AI-TW

AI-TRANSPWOOD

DISCOVER TRANSPARENT WOOD AND AI-TW PROJECT

Dive into Transparent Wood Innovation: explore its unique features, market potential, AI-Driven models, and Transparent Wood samples with AI-TW project partners!

Webinar | 19th December 2024 | 9.30-11.30 AM CET

Agenda

AI-TRANSPWOOD

9.30 AM | **WEBINAR OPENING**

9.45 AM | **THE AI-TW PROJECT** - *Stefania Fortino (VTT)*

9.55 AM | **EXPLORING TRANSPARENT MATERIALS** - *MATto materials library (POLITECNICO DI TORINO)*

10.05 AM | **WHAT IS TRANSPARENT WOOD?** - *Giulio Malucelli (POLITECNICO DI TORINO)*

10.20 AM | **A CLOSER LOOK AT TW SAMPLES** - *MATto materials library (POLITECNICO DI TORINO)*

10.30 AM | **MAKING BUSINESS WITH TW?** *Chiara Lacroix (STRANE INNOVATION)*

10.45 AM | **TW AND SUSTAINABILITY: UTOPIA OR REALITY?** - *Doriana Dal Palù, Beatrice Lerma, Giulio Malucelli (POLITECNICO DI TORINO)*

10.50 AM | **ARTIFICIAL INTELLIGENCE AND TW** - *Kari Kolari (VTT)*

10.55 AM | **AI FOSTERS MATERIAL DESIGN?** Antti Puisto (VTT)

11.00 AM | **Q&A session and CONCLUDING REMARKS** - *All AI-TW partners*

Your idea is important!

Your idea is important!

AI-TRANSPWOOD

If you think about TW, what comes to mind?

Your idea is important!

How to participate?

1 Go to wooclap.com

2 Enter the event code in the top banner

Event code
HROTTG

The AI-TW project

Stefania Fortino

Senior Scientist at VTT Technical Research Centre of Finland, Finland

The AI-TranspWood project

General information on the project

Call: HORIZON-CL4-2023-RESILIENCE-01-23 Computational models for the development of safe and sustainable by design chemicals and materials (Lump sum funding scheme)

Duration: 3-year project (1.1.2024 - 31.12.2026)

EU grant amount: 6,955,522.23 EUR

Project Officer: Kristina Bole

Project Coordinator: Stefania Fortino, VTT

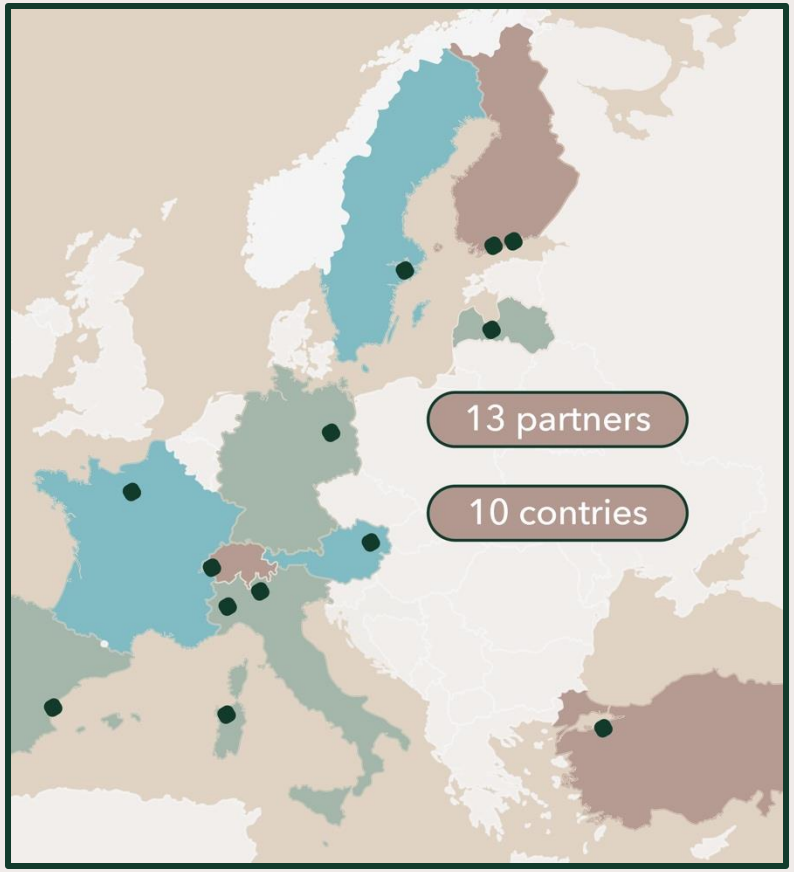
Project Manager: Kari Kolari, VTT

Kickoff meeting: Espoo, Finland, 6-7.2.2024)

2nd consortium meeting: Sassary, Italy, 18-19.9.2024

1st webinar: 19.12.2024

Project website: https://www.ai-transpwood-project.eu/



Academic Partners

Aalto-yliopisto Aalto-universitetet Aalto University

KTH Vetenskap och Konst

Politecnico di Torino

TU Wien Technische Universität Wien

UNISS Università degli Studi di Sassari

Industrial Partners - Research Centers

Project leader

VTT

AIMPLAS

bm Plastic

EPFL cecam Centre Européen de Calcul Atomique et Moléculaire

Latvijas Finieris

Oyak Renault Otomobil Fabrikaları

Strane Innovation

The AI-TranspWood project

Background

Transparent Wood (TW) is an innovative material among the most promising of the global scene, with a potential important role in terms of **sustainability** and with potential applications also as a **substitute for plastics and glass** in various industrial sectors, e.g.

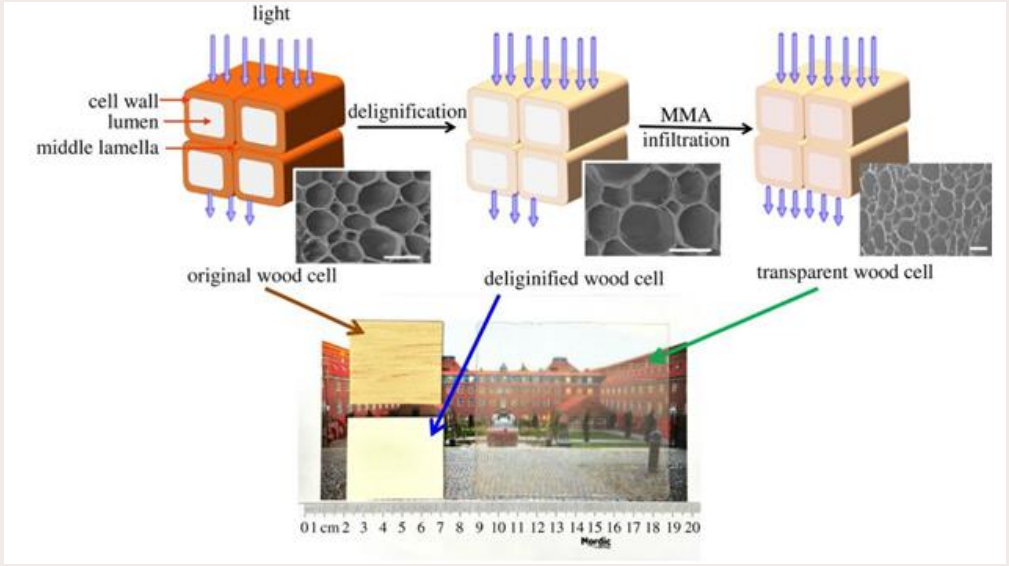
- **construction, automotive, electronics and furniture**

In the last decade, partner KTH has carried out relevant experimental research on this material. However,

- **TW is not yet in the market**
- **optical properties** and other properties and functionalities should be improved or developed

In AI-TranspWood project, experts of the following fields joined to create advanced tools for TW development :

- wood and wood process **multiscale modelling**
- experimental research on **chemistry and manufacturing**
-



Transparent wood for functional and structural applications
Yuanyuan Li, Qiliang Fu, Xuan Yang and Lars Berglund

The AI-TranspWood project

Objectives of the project

To create an **AI-driven multiscale methodology** for new safe, sustainable, and functional wood-based composites and demonstrate the concept for Transparent Wood (TW)

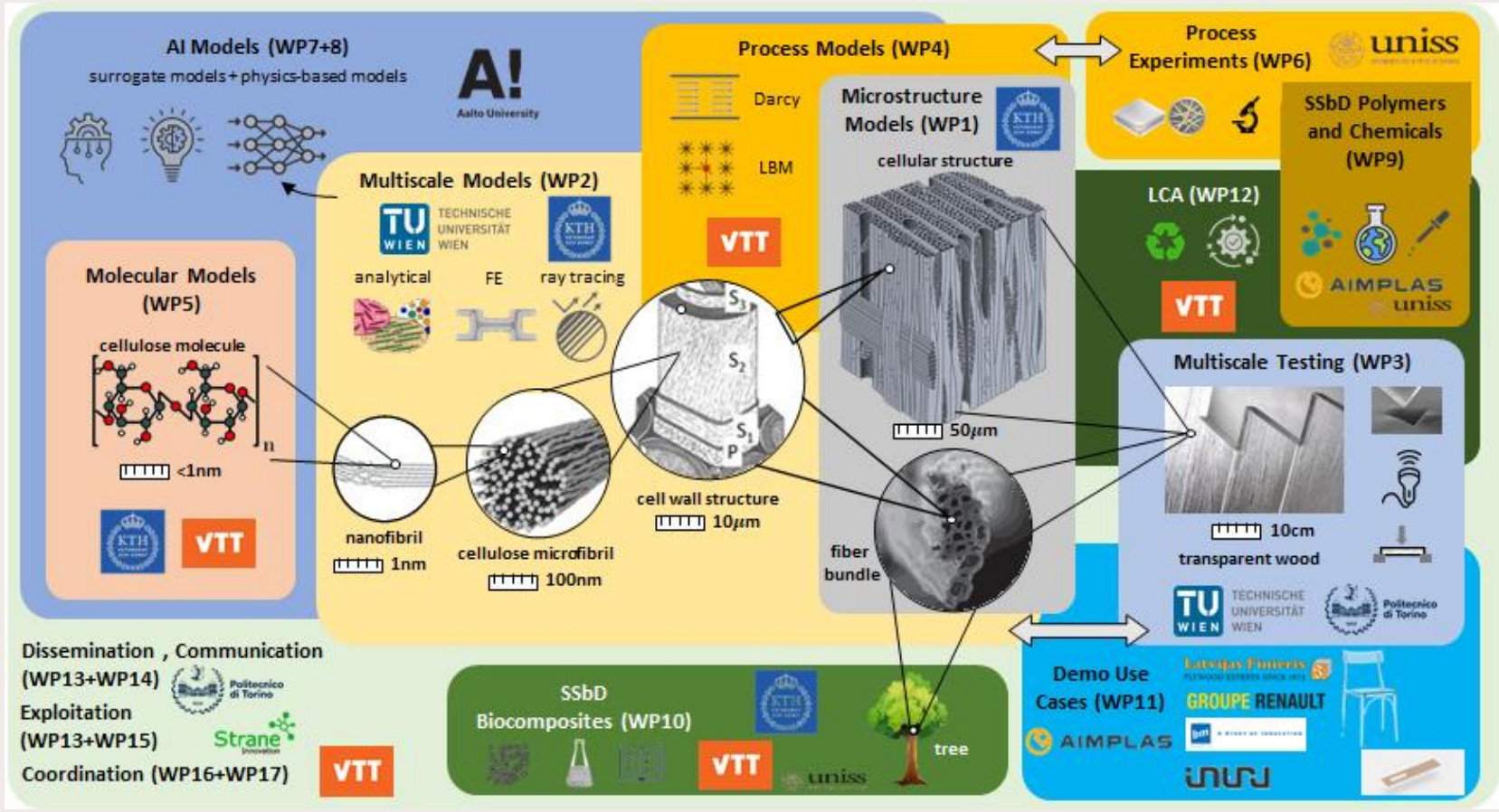
To develop an AI-supported **Safe and Sustainable by Design (SSbD) framework** for TW, we will provide innovative sustainable materials and cost-effective tools for European industries paving the way towards green and sustainable transition

AI- and SSbD tools used by the chemicals and materials community with new transparent wood materials, will contribute **to increase the innovation capacity of SMEs and industry** for future sustainable products

The numerical tools will be available in the **European EESSI platform**

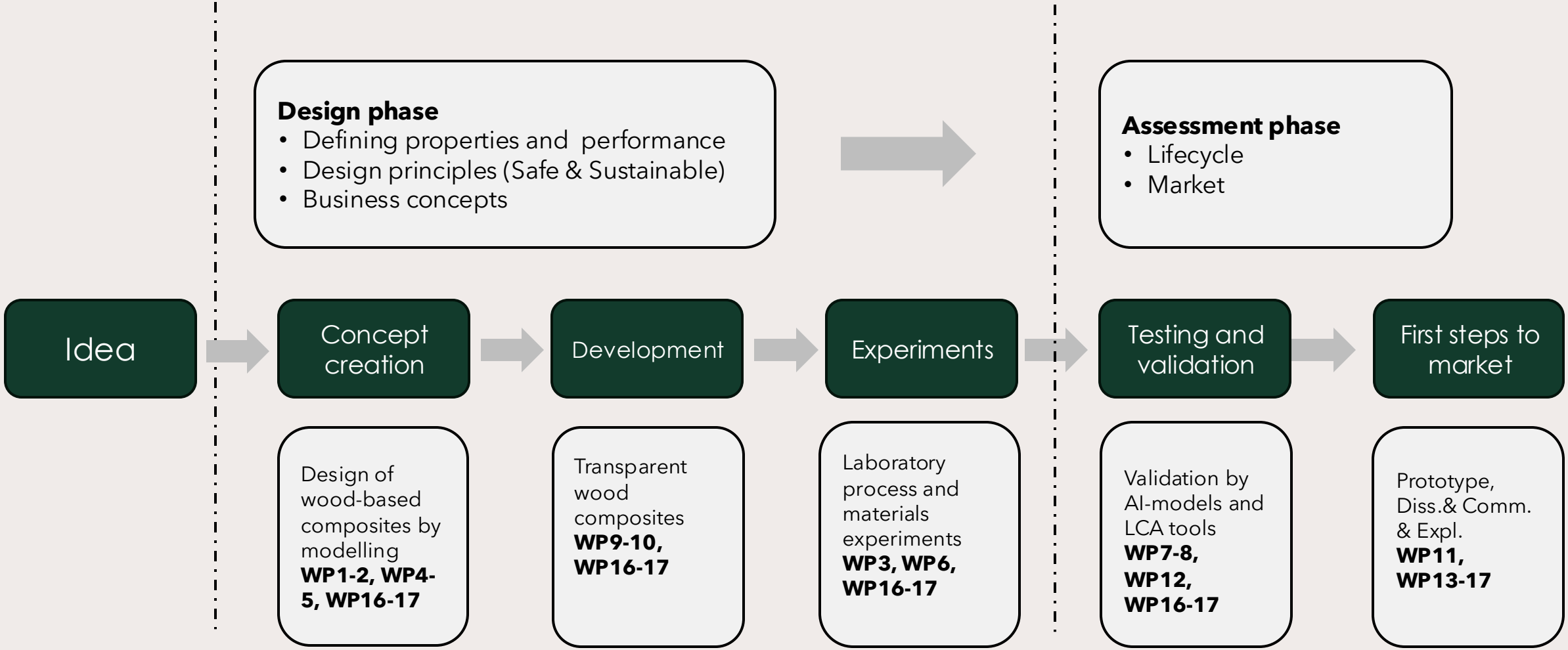
The AI-TranspWood project

Structure of the project, Work Packages and main leaders



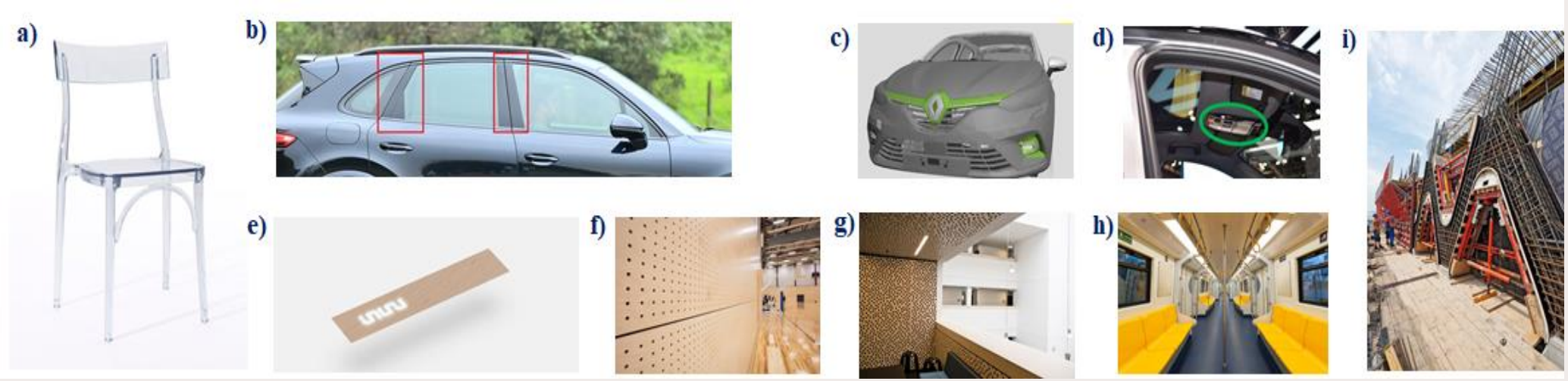
The AI-TranspWood project

Safe and Sustainable by Design (SSbD) concept



The AI-TranspWood project

Planned industrial applications



Examples of TW integrated products

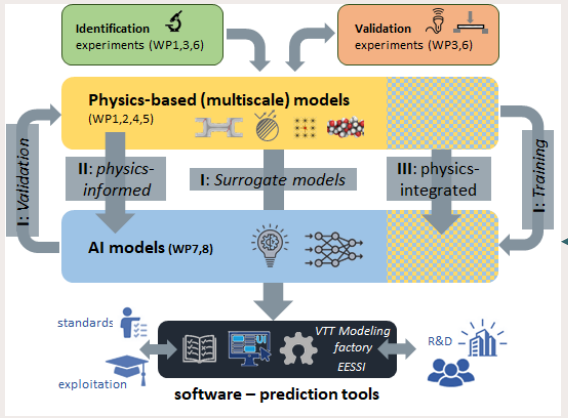
- **BM plastic**: **a)** seat application for chair; **b)** aesthetic glossy application on upper side pillars
- **Oyak Renault**: **c)** frontface decorative exterior part – PC with hot stamp chrome; **d)** interior application with aesthetic surface and lightguide
- **Inuru: e)**: Inuru's electronic luminous film (ELF) integrated into a wooden surface
- **Finieris**: **f), g), h)** integrated OLED signs, directions, decorative elements in wall and ceiling panels, flooring and public transport lining elements; **i)** improved plywood surfaces

The AI-TranspWood project

SSbD - From experimental and computational research to prototypes

Production of TW sheets from pristine wood

AI-based multiscale modelling tools



Definition of prototypes with the support of an External Advisory Board

EAB Member Institution	Country	Research/industrial sector
Innorenew CoE	SI	Sustainable Construction
Federation of the Finnish Woodworking industries	FI	Wood Construction and standards
Association of the Austrian Wood Industries	AT	Wood processing, wood construction
Kvist	DK	Furniture, interior design
Stellantis	IT	Automotive (previously Fiat)
RISE	SE	Research solutions for sustainable future

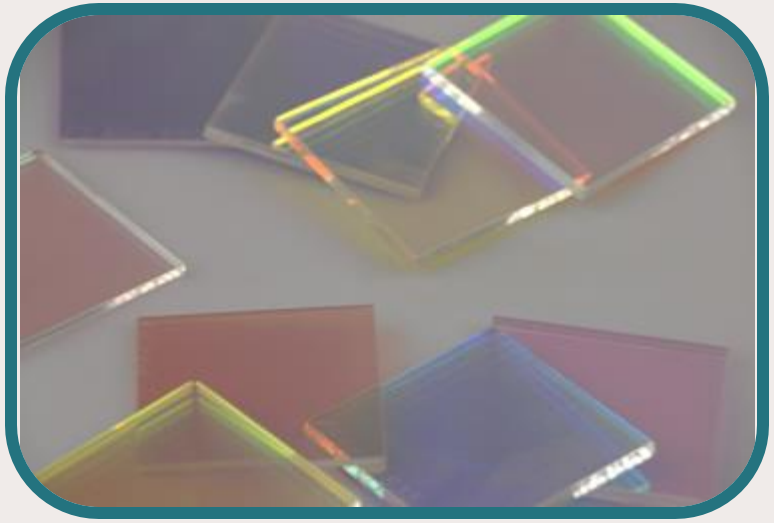
AI-TRANSPWOOD

Exploring transparent materials

Beatrice Lerma, Doriana Dal Palù, Eva Vanessa Bruno

Associate Professor, Assistant Professor and Research Assistant in Design at Politecnico di Torino, Italy

Exploring Transparent Materials



3D textures

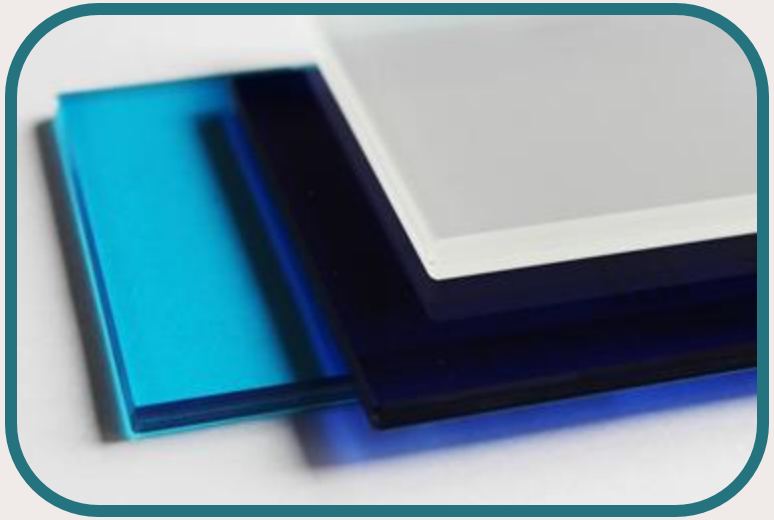
Glass

Light separation

Exploring Transparent Materials

Colors and transparencies

Glass



Amorphous (semi)crystalline

Exploring Transparent Materials

AI-TRANSPWOOD

Lightweight and transparent

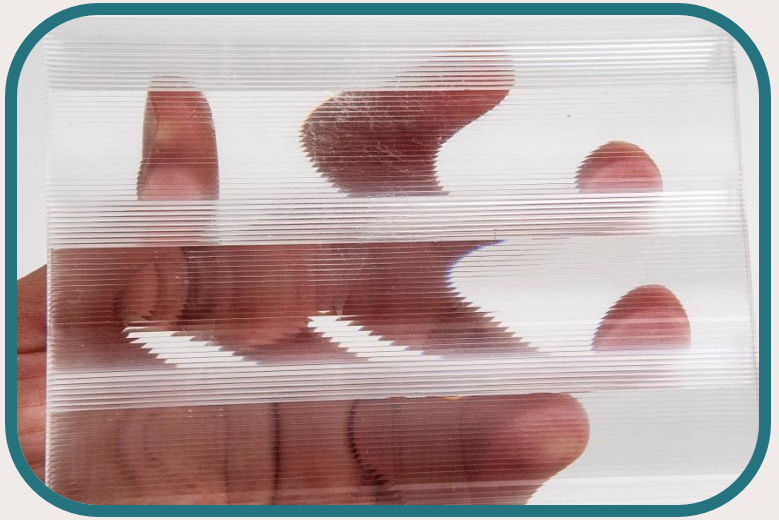
Plastic

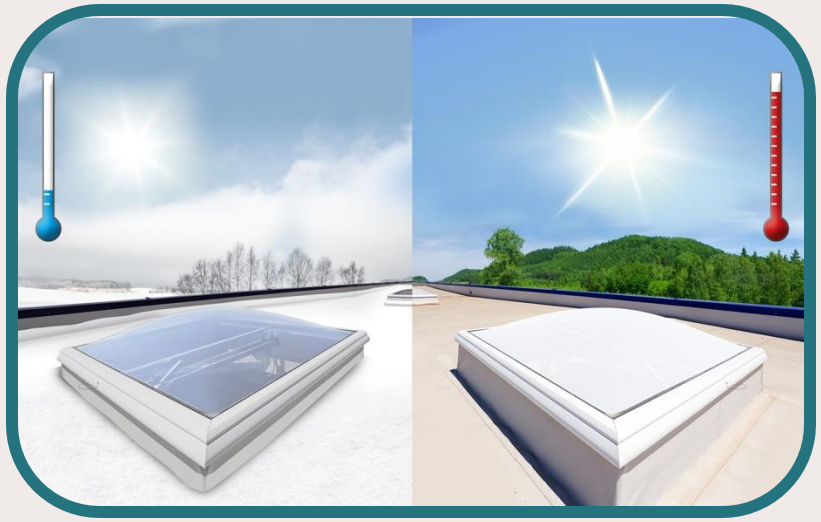
Resistant and easy to process

Exploring Transparent Materials

Change in translucence

Plastic

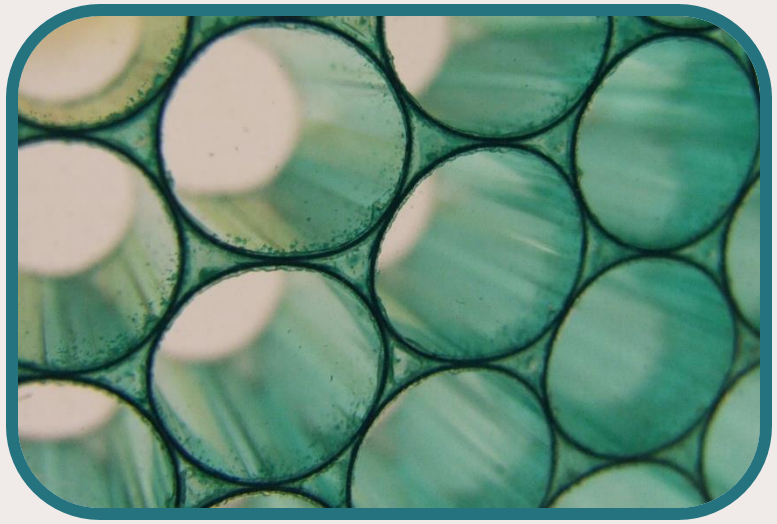




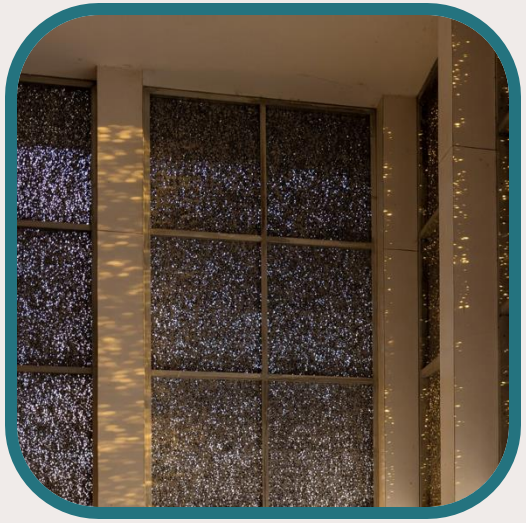
Optical sheets

Exploring Transparent Materials

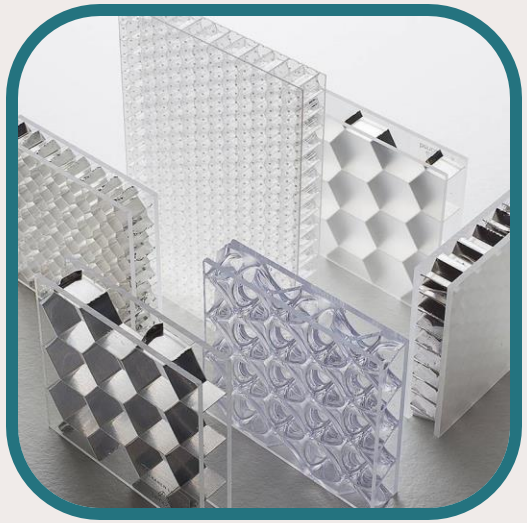
AI-TRANSPWOOD



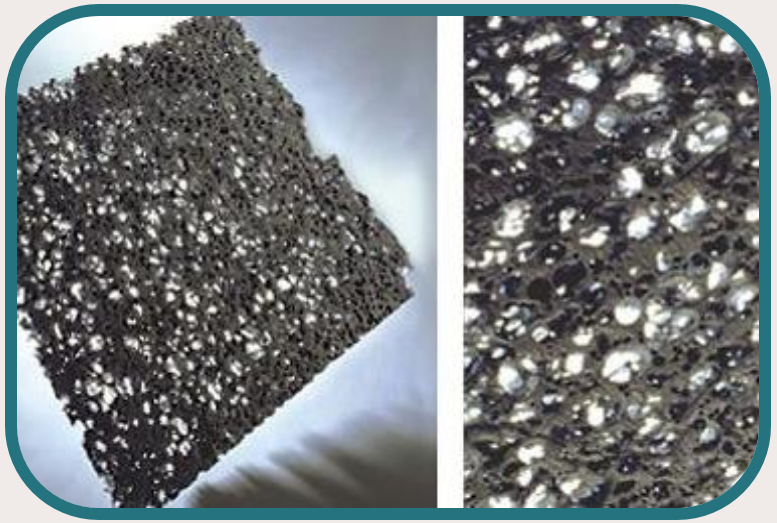
Amorphous forms



Others?



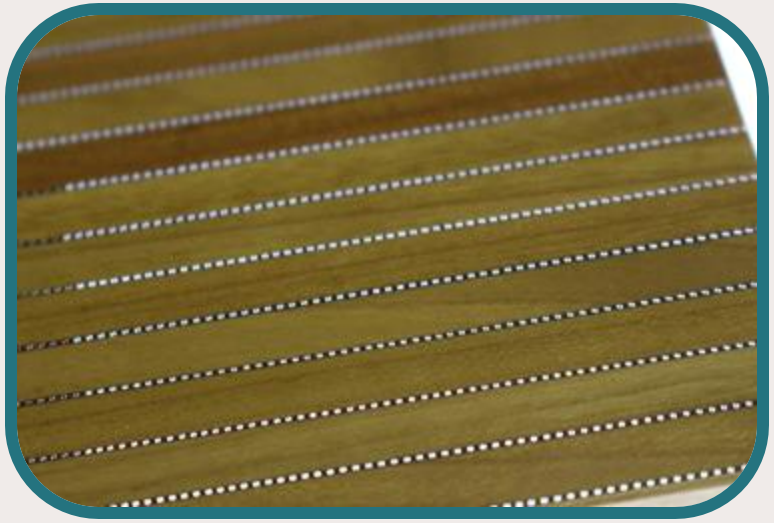
Honeycomb panel



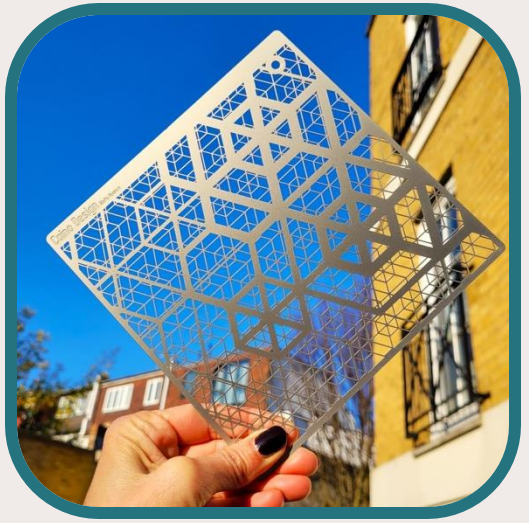
Exploring Transparent Materials

Optical fiber

Others?



Semi-transparent metal



What is Transparent Wood?

Giulio Malucelli

Full professor in Materials Science and Technology at Politecnico di Torino, Italy

What is Transparent Wood?

AI-TRANSPWOOD

Transparency


Photo by James Haworth on Unsplash

Merriam-Webster

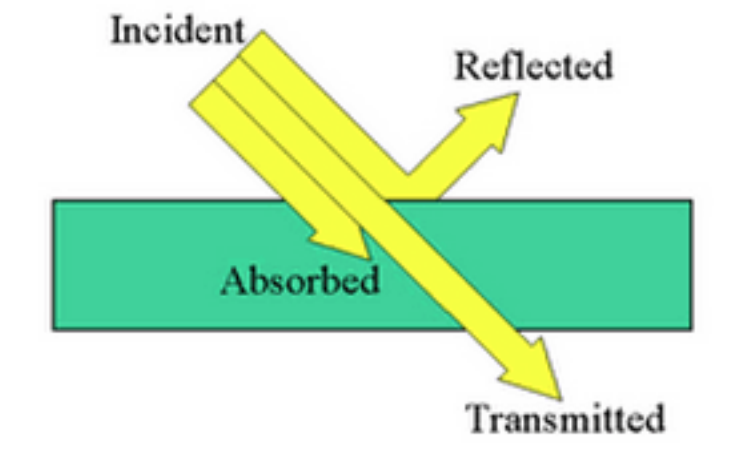
"Transparency"

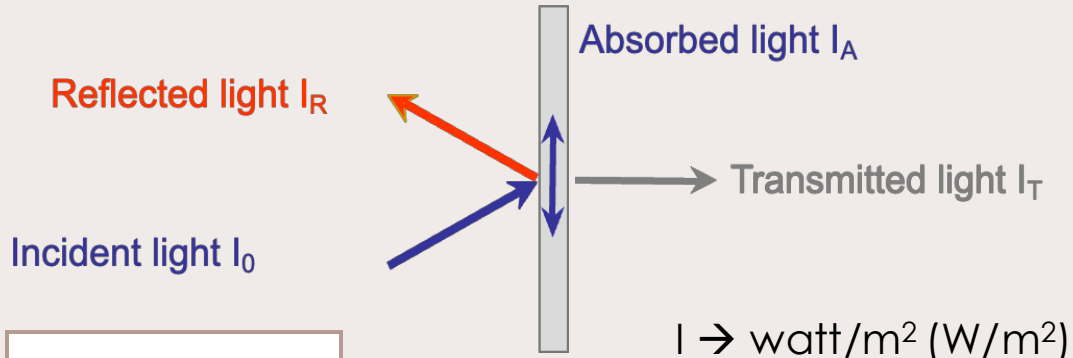
«the quality or state of being **transparent**»

What is Transparent Wood?

How light interacts with materials?

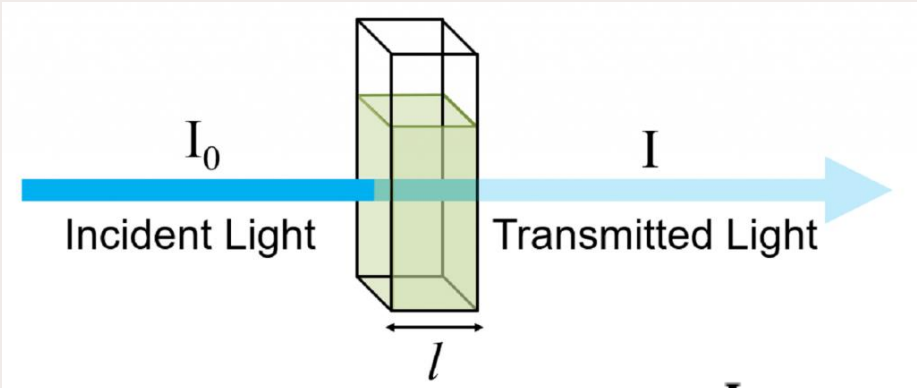
Transmittance





$I_0 = I_R + I_A + I_T$

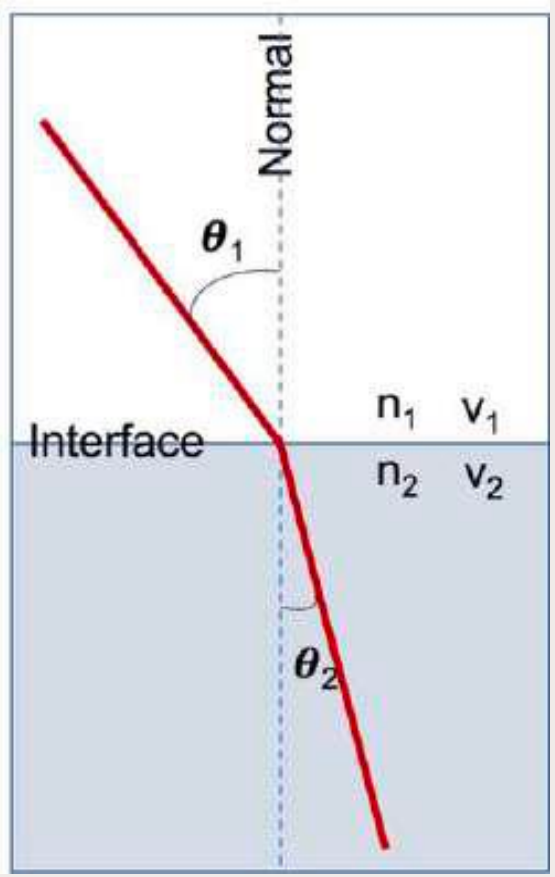
I → watt/m² (W/m²)

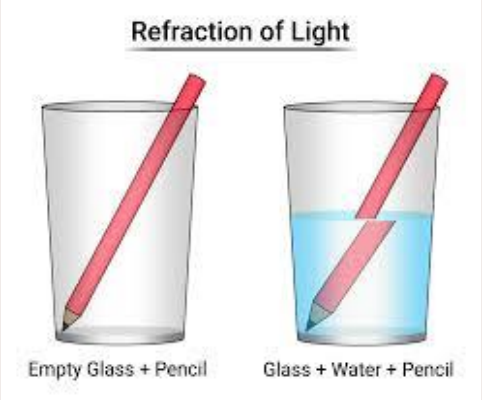


$$T(\%) = 100\frac{I}{I_0} \qquad T = \frac{I}{I_0}$$

What is Transparent Wood?

What happens when light passes through materials having different refractive indices?





The transparency of a material is related to the phenomena of **light scattering** through the material itself

Light refraction at the interface between two media with different indexes of refraction, where $n_2 > n_1$.

Since $v_2 < v_1$ ---> $\theta_2 < \theta_1$

$n_1 \sin \theta_1 = n_2 \sin \theta_2$ **Snell's law**

What is Transparent Wood?

AI-TRANSPWOOD

Wood is not transparent at all…

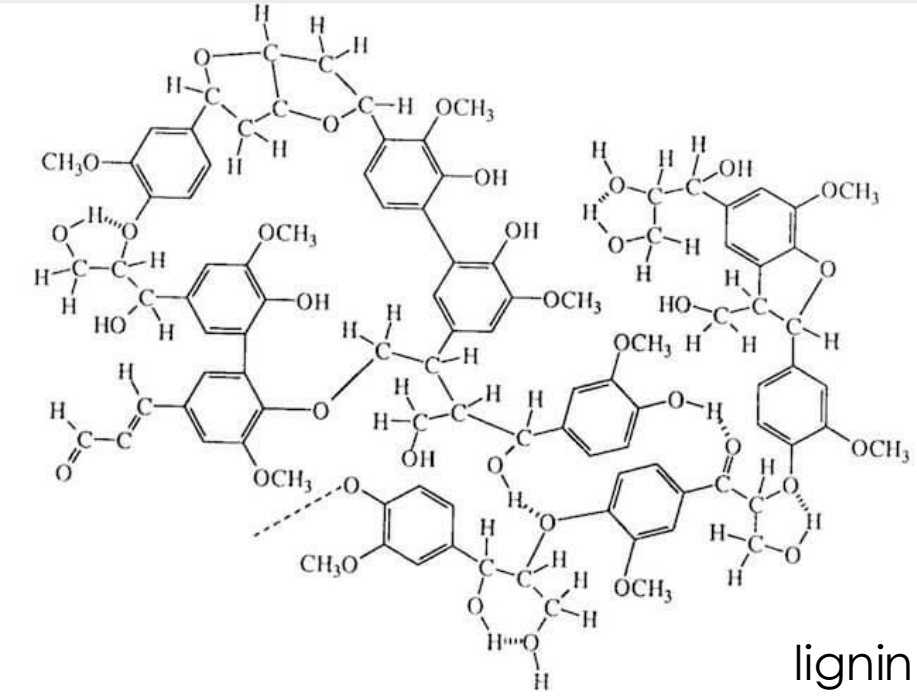
What is Transparent Wood?

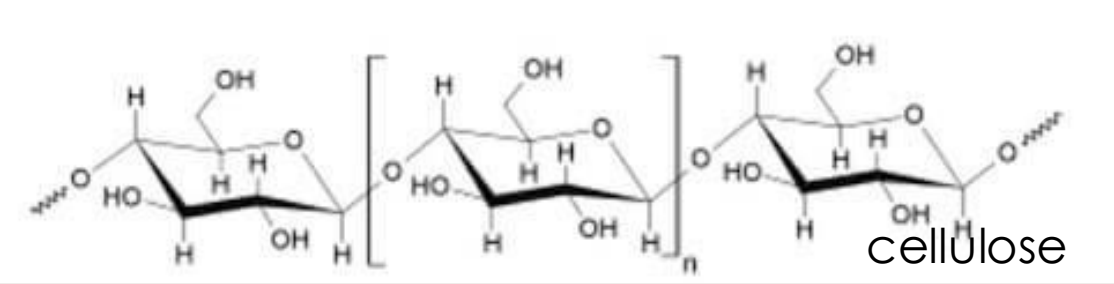
Chemical composition of wood

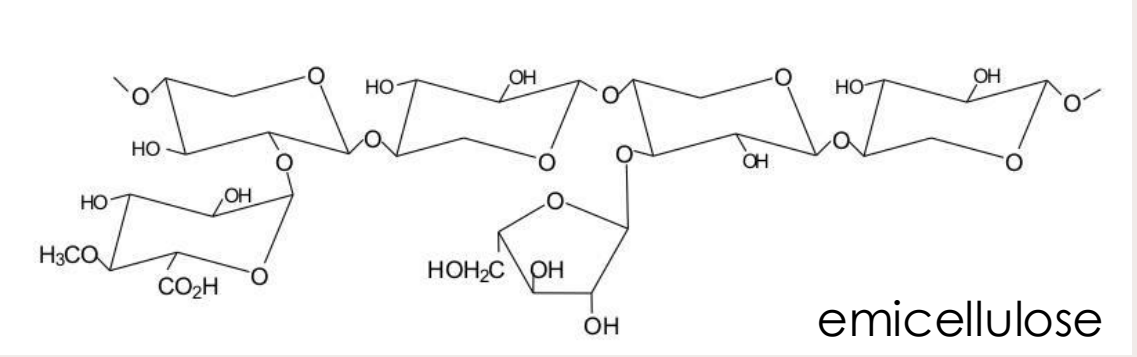
Elemental analysis:

50% C
45% O
5% H

- Cellulose (40-50%),
- Hemicellulose (15-35%)
- Lignin (20-35%)
- Low Molecular weight organic (2-4.5%) and inorganic (0.2-0.6%) components



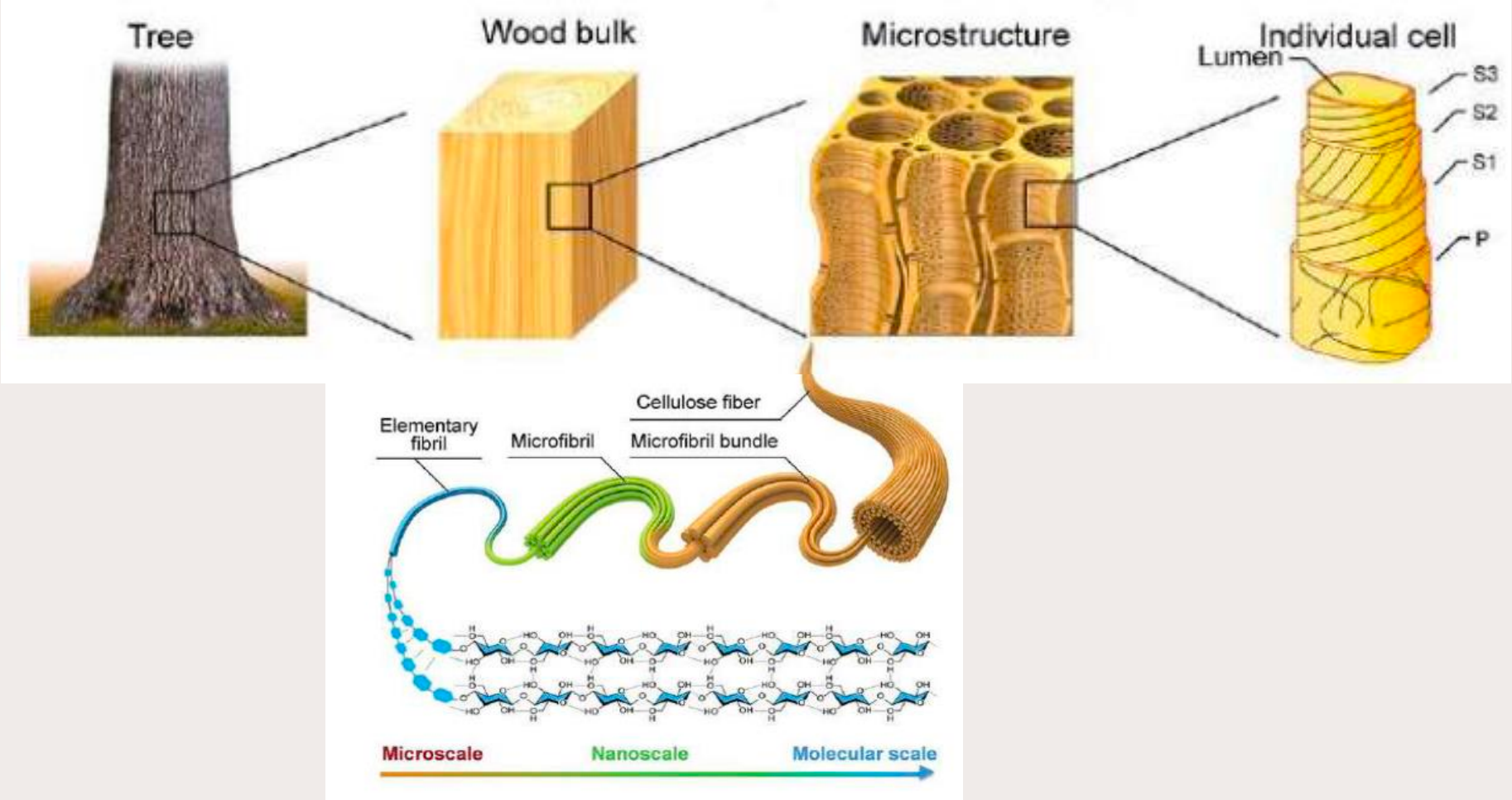




What is Transparent Wood?

AI-TRANSPWOOD

Hierarchical cellular structure of wood with pronounced anisotropy



What is Transparent Wood?

AI-TRANSPWOOD

The discovery of Transparent wood

Transparent Wood – A New Approach in the Functional Study of Wood Structure

By Siegfried Fink

Institut für Forstbotanik und Baumphysiologie, Bertoldstrasse 17, D-7800 Freiburg, Federal Republic of Germany

Vol. 46 (1992) No. 5

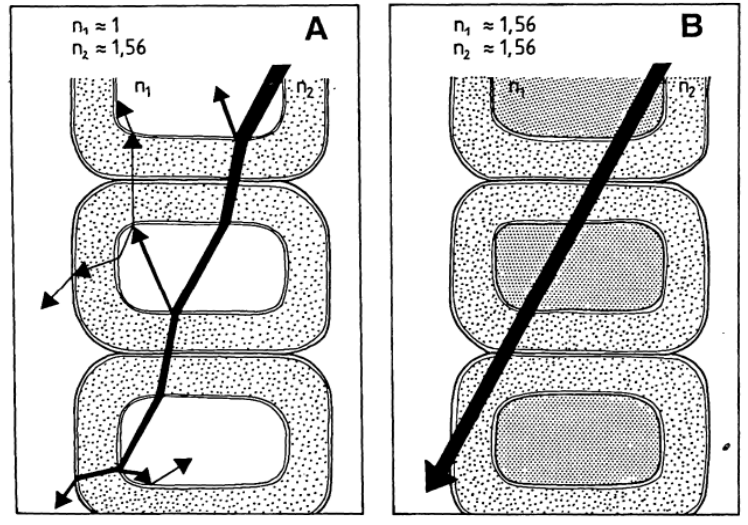
Holzforschung
46 (1992) 403–408

Keywords

Transparent wood
Optical wood properties
Course of vessels
Fraxinus excelsior
Quercus rubra
Tilia platyphyllos
Ulmus carpinifolia

Summary

Samples of wood can be made nearly transparent by subsequent (a) chemical clearing (bleaching), and (b) physical clearing through the inclusion into a matrix with the same refractive index (about n = 1.56). Two liquids and two different monomeric formulations with low viscosity are presented which can be easily infiltrated into the samples; the latter, upon polymerization, yield polymers with the desired optical properties. Woody cell walls can be "optically dissolved" by this technique up to a depth of 4 mm. Contrasting of the vessels with pigmented plastic fillings before this treatment can demonstrate *in situ* the course of vessels in intact wood. Using this technique, regular and irregular patterns in various samples are visualized and unusual structures, such as downward bends of vessels, are detected.



What is Transparent Wood?

AI-TRANSPWOOD

Re-discovery of Transparent wood

2016

BioMACROMOLECULES

Article

pubs.acs.org/Biomac

Optically Transparent Wood from a Nanoporous Cellulosic Template: Combining Functional and Structural Performance

Yuanyuan Li,[†,‡] Qiliang Fu,[†,‡] Shun Yu,[‡] Min Yan,[§] and Lars Berglund*[,‡]

[‡]Wallenberg Wood Science Center, Department of Fiber and Polymer Technology, and [§]School of Information and Communication Technology, KTH Royal Institute of Technology, SE-10044 Stockholm, Sweden

Biomacromolecules 2016, 17, 4, 1358–1364, https://doi.org/10.1021/acs.biomac.6b00145

KTH - Royal Institute of Technology (Sweden)

Prof. Lars Berglund

Materials Views

www.MaterialsViews.com

ADVANCED MATERIALS

www.advmat.de

Highly Anisotropic, Highly Transparent Wood Composites

*Mingwei Zhu, Jianwei Song, Tian Li, Amy Gong, Yanbin Wang, Jiaqi Dai, Yonggang Yao, Wei Luo, Doug Henderson, and Liangbing Hu**

Adv. Mater. 2016, 28, 5181–5187, https://doi.org/10.1002/adma.201600427

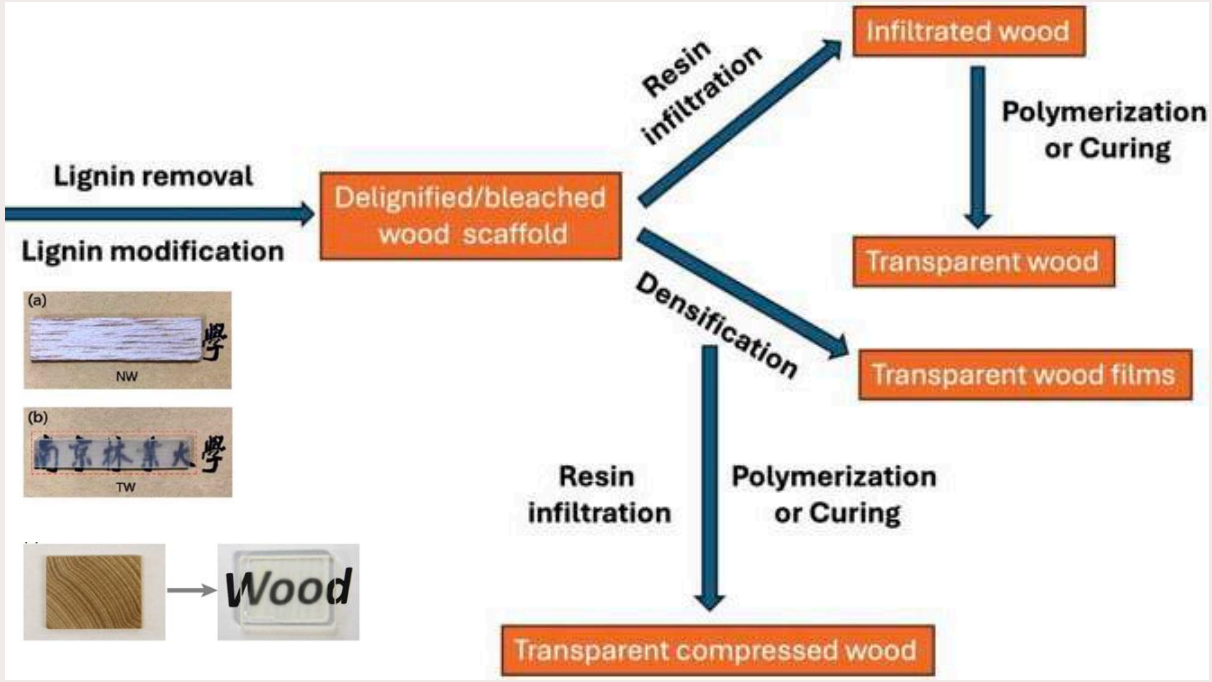
University of Maryland (USA)

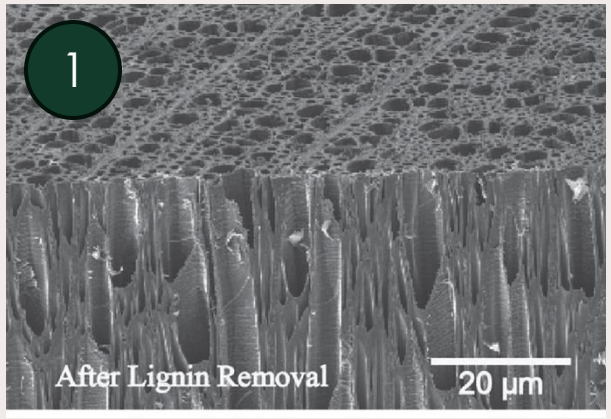
Prof. Liangbing Hu

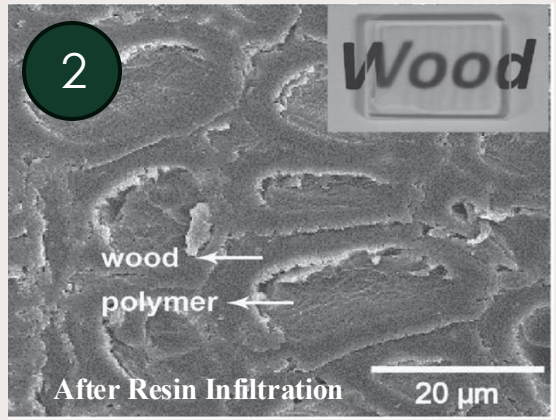
What is Transparent Wood?

AI-TRANSPWOOD

How to produce TW





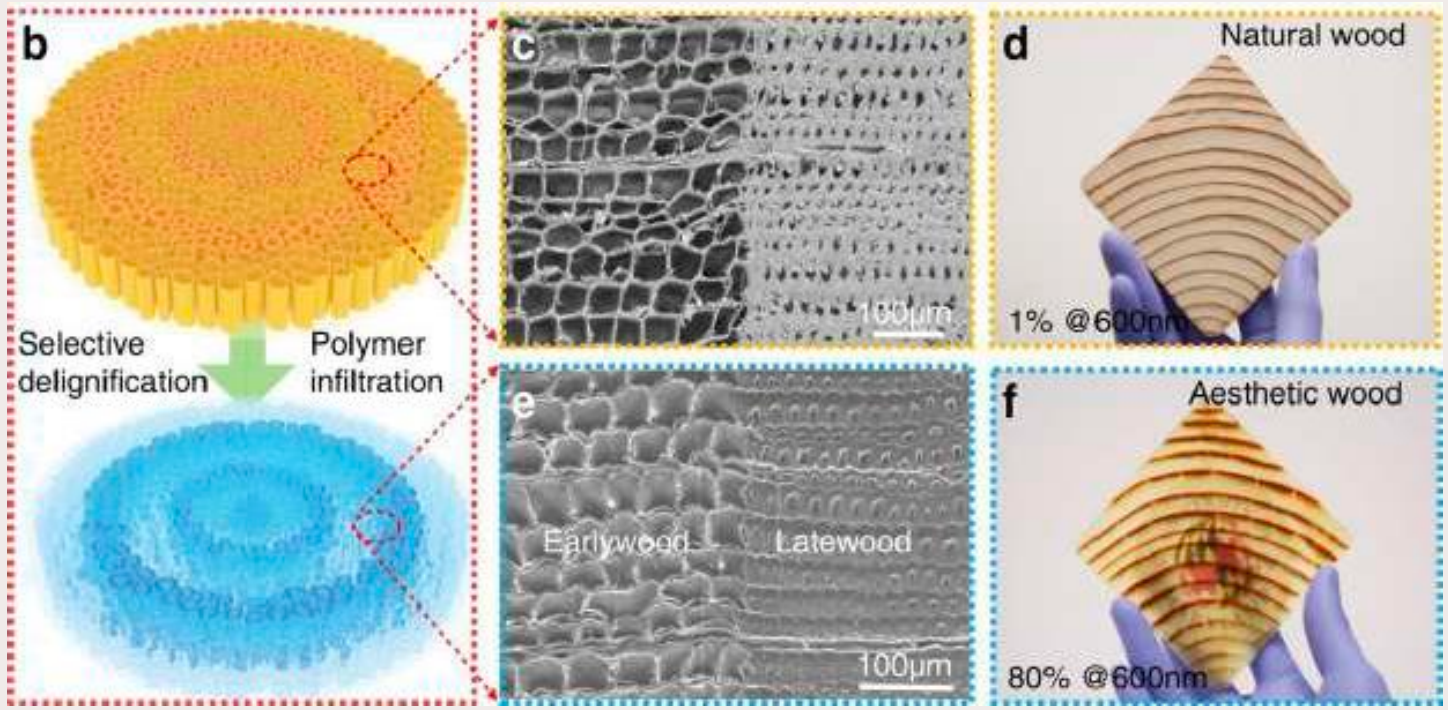


P. Kivikytö-Reponen, S. Fortino, et al. An AI-driven multiscale methodology to develop transparent wood as sustainable functional material by using the SSbD concept *Comput. Struct. Biotechnol. J.*, 2024

What is Transparent Wood?

AI-TRANSPWOOD

The "aesthetic wood"



Mi, R., Chen, C., Keplinger, T. *et al*. Scalable aesthetic transparent wood for energy efficient buildings. *Nat Commun* **11**, 3836 (2020).

Mi, R., Chen, C., Keplinger, T. *et al*. Scalable aesthetic transparent wood for energy efficient buildings. *Nat Commun* **11**, 3836 (2020).

What is Transparent Wood?

AI-TRANSPWOOD

Final considerations about Transparent Wood

Pros

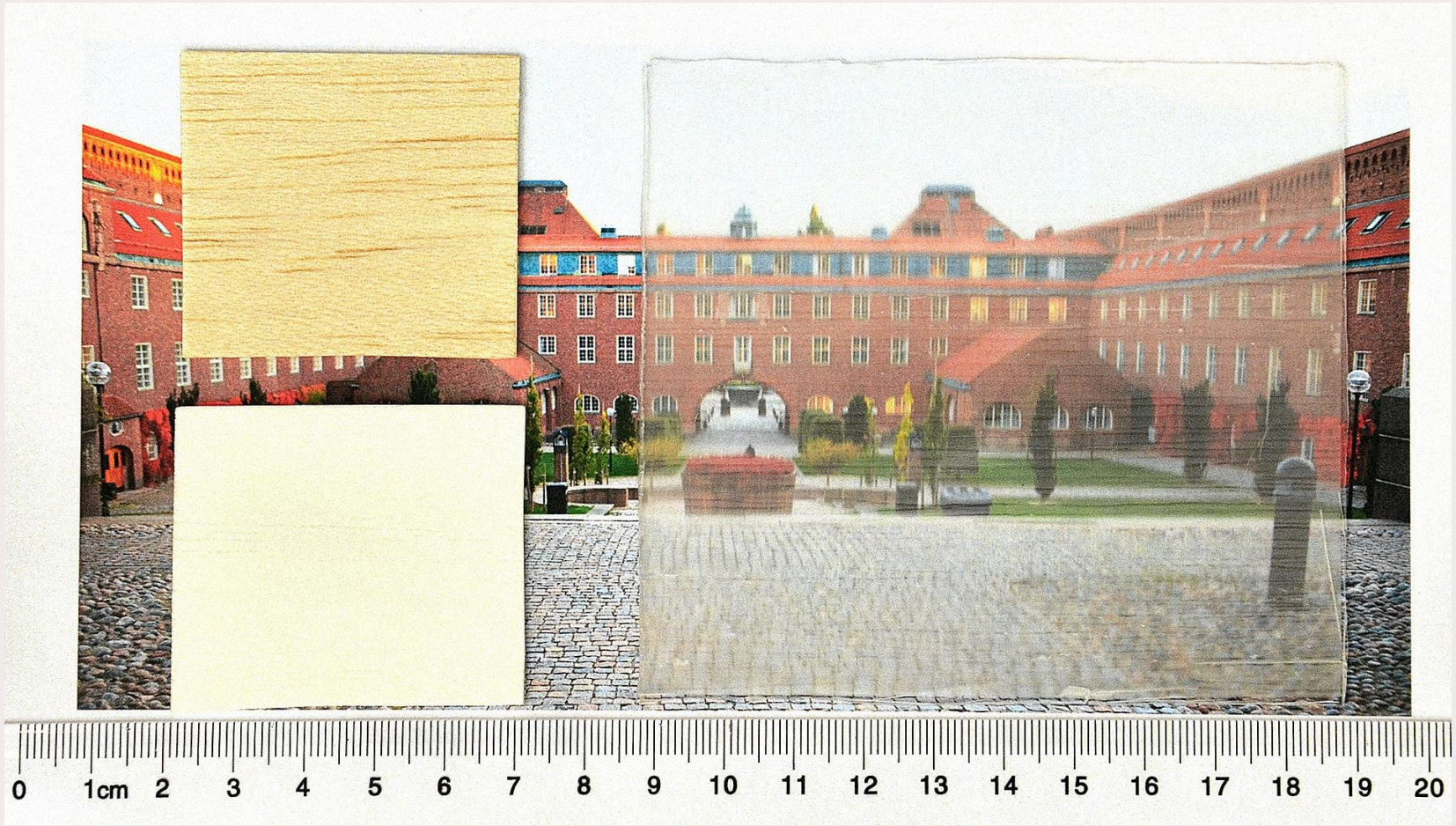
- Lightness
- Toughness
- Optical Transmittance
- Low energy consumption for processing
- Low carbon footprint
- Low thermal conductivity
- Resistance to environmental conditions
- No propensity to corrosion

Cons

- Difficult measurement of the RI of delignified wood
- Limitations in size
- Need to use chemicals with low environmental impact
- Need to infiltrate bio-sourced resins
- Limited economic exploitation of transparent wood

What is Transparent Wood?

AI-TRANSPWOOD



https://www.fastcompany.com/3058621/this-swedish-scientists-transparent-wood-could-transform-architecture

A closer look: let's get in touch with TW samples

Beatrice Lerma, Doriana Dal Palù,
Eva Vanessa Bruno

Politecnico di Torino, Italy

Your idea is important!

AI-TRANSPWOOD

Which applications or application sectors do you think are relevant for Transparent Wood?

Making Business with Transparent Wood?

Chiara Lacroix

Head of R&I Sustainable Agriculture,
Strane Innovation, France

Making business with Transparent Wood?

AI-TRANSPWOOD

AI-TRANSPWOOD

EXPLOITATION

Make concrete use of the results

Commercialize products

Contribute to further research

Create services

Shape policies

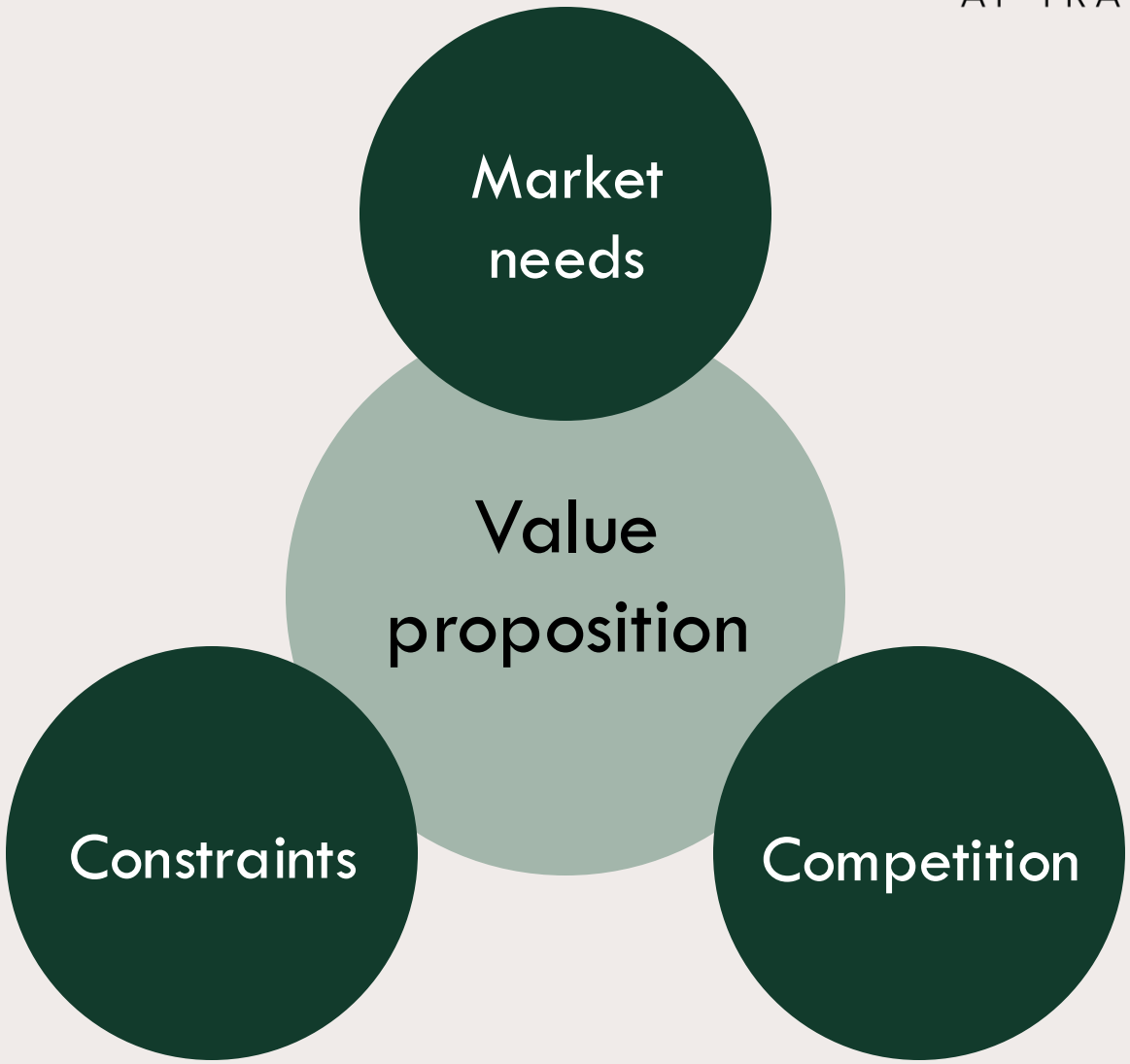
Maximize the project's impact

MARKET EXPLORATION

Making business with Transparent Wood?

AI-TRANSPWOOD

MARKET EXPLORATION



Making business with Transparent Wood?

AI-TRANSPWOOD

MARKET EXPLORATION

Key steps

Transparent Wood's properties

Comparison with other materials

Applications of other materials

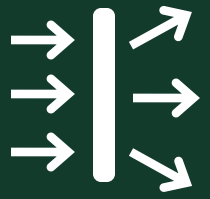
Constraints of applications

Making business with Transparent Wood?

AI-TRANSPWOOD

MARKET EXPLORATION

TW's properties

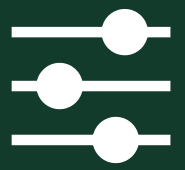


Transmittance & diffusivity

Lightness

Low thermal conductivity

Mechanical strength



Customizable

Low carbon footprint

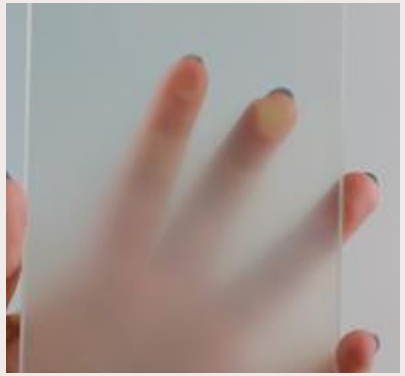
Making business with Transparent Wood?

AI-TRANSPWOOD

MARKET EXPLORATION

Comparison with other materials

TRANSPARENT/TRANSLUCENT MATERIALS



GLASS

- ✓ Clear view
- × Heavy
- × Thermal insulation
- × Impact resistance
- × Energy-intensive

PLASTIC

- ✓ Clear view
- × Mechanical properties
- × Petroleum-based

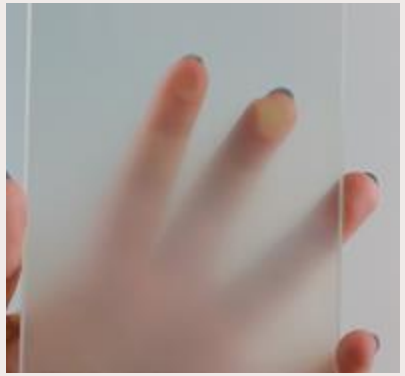
Making business with Transparent Wood?

AI-TRANSPWOOD

MARKET EXPLORATION

Comparison with other materials

TRANSPARENT/TRANSLUCENT MATERIALS



GLASS

PLASTIC

AEROGEL

TRANSLUCENT CONCRETE

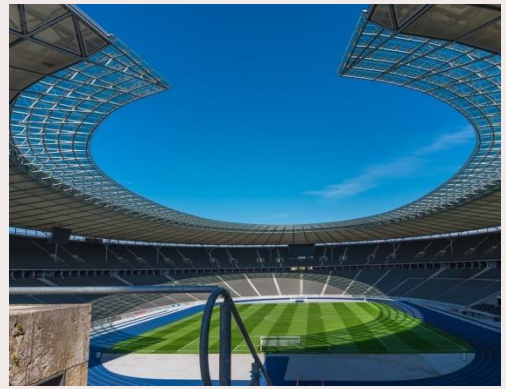
Making business with Transparent Wood?

AI-TRANSPWOOD

MARKET EXPLORATION

Applications of other materials

Protect from the outside while letting light through



Making business with Transparent Wood?

AI-TRANSPWOOD

MARKET EXPLORATION

Applications of other materials

Contain while allowing to see what is inside

Optical purposes

Making business with Transparent Wood?

AI-TRANSPWOOD

MARKET EXPLORATION

Applications of other materials

In combination with artificial light

Making business with Transparent Wood?

AI-TRANSPWOOD

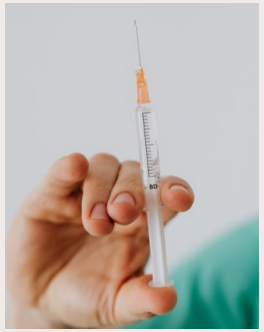
MARKET EXPLORATION

Applications of other materials

Separating spaces while keeping visibility




Many others

Making business with Transparent Wood?

AI-TRANSPWOOD

MARKET EXPLORATION

Constraints of applications

VERY STRONG CONSTRAINTS

Making business with Transparent Wood?

AI-TRANSPWOOD

MARKET EXPLORATION

Constraints of applications

SIGNIFICANT CONSTRAINTS IN ALL CASES

Car headlights

Optical requirements

Resistance to external environment

Thermal behaviour

Safety standards

Competition with established materials

Furniture

Typically high thickness

Mechanical properties

Resistance to water, coffee, cleaning products...

Discreet assembly

Sustainability

Making business with Transparent Wood?

AI-TRANSPWOOD

MARKET EXPLORATION

Share your insights

Automotive

Construction

Electronics

Furniture

Insights from actors in these 4 sectors are welcome

Choose a slot or contact us

clacroix@strane-innovation.com
info@ai-transpwood-project.eu

Book a short online meeting

Your idea is important!

AI-TRANSPWOOD

Do you think Transparent Wood is environmentally sustainable?

Transparent Wood and sustainability: utopia or reality?

Doriana Dal Palù, Beatrice Lerma, Giulio Malucelli

Politecnico di Torino, Italy

Transparent Wood and sustainability: utopia or reality?

AI-TRANSPWOOD

Origins | **Transformation** | **Application** | **End of life**

Transparent Wood and sustainability: utopia or reality?

AI-TRANSPWOOD

Origins

- Renewable resource → It is a 100% natural and biodegradable resource (biomass)
- Responsible cut processing → It is practically “inexhaustible” through a sustainable and controlled cultivation allowing the same or more trees to be planted and grown before being used.

Transparent Wood and sustainability: utopia or reality?

Transformation

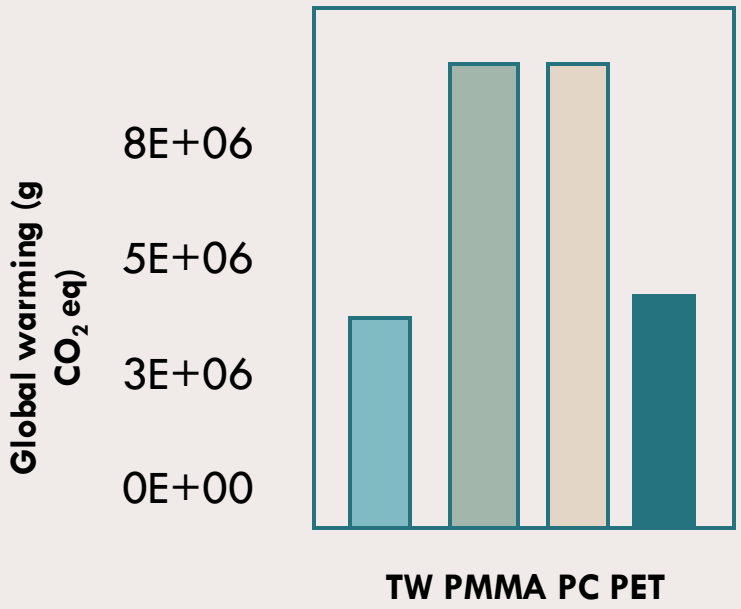
- Bio-based infiltration → The infiltration process can be performed using resins with low environmentally impact (i.e., partially bio-sourced products)
- Less energy-intensive processing → All the processing steps can be carried out in mild conditions (room temperature, vacuum-assisted) limiting the energy required.

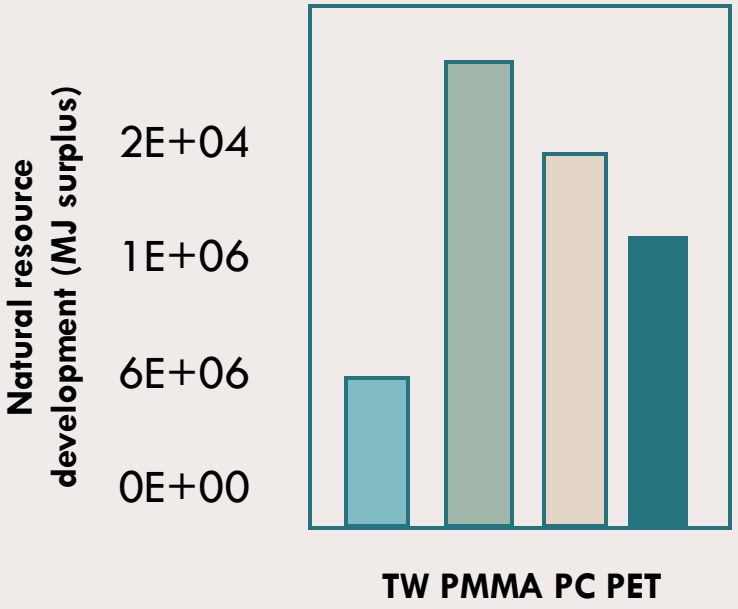
Transparent Wood and sustainability: utopia or reality?

AI-TRANSPWOOD

Transformation

Compared to others fossil-derived materials, TW exhibits a lower impact on both global warming and natural resource depletion





Still open issue: the employed chemistries

J. Wu, H. Ye, S. Li, Z. Que, Y. Peng, L. Cai and C. Xia, *Constr. Build. Mater.*, 2024, **438**, 137303.

Transparent Wood and sustainability: utopia or reality?

Sustainability & applications

Energy saving → TW could be an excellent replacement for glass in glazing applications, thanks to TW low thermal conductivity.

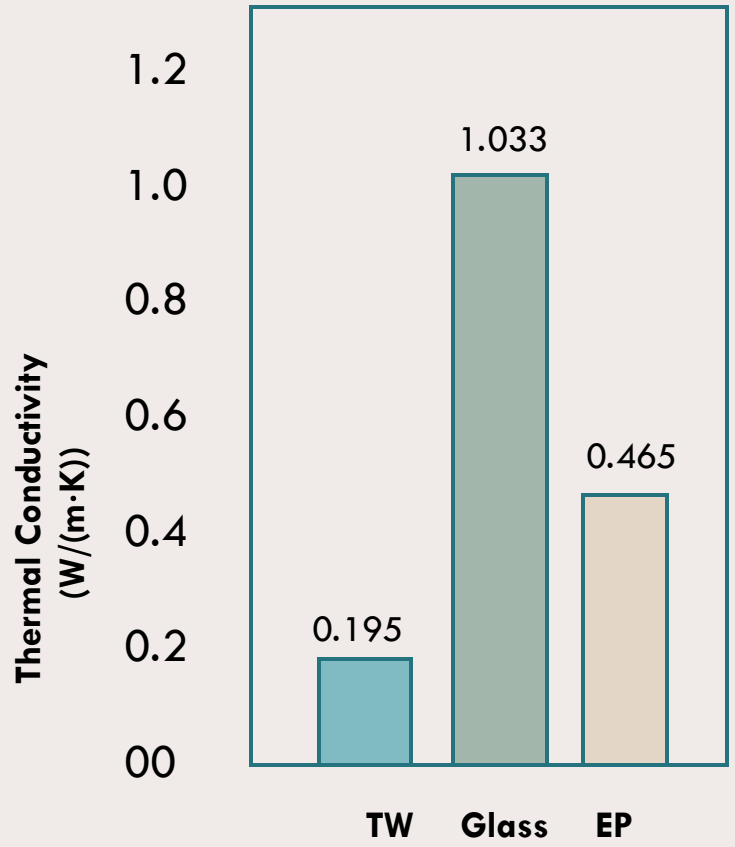
Transparent Wood and sustainability: utopia or reality?

AI-TRANSPWOOD

Sustainability and applications

Low thermal conductivity TW

Thermal conductivity of glass, cured epoxy resin (EP), Transparent Wood (TW)



X. Hu, Y. Zhang, J. Zhang, H. Yang, F. Wang, Bin Fei e N. Noor, Renew. *Energy*, 2022

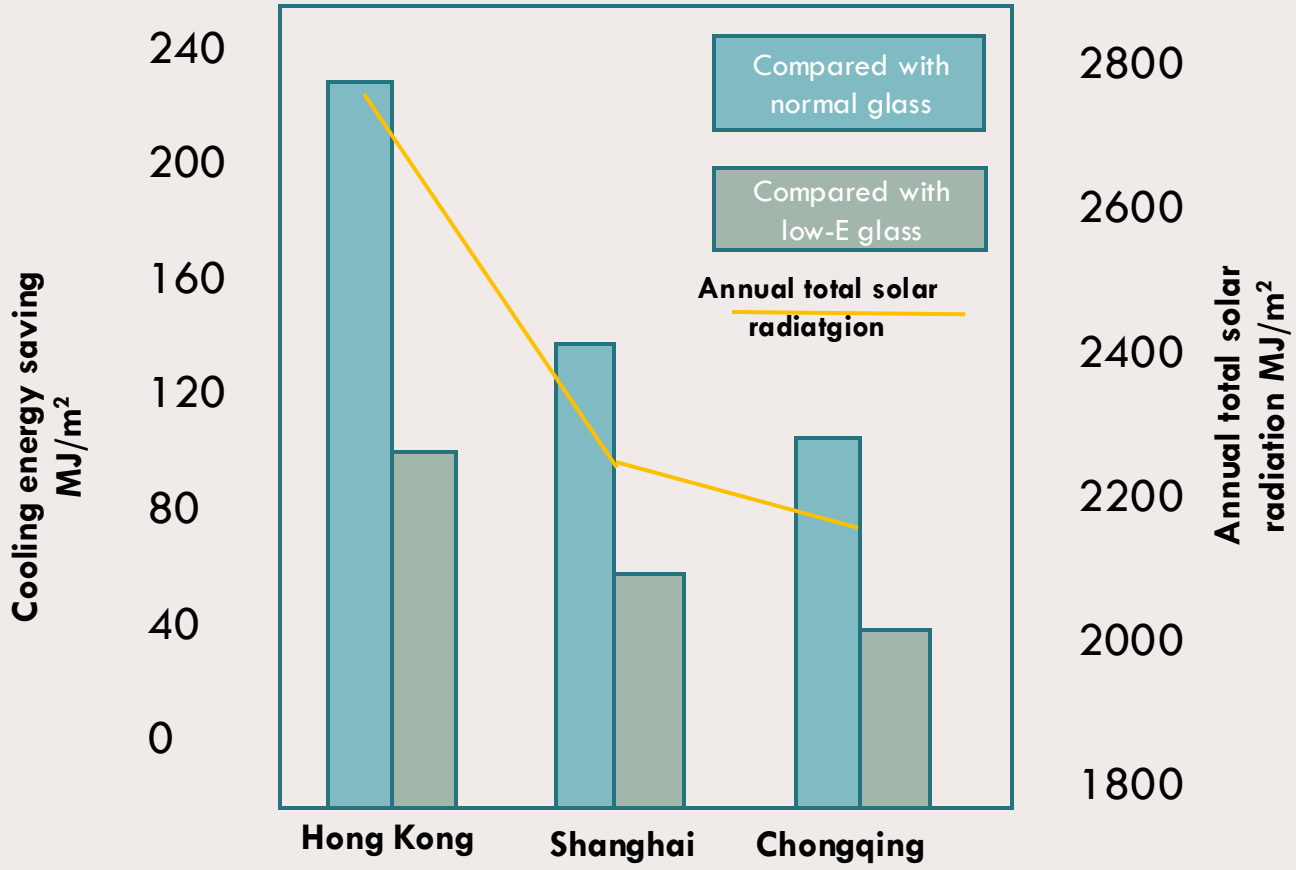
Transparent Wood and sustainability: utopia or reality?

AI-TRANSPWOOD

Sustainability and applications

Cooling energy saving

Annual cooling energy saving compared with the other two types of glazing materials, i.e., standard glass and low-emissivity (Low-E) glass, and annual total solar radiation for the three cities considered



X. Hu, Y. Zhang, J. Zhang, H. Yang, F. Wang, Bin Fei e N. Noor, Renew. *Energy*, 2022

Transparent Wood and sustainability: utopia or reality?

End of life

TW is a very "young" material!
Currently there aren't any indication regarding the TW end of life.

Possible scenarios

- Reuse and revalorization
- Grinding → wood flour or compounding
- Thermovalorization
- Biodegradation (?)

Your idea is important!

After this section, do you think Transparent Wood possesses potential sustainability for the environment?

Your idea is important!

Where do you think Transparent Wood has the highest potential for being environmentally sustainable?

Where do you think the scientific efforts should be focused to improve its environmental sustainability?

Artificial Intelligence and Transparent Wood

Kari Kolari

Principal Scientist at VTT Technical Research Centre of Finland, Finland

Artificial Intelligence and Transparent Wood

AI-TRANSPWOOD

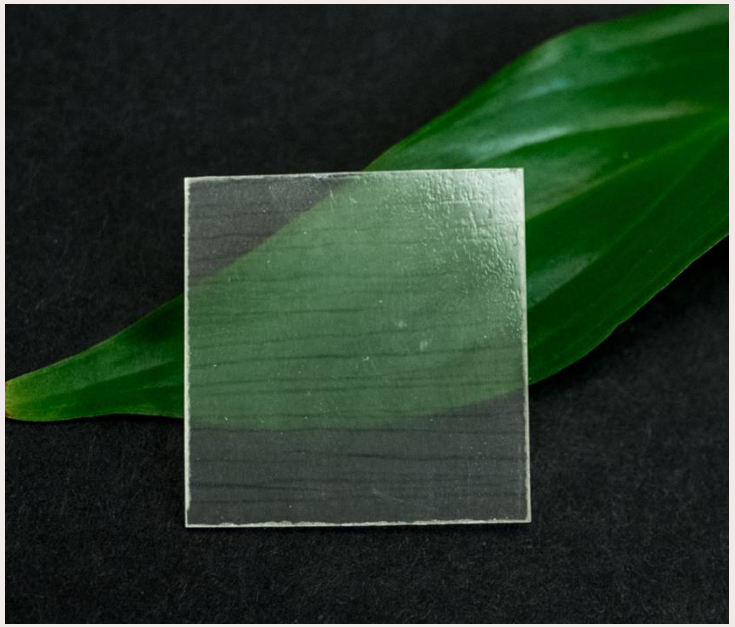
Objective:

Develop an AI-driven methodology and tools for wood-based composites.

Focus:

Improve transparent wood properties

- Transparency
- Mechanical strength
- Processability / manufacturing



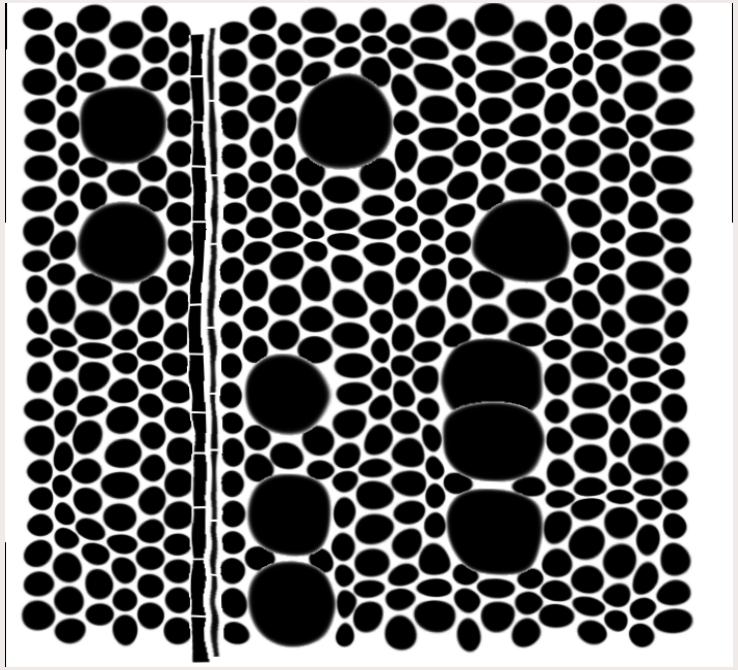
Artificial Intelligence and Transparent Wood

AI-TRANSPWOOD

Examples - AI in the Transparent wood (TW) -project

Three AI applications:

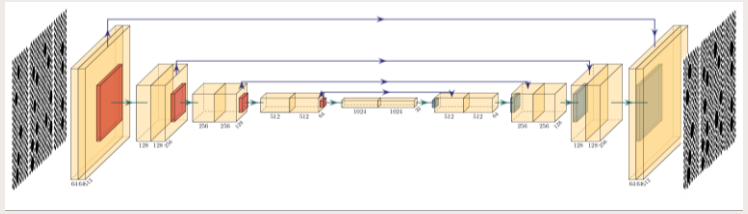
1. Microstructure modelling (Lead: Aalto University)
2. Multiscale modelling. Modelling material properties (Lead: Aalto University)
3. AI-based mapping of material properties and process efficiency (Lead: VTT)

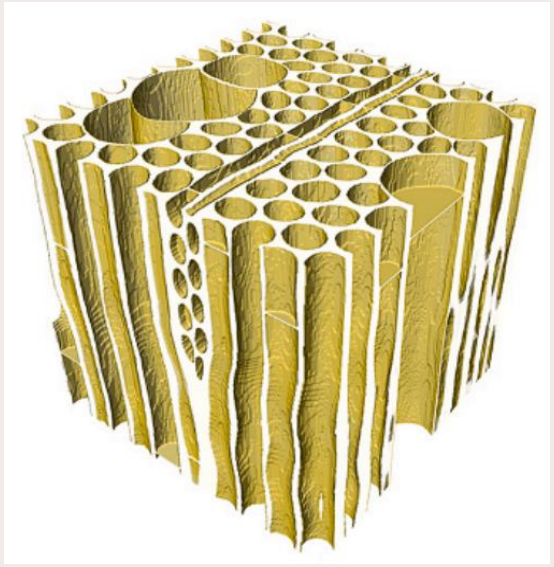


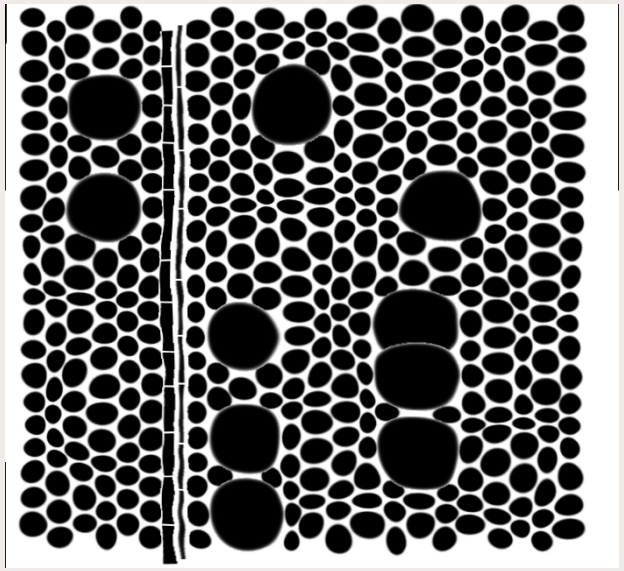
Artificial Intelligence and Transparent Wood

Three AI applications:

1. Microstructure modelling (Leader: Aalto University)



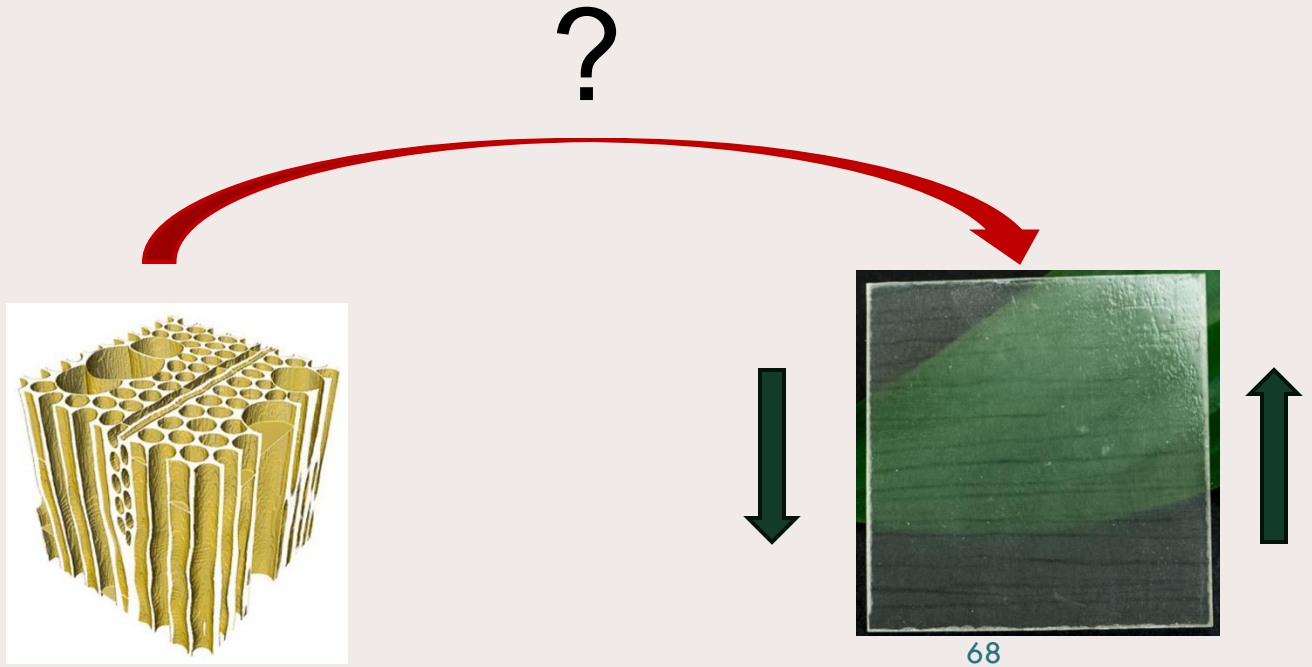




Artificial Intelligence and Transparent Wood

Three AI applications:

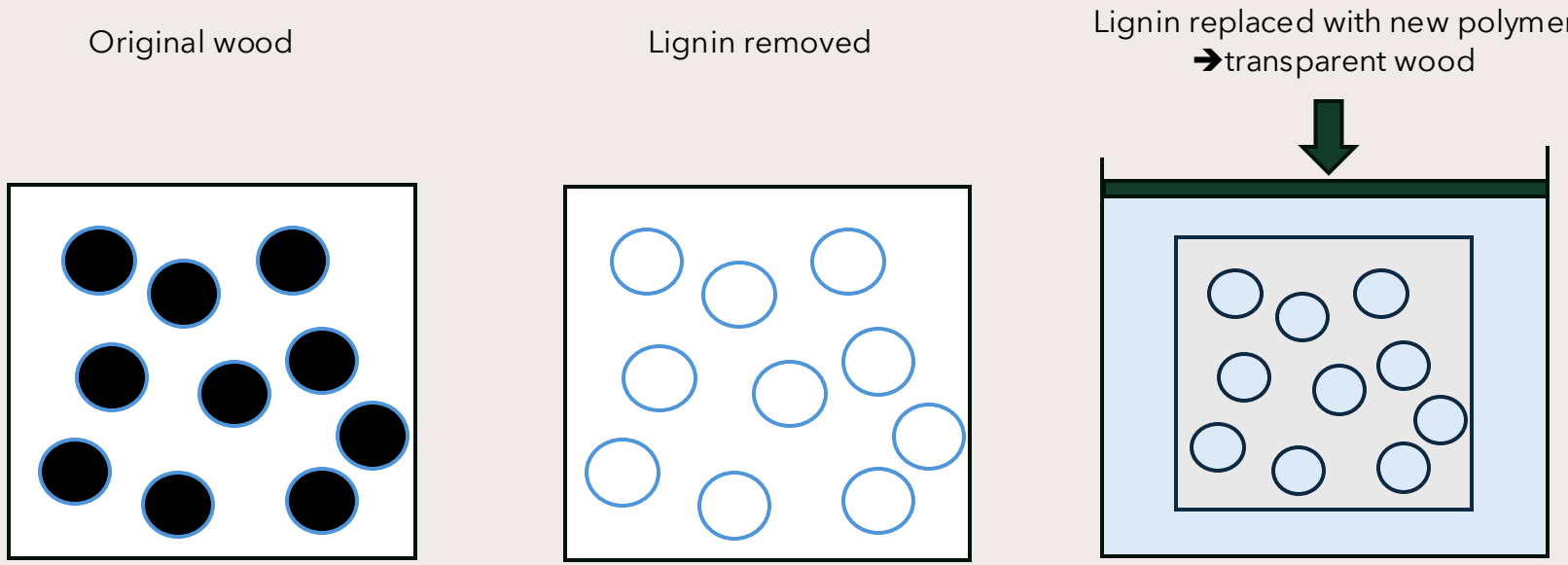
2. Multiscale modelling
    - Predicting a full-size properties from small scale



Artificial Intelligence and Transparent Wood

Three AI applications:

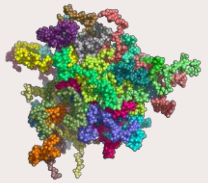
3. AI-based mapping of material properties and process efficiency
   - **Finding a new material, polymer**
   - **Infiltration modelling a new polymer**



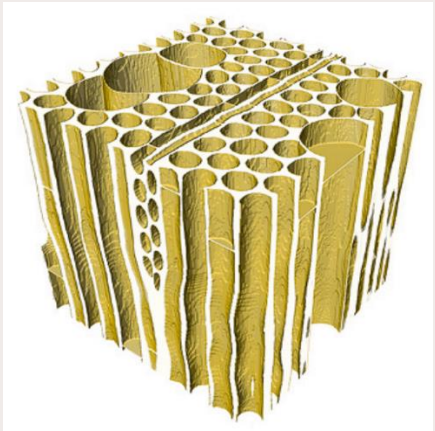
Artificial Intelligence and Transparent Wood

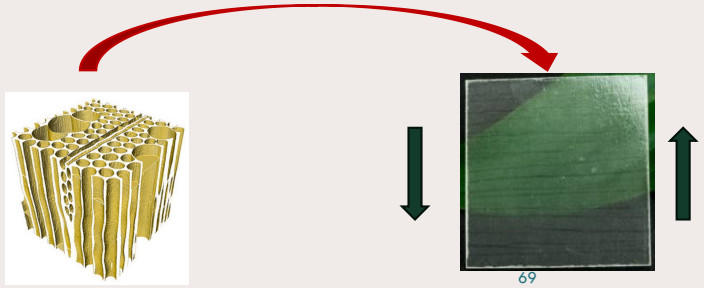
Conclusion - AI in the project:

- Promising results already
- Result are still preliminary – project at early stage
  - AI has not yet implemented in all WP's
- Expect to get successful results



Compare





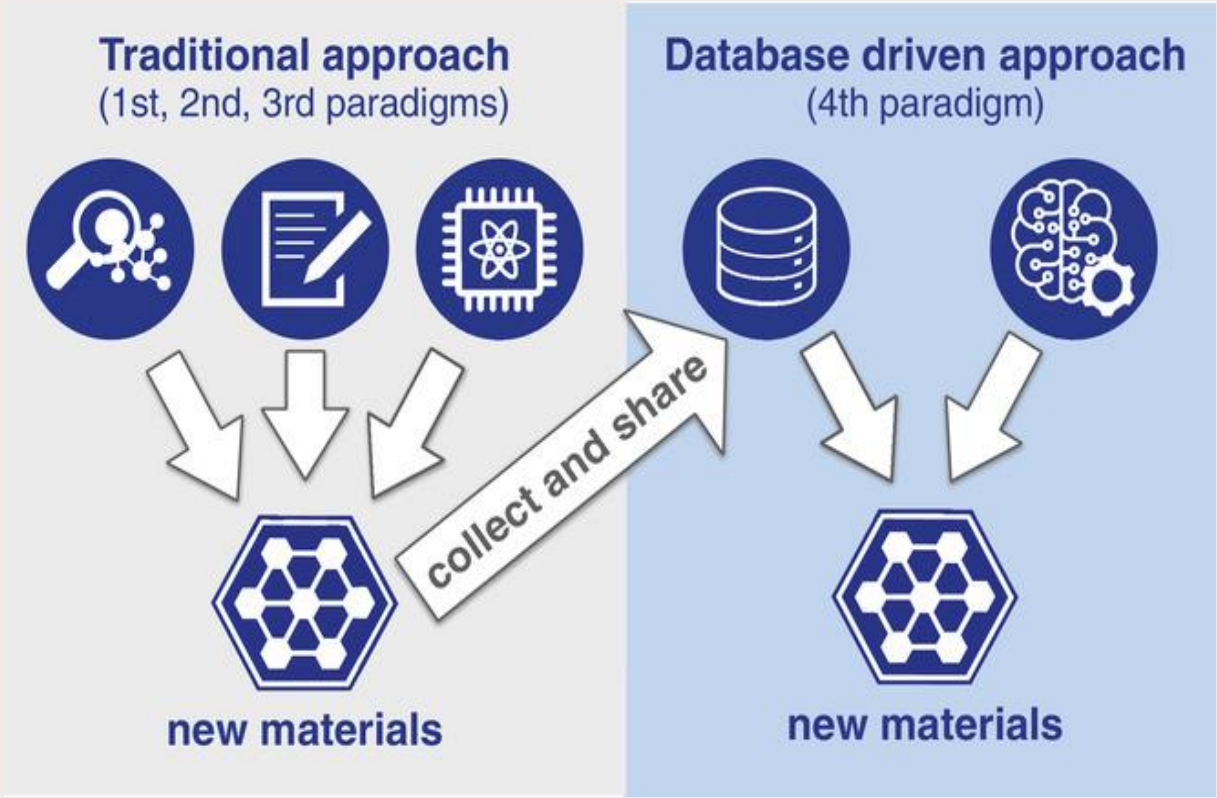
AI fosters materials design?

Antti Puisto

Research Team Lead at VTT, Finland

AI fosters materials design?

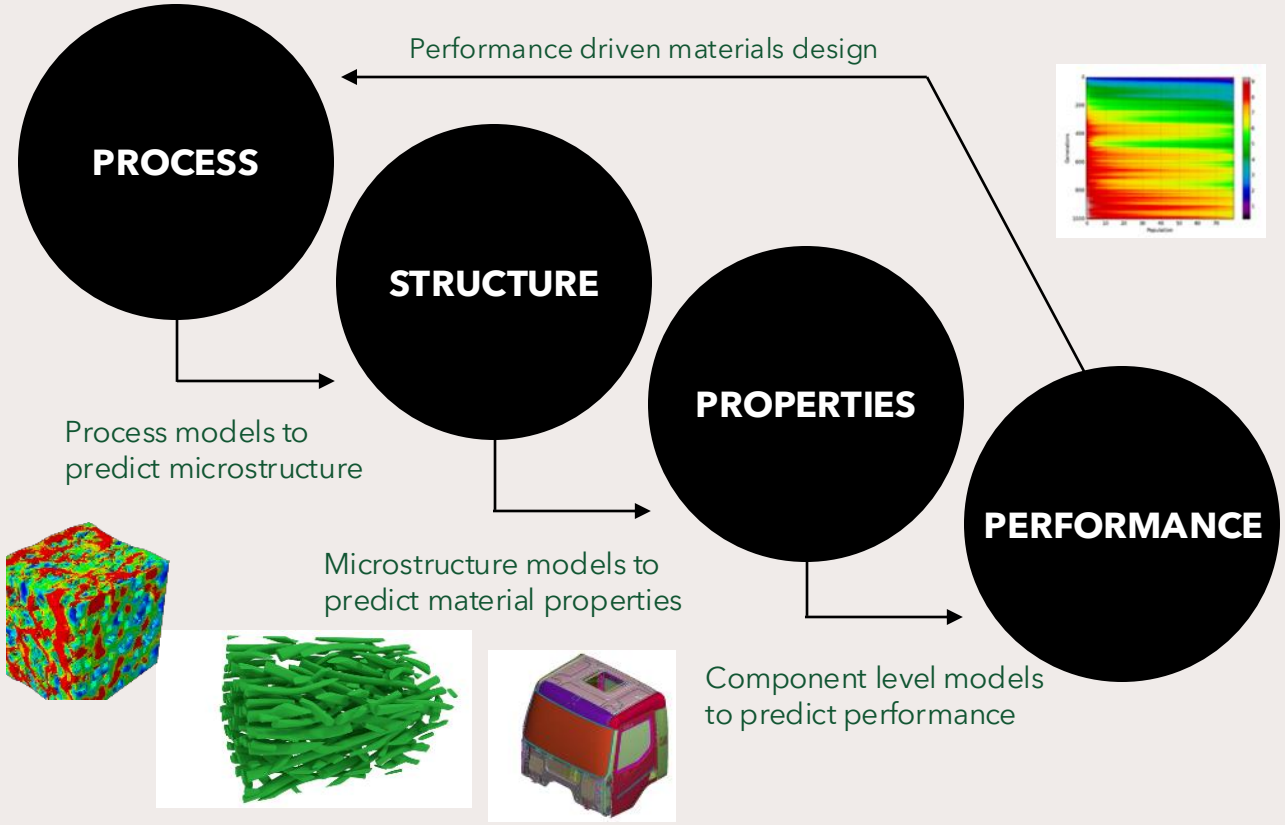
Materials of the future: paradigm shift from forward process to inverse design

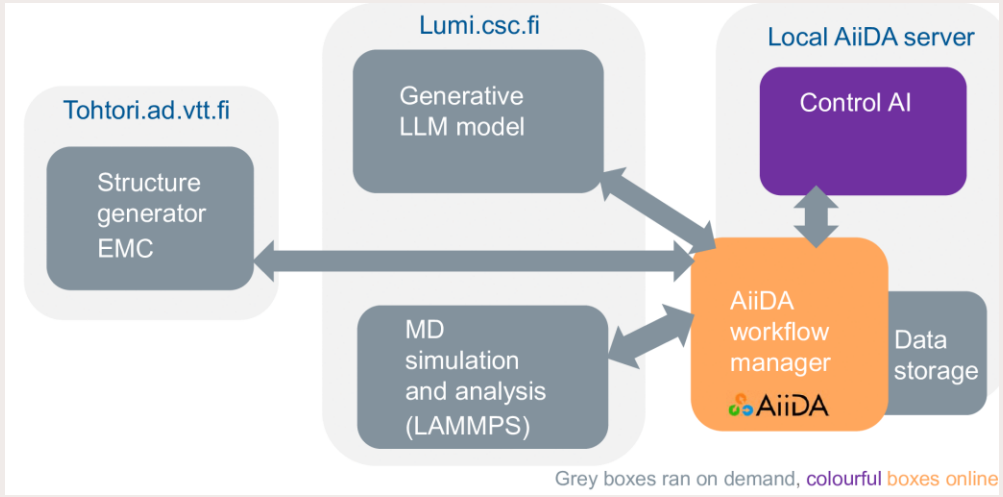


Himanen, Lauri, et al. "Data-driven materials science: status, challenges, and perspectives." *Advanced Science* 6.21 (2019): 1900808.

AI fosters materials design?

Materials modelling enabling the paradigm shift





Self-driving virtual laboratory: Automatic property space screening using computational models, workflow automation and generative AI

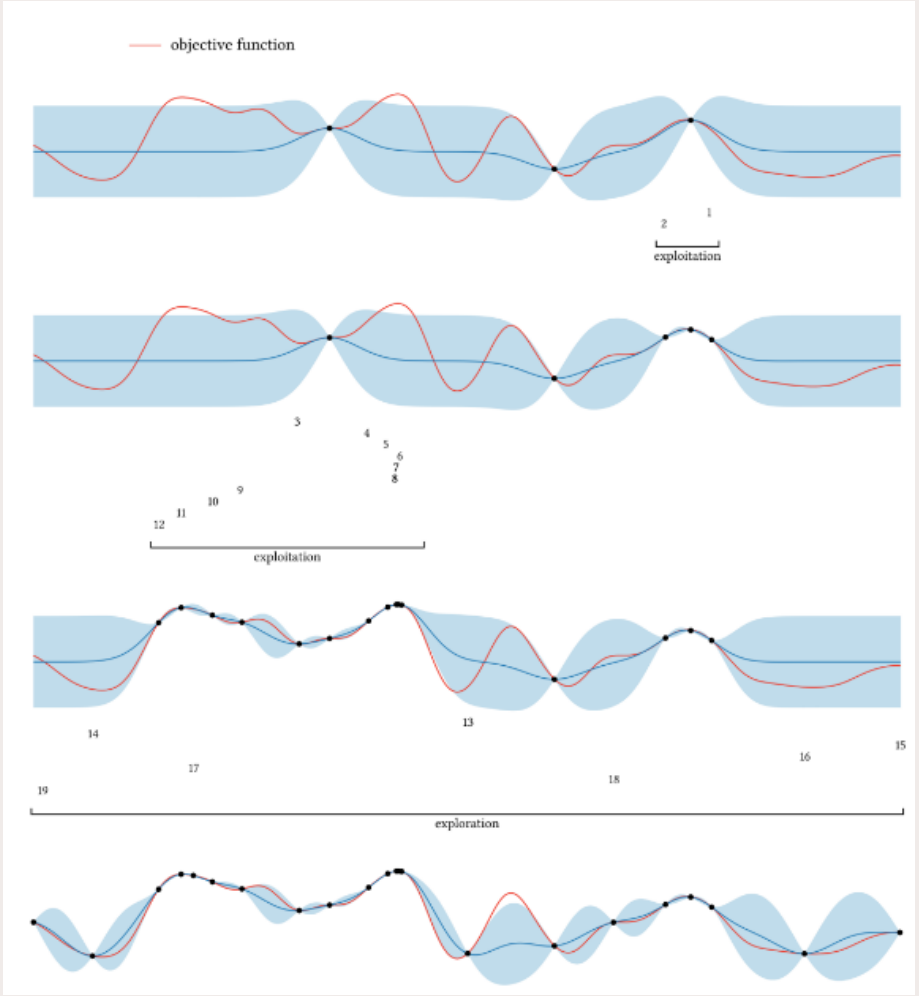
AI fosters materials design?

How can AI accelerate the data production?

Traditional experimental techniques and theoretical simulations are often time-consuming and resource-intensive

AI can significantly enhance the efficiency of materials design accelerating these processes by:

- Automating data analysis and interpretation
- Developing surrogate models that can replace time-consuming simulations/experiments
- Guiding the design of experiments and simulations (figure)



Garnett, Roman. Bayesian optimization. Cambridge University Press, 2023.

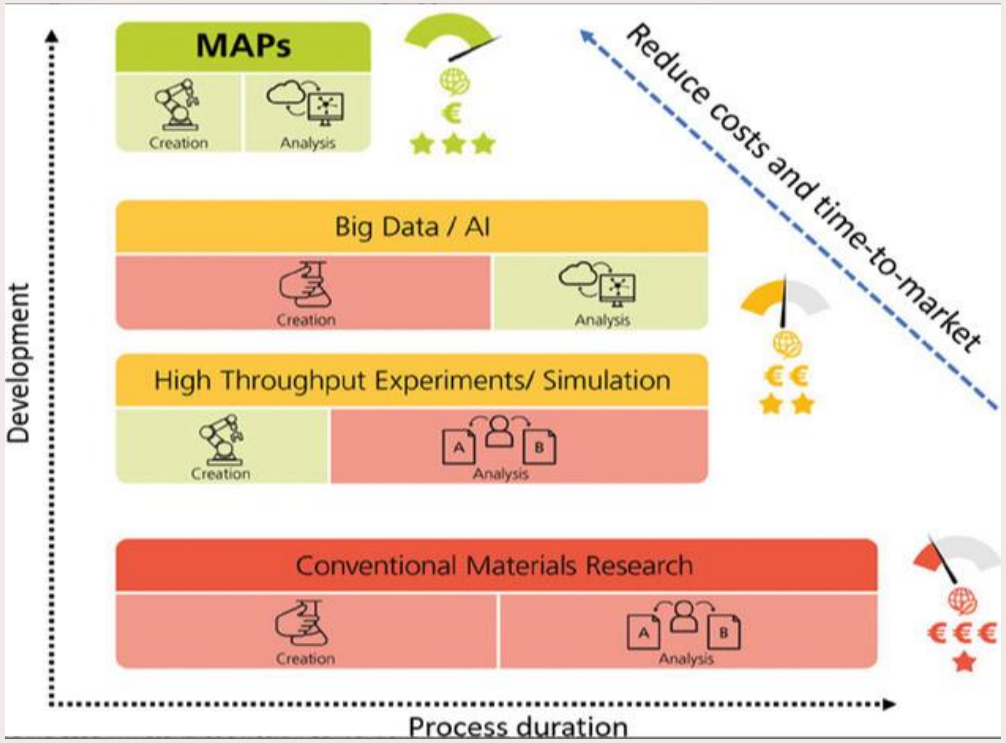
AI fosters materials design?

AI-TRANSPWOOD

Current state of the art

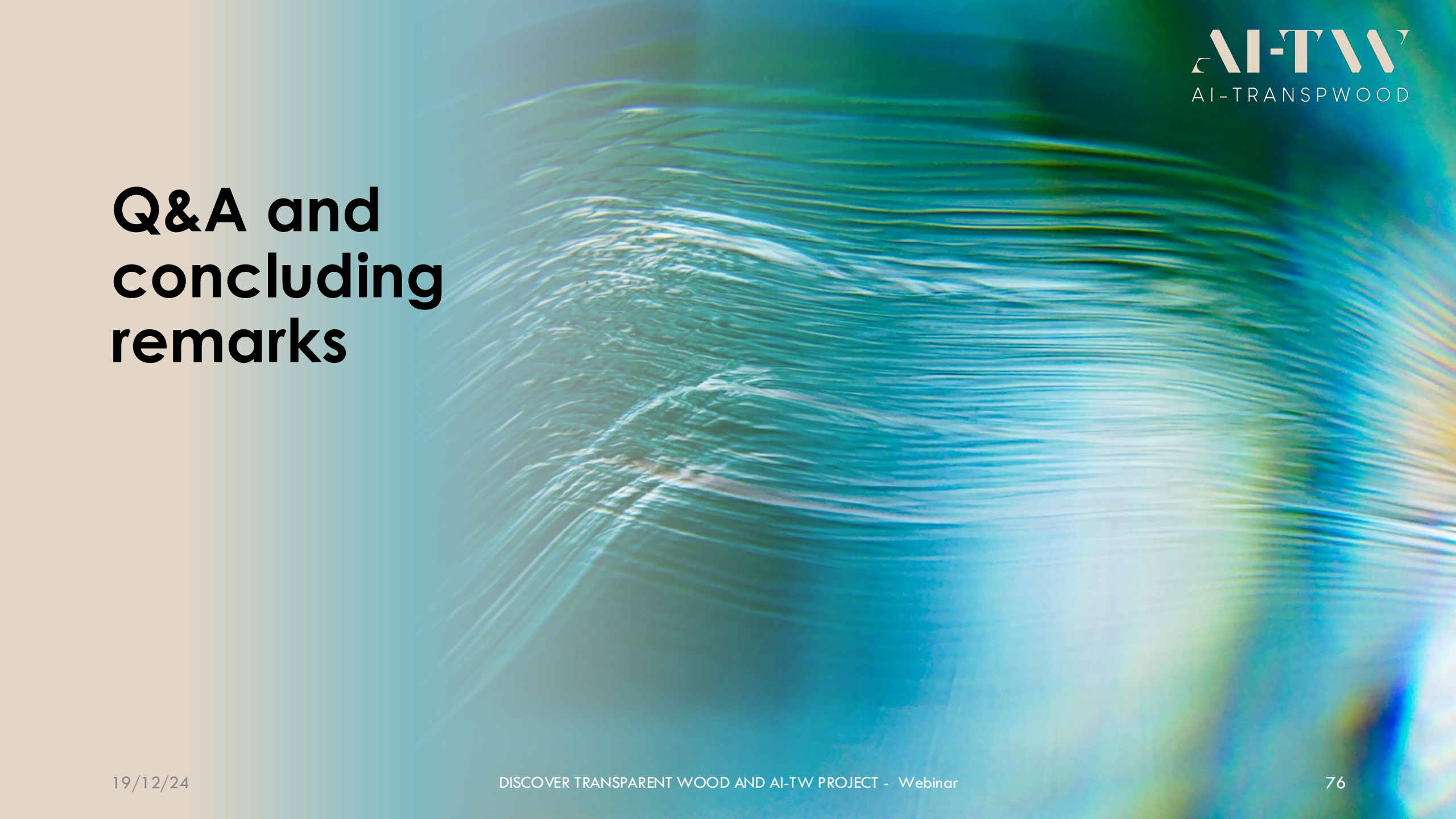
Material Accelerator Platforms: Autonomous materials science laboratories integrating robotics, computer vision, ML, and generative AI

- Synthesise, characterise, and test materials without human intervention
- Seamless integration of computational and experimental efforts



Stier, Simon P., et al. "Materials Acceleration Platforms (MAPs): Accelerating Materials Research and Development to Meet Urgent Societal Challenges." *Advanced Materials* 36.45 (2024): 2407791.

Q&A and concluding remarks



Your idea is important!

Did you enjoy the webinar? Would you like to further participate in future initiatives on the topic?

Follow us!

AI-TRANSPWOOD

@AI-TranspWood Project

@AI_TranspWood_project

@AI-TranspWood Project

@AI_TranspWood

@AI-TranspWood Project

www.ai-transpwood-project.eu

info@ai-transpwood-project.eu

AI-TW Website

Next events!

13 June 2025

Don't miss the next in-person event of AI-TW project!

1-day workshop at the Castello del Valentino, **in Turin**, in Italy.

Stay tuned, details will follow on our social media and newsletter!

Thanks for your participation and stay tuned!

AI-TW

AI-TRANSPWOOD

DISCOVER TRANSPARENT WOOD AND AI-TW PROJECT

Dive into Transparent Wood Innovation: explore its unique features, market potential, AI-Driven models, and Transparent Wood samples with AI-TW project partners!

Webinar | 19th December 2024 | 9.30-11.30 AM CET