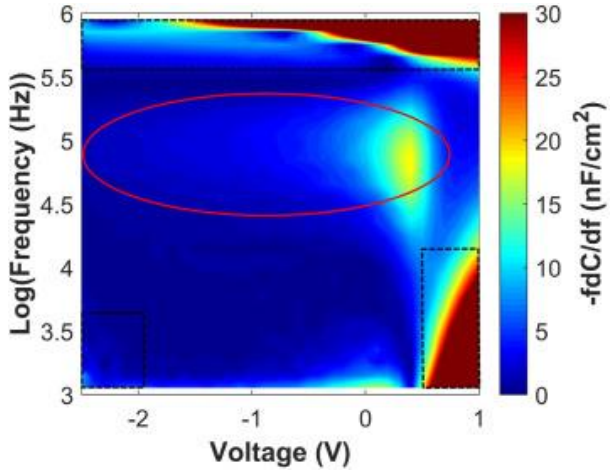
Tabletop SEM tool



Hall set-up



Steady state and transient Photoluminescence spectroscopy
reachable up to ~ 80 K



Admittance spectroscopy

Access to IMEC/UHasselt Characterization facility :

X-ray diffraction
Atomic force microscopy
Secondary Ion Mass Spectroscopy
Photoelectron Spectroscopy
Photocurrent spectroscopy

In a nutshell...

Facilities for characterization

Morphology and composition
- SEM
- EDS
- XPS/UPS
- SIMS
- AFM

Structural
- X-Ray diffraction

Electrical
- Hall Setup
- Admittance spectroscopy

Photo characterization
- Photoluminescence
- Photocurrent spectroscopy

Material synthesis capabilities

Sulphides/Selenides Thin Film
- Cu_2Se
- $Cu(In,Ga)(S,Se)_2$
- Cu_3BiS_3
- Sb_2S_3
- MoS_2

Oxide Thin Film
- Cu/ZnO
- Cu_2O
- ZnO
- NiOx
- SnOx

Halide perovskites
- $MAPbI_3$
- $FAPbI_3$
- $Cs_xFA_{1-x}Pb(I,Br)_3$

Co-catalysts
- Co/Ni-S
- NiO_x

Manufacturing facilities

- *35x35 cm^2* Linear Sputtering and Co-evaporation cluster tool
- *30x30 cm^2* slot die coating
- *15x15 cm^2* Blade coater
- *30x30 cm^2* picosecond laser scribing
- Module encapsulation tool

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Current projects associated with Solar Fuels

Kesterite based Photoelectrodes for Water and Nitrogen Reduction (**KESPER**) (https://www.uhasselt.be/en/projects/detail/24269-project-r-13406)

- Demonstration of photoelectrodes for renewable generation of hydrogen and ammonia

Partners:

Transition to Renewables (**T-REX**) (https://www.uhasselt.be/en/projects/detail/21780-project-r-12321)

- Conversion of CO_2 into renewable materials via electrified routes

Partners:

Procura Belgium (https://procurabelgium.be/en)

- Power to X, carbon capture & utilization roadmap for Belgium

Partners:

Novel nanomaterials and nano-architectures for CO2 capture and utilization (**Nano-CCU)** (https://moonshotflanders.be/mot3-nano-ccu/)

- Convert CO2 from flue gasses into a valuable platform molecule for the chemical industry.

Partners:

Synergetic design of catalytic materials for integrated photo-and electrochemical CO_2 conversion(**SYN-CAT**) (https://moonshotflanders.be/mot3-syn-cat/)

- Demonstration of GDEs integrated with Cu/ZnO bilayer catalyst, Cu, Cu_2-xSe, ZnO, Cu_2O for CO_2R

Partners:

Point of contact

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