Solar hydrogen production

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Foto: A. Bramsiepe, KIT.

What are we talking about?

Photocatalytic hydrogen production

Hydrogen from just sunlight and water



Content

What problem do we solve?

The promise we make.

What are components of a photocatalytic process?

Building a technology from two components.

How to make a good photoreactor?

Design guideline for reflective multi-pass micro photoreactors.

How to find a good photocatalyst?

Material screening.

Which problem do we try to solve?

The promise we make ...

Problem: Wasserstoffmarkt

- Kostenintensive Elektrolyseure
- Energiepreisfluktuationen
- Fehlende Transportinfrastruktur


ENERGIEWENDE

Grüner Wasserstoff bleibt knapp und teuer

Ein Kommentar von Hanna Decker

04.05.2025, 19:35 Lesezeit: 3 Min.

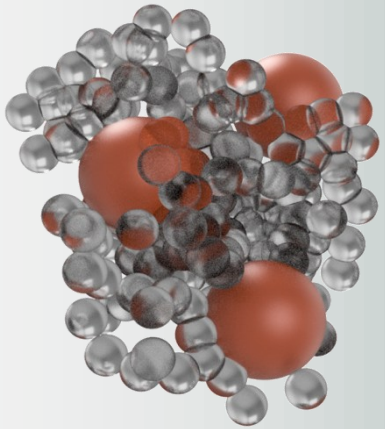
Lösung: Fotokatalytische Wasserspaltung

- Keine Elektrolyseure
- Energiemarktunabhängigkeit
- Dezentrale Produktion möglich

What are the components?

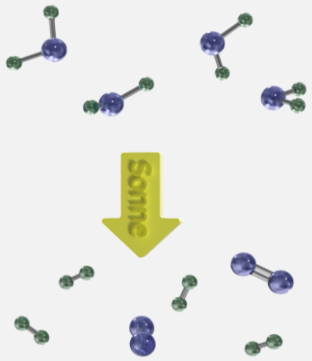
Building a technology from two components.

Photocatalysts

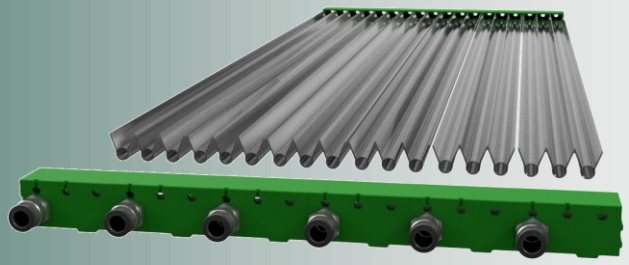


10 µm

Efficient photosynthesis in low-cost systems



Photoreactors



10 cm

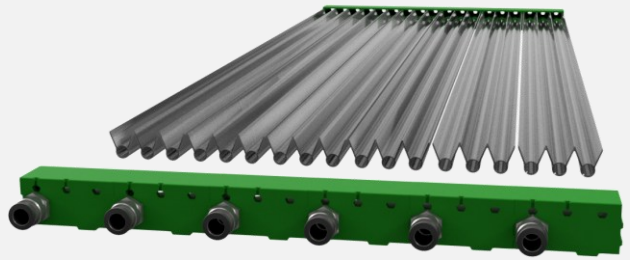
What is it doing?

Technical profile of photoreactors for solar production.

Enabling high efficiency

Optimal operating conditions

Ensuring high transport efficiency



Being low cost

Minimal material footprint

Low material cost

Mass manufacturability

Reduced system requirements

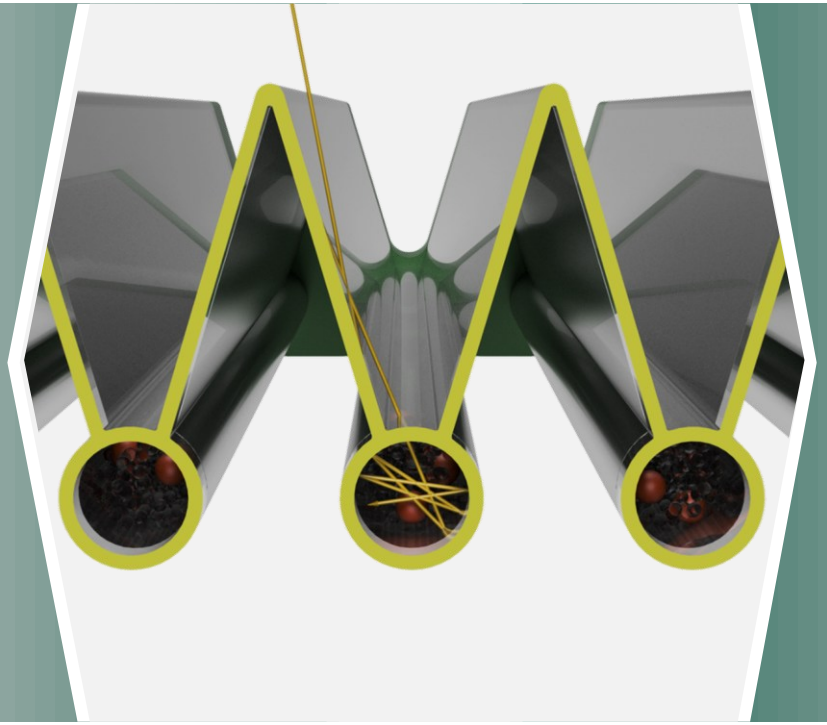
Why reflective multi-pass photoreactors?

Introducing the KIT photoreactor concept

Enabling high efficiency

Optimal operating conditions
↳ **Partial absorption**

Ensuring high transport efficiency
↳ **Multi passage**



Being low cost

Minimal material footprint
↳ **High catalyst usage**

Low material cost
↳ **Polymers**

Mass manufacturability
↳ **Extrusion & injection moulting**

Reduced system requirements
↳ **No suntracking**

How to design photoreactors?

Optimization and performance.

Base design

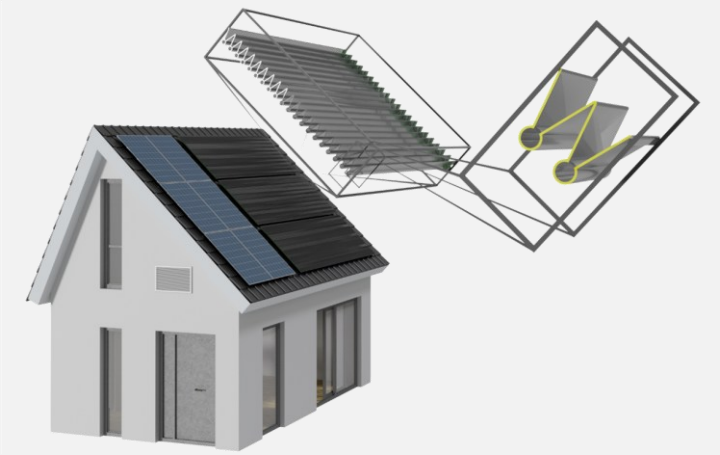
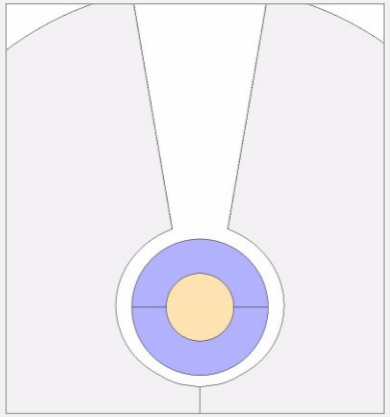


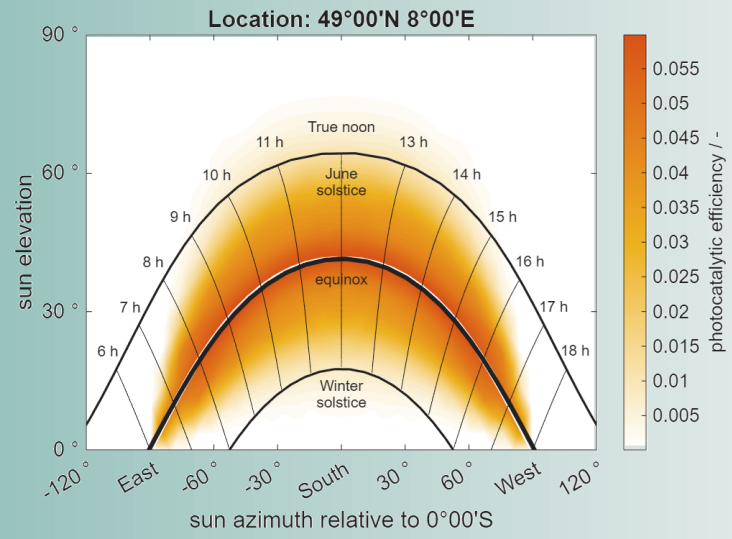
Figure: Kant, P. et al., Joule 7, 2023. DOI: 10.1016/j.joule.2023.05.006

Numerical optimization



Patent (pending): WO002024056575A1.

All-year performance



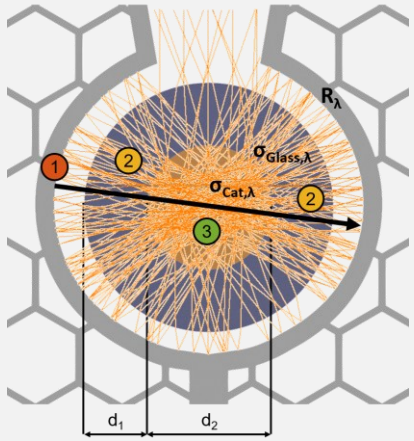
Kant, P. et al., Joule 7, 2023. DOI: 10.1016/j.joule.2023.05.006

Max. 5.8 % photocatalytic efficiency for model reaction.

Is there a photoreactor design guideline?

Inherent transport losses and design guideline

Inherent losses



1 Cavity wall absorption
2 Reactor absorption
3 Photocatalyst absorption

Design guideline

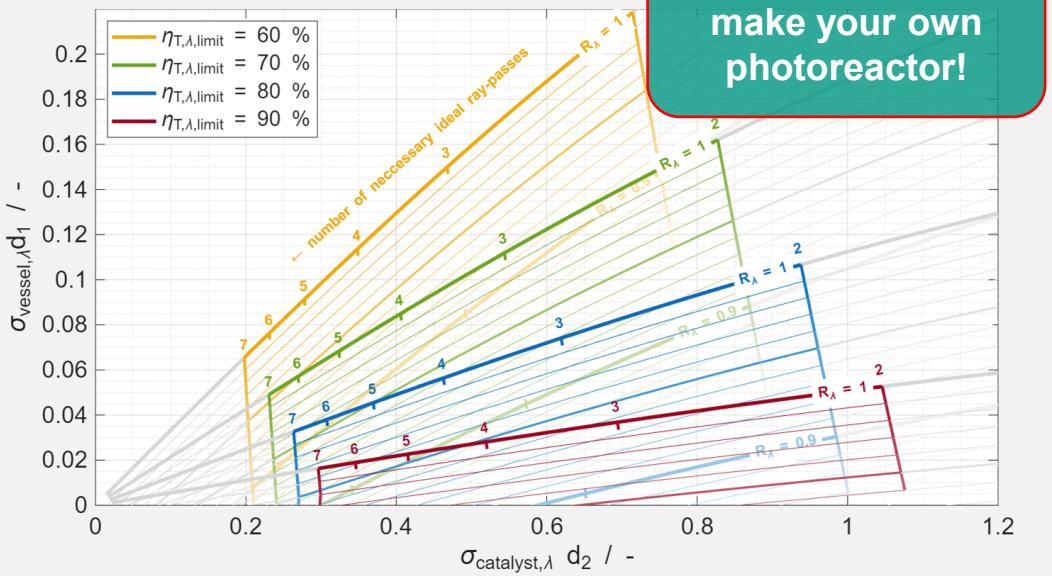


Figure: Kant, P. et al., Joule 7, 2023. DOI: 10.1016/j.joule.2023.05.006

Allows you to make your own photoreactor!

Photocatalysis and microreactors

Feasibility criterion for high η_T

$$\sigma_{catalyst,\lambda} d_2 \epsilon [0.2,1]$$

Typical material properties

$$\sigma_{catalyst,\lambda} \epsilon [100\ m^{-1}, 1000\ m^{-1}]$$

Typical characteristic dimensions

$$\boldsymbol{d_2 \epsilon [0.2\ mm, 10\ mm]}$$

Photoreactors are microreactors!

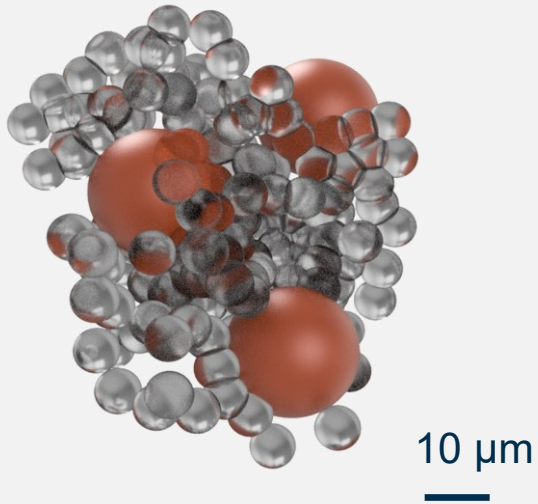
Photocatalyst: What is it doing?

Technical profile of photocatalysts for solar hydrogen production.

Enabling high efficiency

High quantum yield

Solar spectrum match



Enabling H_2 and O_2 separation

Spatially separated OER and HER

Summary

What are the core components of a photocatalytic process?

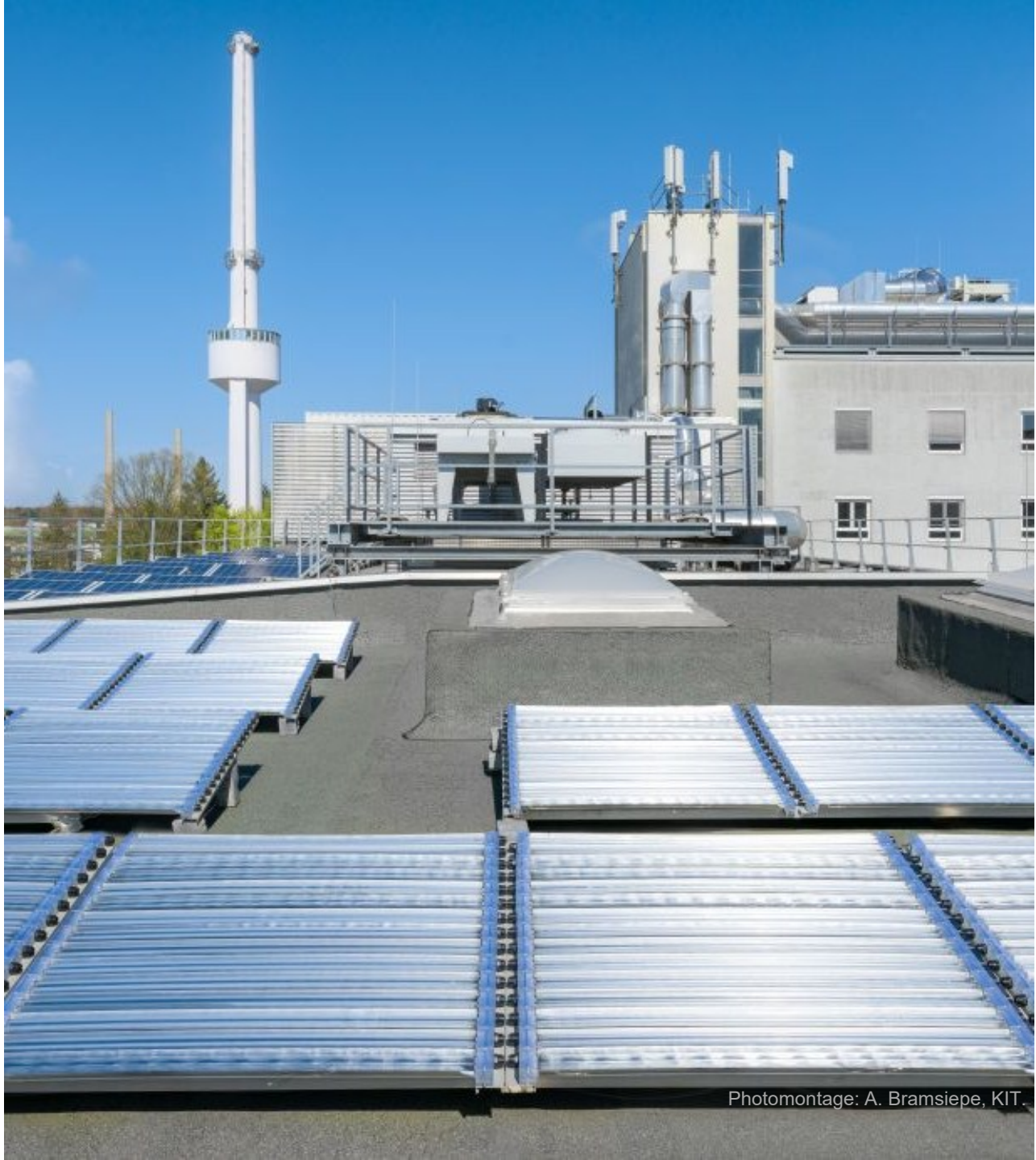
Photocatalyst & photoreactor.

How to make a good photoreactor?

Ensuring high radiation transport efficiency.

How to make a good photocatalyst?

Ensuring high radiation transport efficiency.



What’s next?

Research transfer

From solar photons to sustainable values

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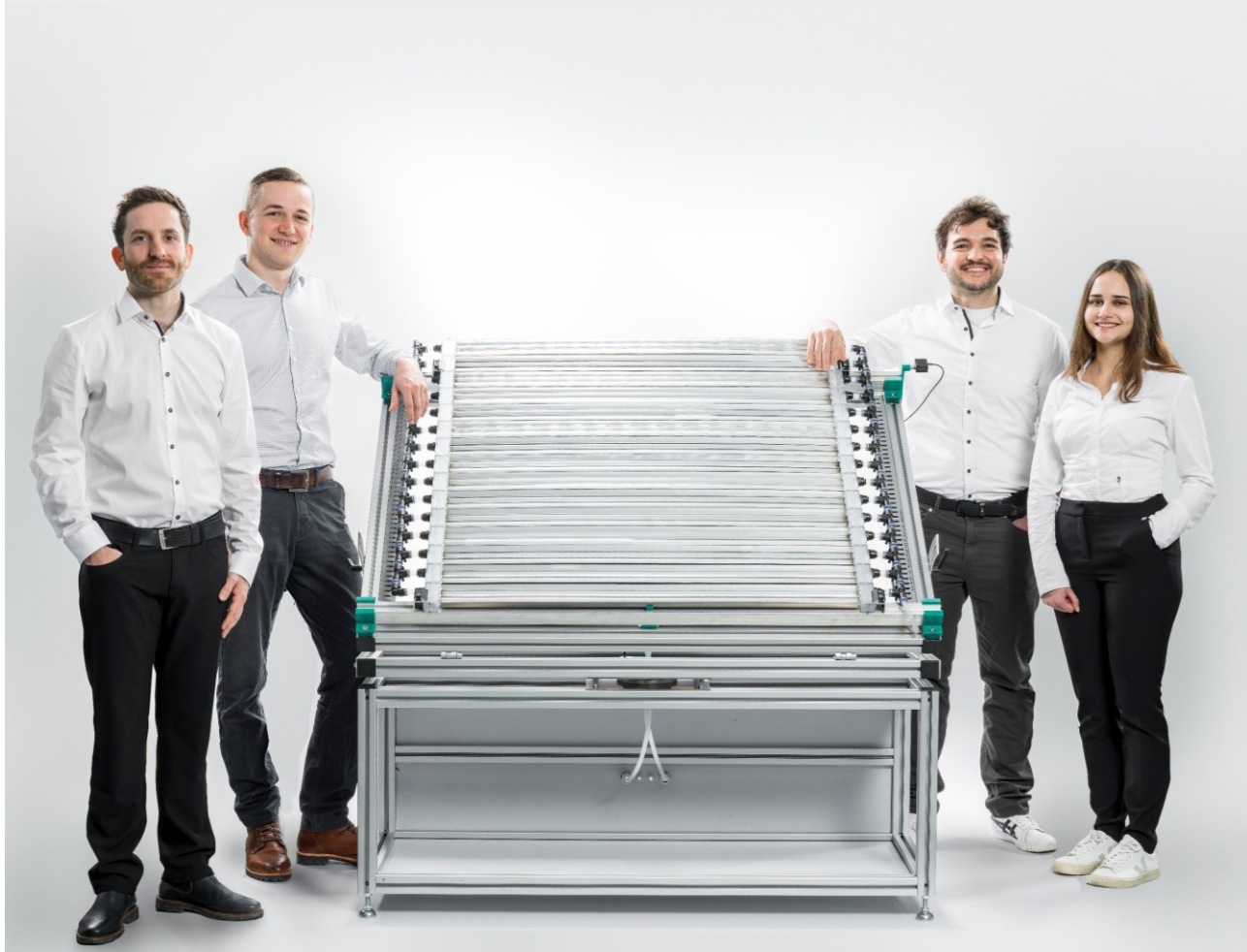


Foto: A. Bramsiepe, KIT.

Thank you

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