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POHJANMAA
COUNCIL OF OULU REGION

BotH_2nia goes Oulu & Raahe 5.–6.5.2022

This is a presentation given at the event BotH$_2$nia Goes Oulu & Raahe on 5.–6.5.2022.

BotH$_2$nia is a network of operators interested in hydrogen. The objective of the network is to create a Nordic hydrogen cluster around the Baltic Sea, beginning with the Bothnian Bay. BotH$_2$nia strengthens the position of the north in the European hydrogen industry!

BotH$_2$nia invites all businesses, research institutes, investors, municipalities and cities to roll up their sleeves for a greener future.

Please notice that the presentation has been modified to comply with the Accessibility Directive. In case for need the original material, please contact Minna Näsman (minna.nasman@both2nia.com).

Solar Hydrogen as a Solution in Hydrogen Transition

Marko Huttula, Prof.

Head of NANOMO Unit MAX IV Finnish coordinator
H2FUTURE PROFI7 LEADER

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Hydrogen strategy based on electrolysis

<u>EU2050 need for hydrogen 2800TWh/v*</u>

=> 4 670TWh electricity
= 330 new nuclear units
= 250 000- 461 000 wind units

In comparison:
Finnish electricity production 2020: 66,6 TWh

ELECTRICITY DEMAND AND PRICE WITH ELECTROLYSIS

*European Hydrogen Backbone 2021

Electricity deficit in Finland 2020 ja 2021

2021 deficit increased 500MW for 6months

2000MW deficit more than doubled from 23% to 50% of time

OL3 would have covered 20– 25% of deficit time

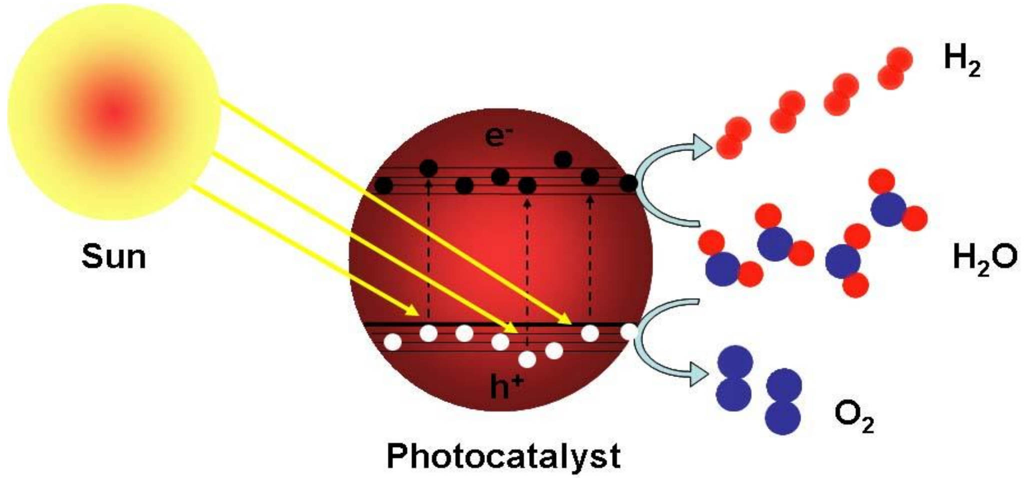
If similar increase in consumption is assumed OL3 covers only15–20% from deficit time

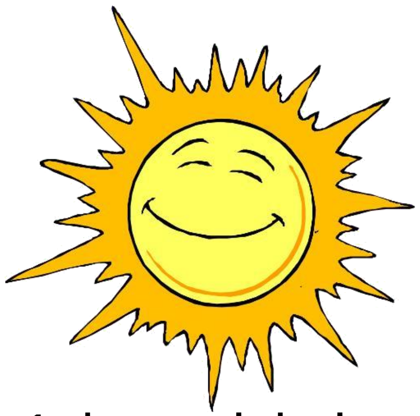
Wind power in Finland produces only 33,8% of it’s nominal capacity.

Source: M. Huttula et al. ”Suomen sähkövajeen tarkastelua”
slide set openly available at: http://jultika.oulu.fi/files/nbnfi-fe2022020717908.pdf

FUTURE SOLUTION: Direct photocatalytic hydrogen production through braking water

The only truly external energy source





1 hour global sunlight
> 1 year human energy needs!

Solar energy harvesting and photocatalytic applications

1 hour = 1 year!

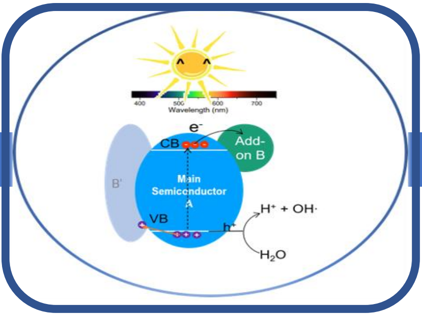
Solar Energy

Photocatalysis

ERDF Funding 2016-2020

KVANTUM INSTITUTE
UNIVERSITY OF OULU

Water purification
H_2 production



NANOCAT 2021-2025

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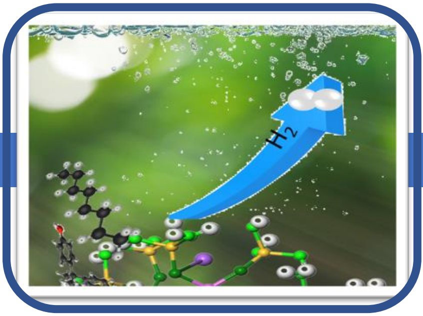
Dimensional operations



CATCH (2021-2026)

Biomimicry

Mimicking leaf nanostructures

School textbook

BBC NEWS

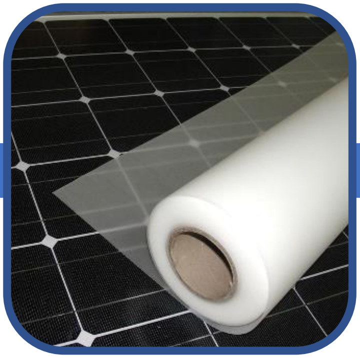

Seeing the light: How India is embracing solar power

Featured internationally

Butterfly wing nanostructures


Oulun yliopiston tutkimus: Perhosten siivistä on löytynyt ratkaisu tehokkaampaan aurinkoenergiaan

Nanofoil

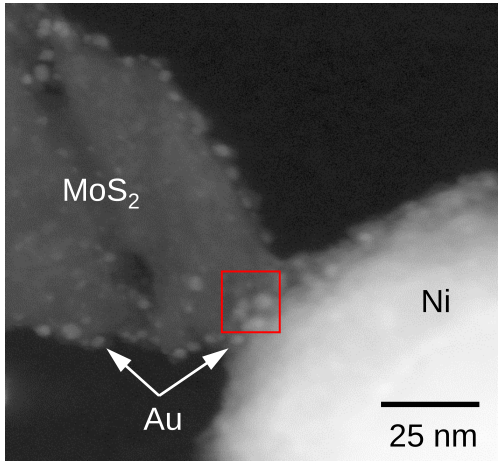


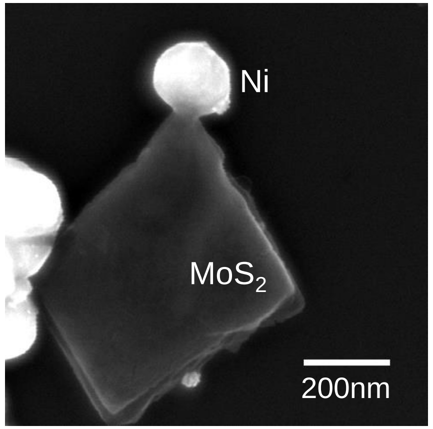
BUSINESS FINLAND

Research 2 Business

“Golden nanoglue” and heterojunction catalysts base for solar hydrogen innovations

Inexpensive and ambient process





Metallic Contact between MoS2 and Ni via Au Nanoglue:
Small 14, 22, 1704526. https://doi.org/10.1002/smll.201704526

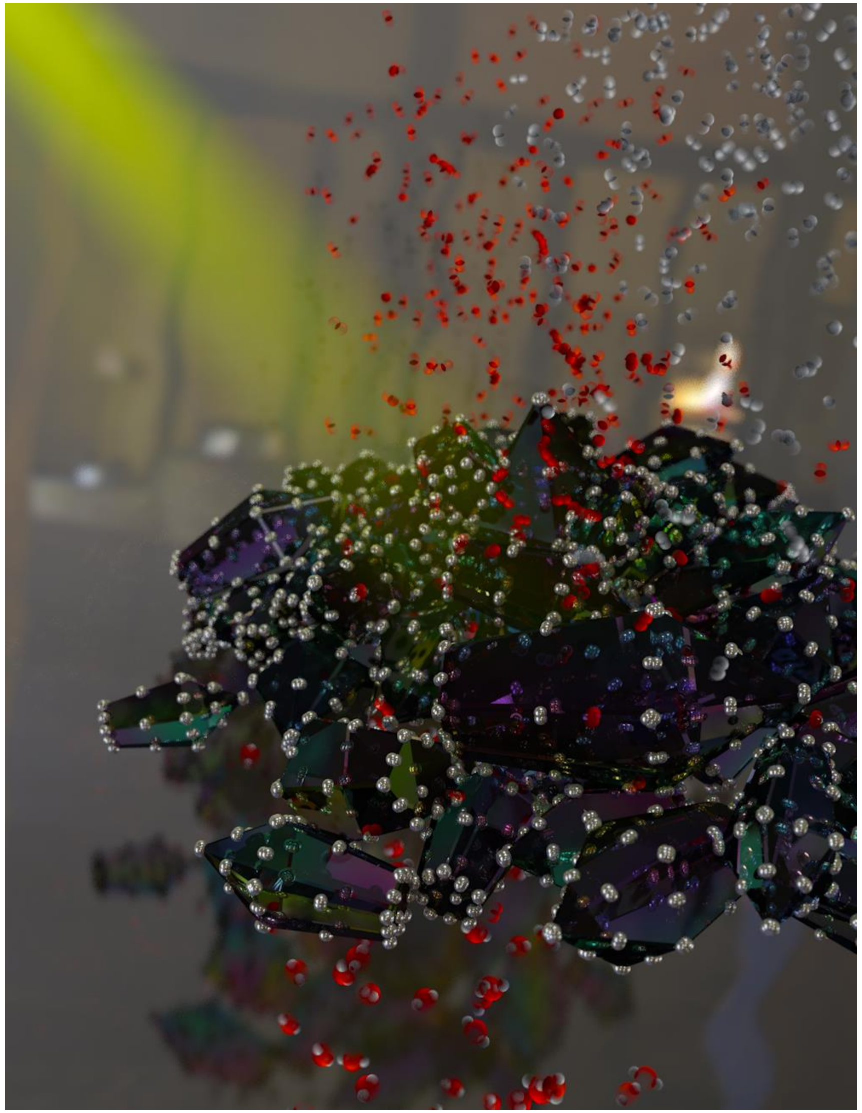


Illustration: Photocatalysis in action

Design principles benefitted for novel nanocatalyst: Hydrogen Production Efficiency

Hydrogen production

- Only water and catalyst are needed, no additives
- Low-cost: 0.7 €/g for the catalyst
- Repeatable and stable for long-term use

Hydrogen production from natural water

- Oulujoki River water
- Kuivasjärvi Lake water

IPR,Patent,

X. Shi, M. Zhang, W. Cao, X. Wang, M. Huttula: Efficient photocatalytic hydrogen evolution via activated multilayer MoS_2. Nanoscale, in press

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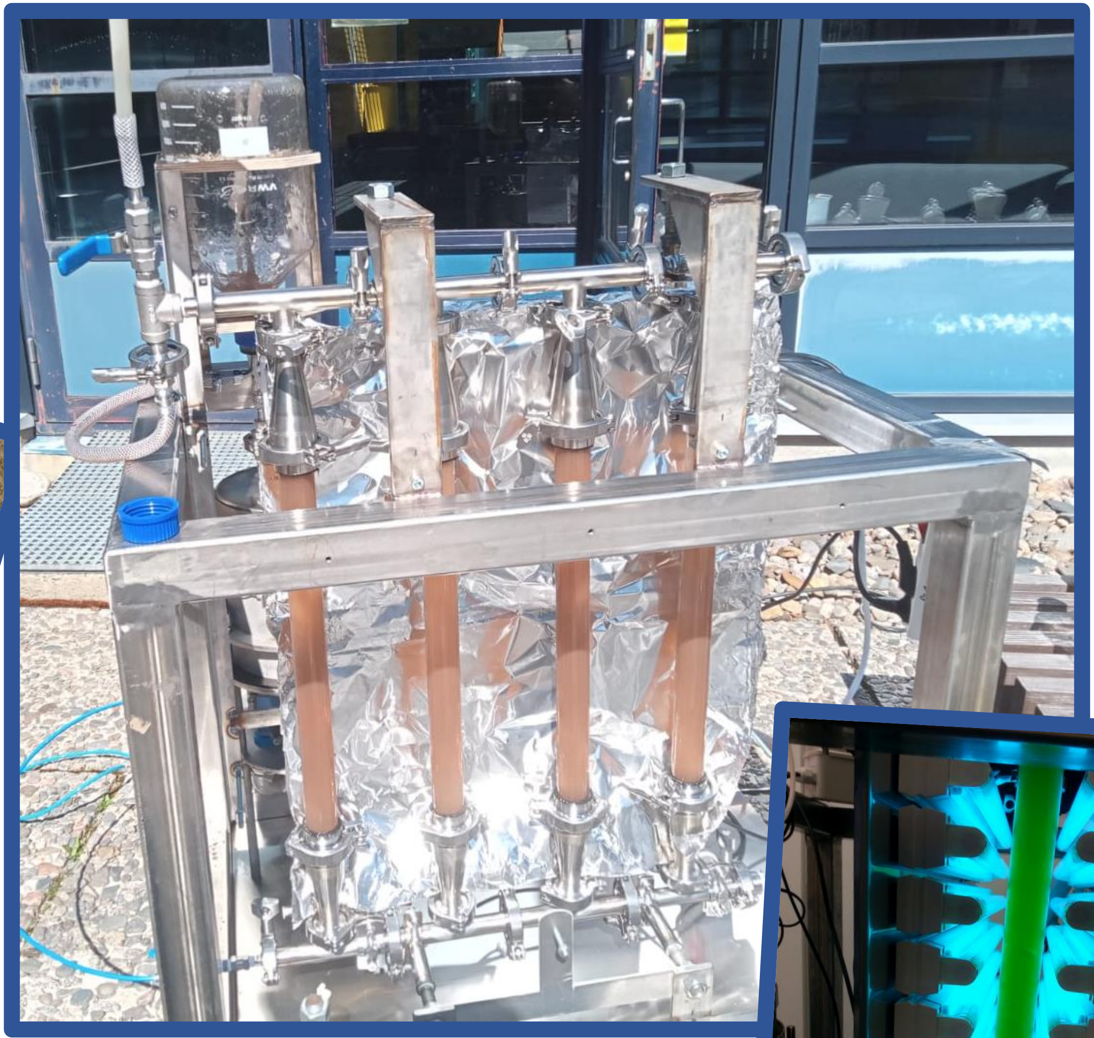
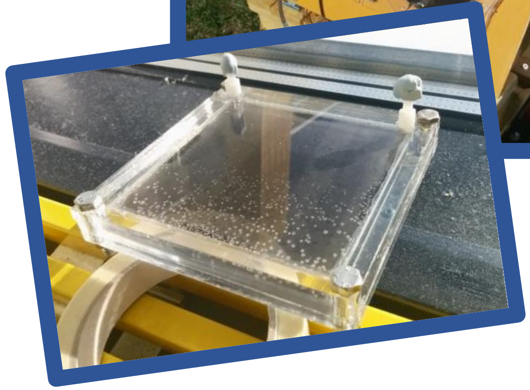
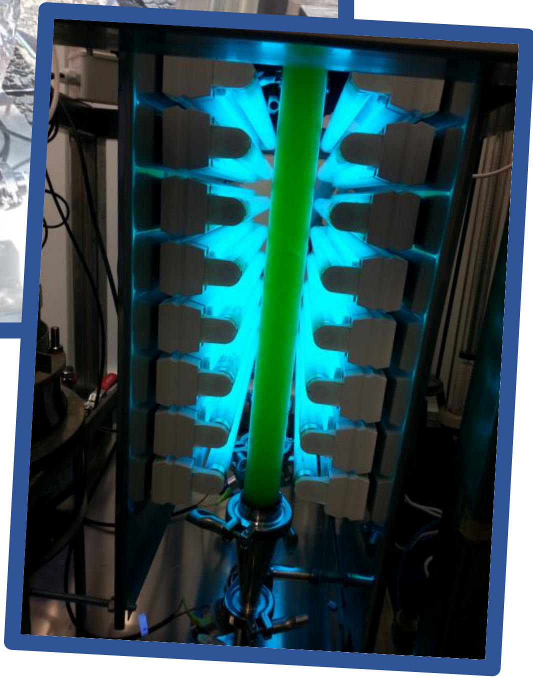
Hydrogen production and water purification







Vipuvoimaa EU:lta 2014–2020

Euroopan unioni
Euroopan aluekehitysrahasto

Prof. Marko Huttula, NANOMO

NANOMO Green Hydrogen Roadmap

2020 | 2025 | 2030 | 2035

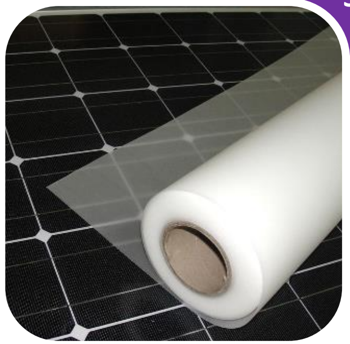
In Situ / Operando Synchrotron and Lab-based Characterization of materials and processes

European Union
European Regional Development Fund

NANOCAT / INTRICat
Fundamental Understanding of Catalyst Activity

ACADEMY OF FINLAND

Roll to Roll anti reflective surfaces



NANOFOIL
Boosting Sunlight Harvesting

BUSINESS FINLAND

SPHERE
Immobilized Catalytic System

First of a kind immobilized HER system

Electricity and CO_2 free H_2 production

CATCH
Ground breaking heterojunctional catalyst development

erc

Cross dimensional strategy for practical photo catalysis

Solar Hydrogen Farm from Pilot to Production

Photocatalytic conversion of CO_2 to fuels and chemicals

Prof. Marko Huttula, NANOMO

Solar hydrogen to global business driver

<u>Solar hydrogen Business drivers:</u>

- In future the **cheapest way** to convert solar energy to hydrogen
- Coversion capasity effects strongly on unit price but effects less when technology developes
- **Increasing electricity price** and energy demand calls for new solutions
- Carbon emission taxing and political future for pricing
- Energy production geographically especially now
- **Total sustainability** in materials, panel production to whole life cycle

Japan, China for example are pushing resources to develop – EU still mostly on electrolysis

https://www.nature.com/articles/s41586-021-03907-3 .

https://www.mdpi.com/2305-7084/2/3/36/htm

OULU CREATING FUTURE TRACKS TO GREEN ENERGY TRANSITION

THANK YOU