



Making the impossible by sculpting carbon at nanoscale

2025

[www.nawah.fr](http://www.nawah.fr)

## Who is NAWAH

15 years of research activities  
in nanomaterials from highly  
recognized institutes

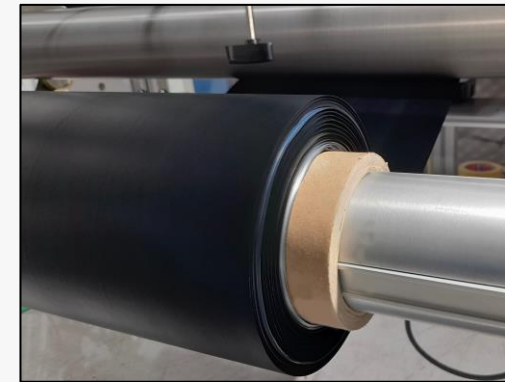


NAWA TECHNOLOGIES

In parallel to 10 years of development  
activities

2023  
Industrial investment  
M. Alexandre Garèse  
(*unique investor*)

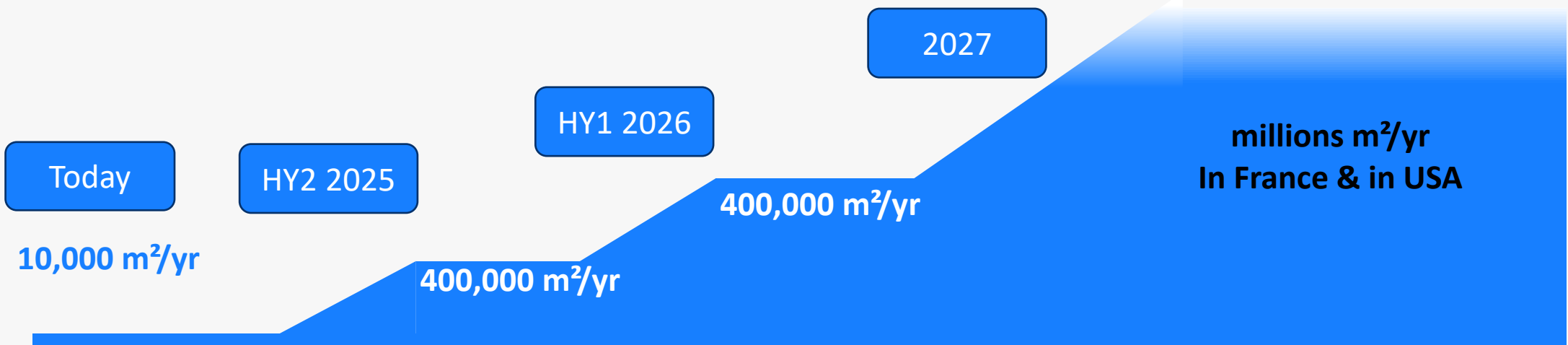
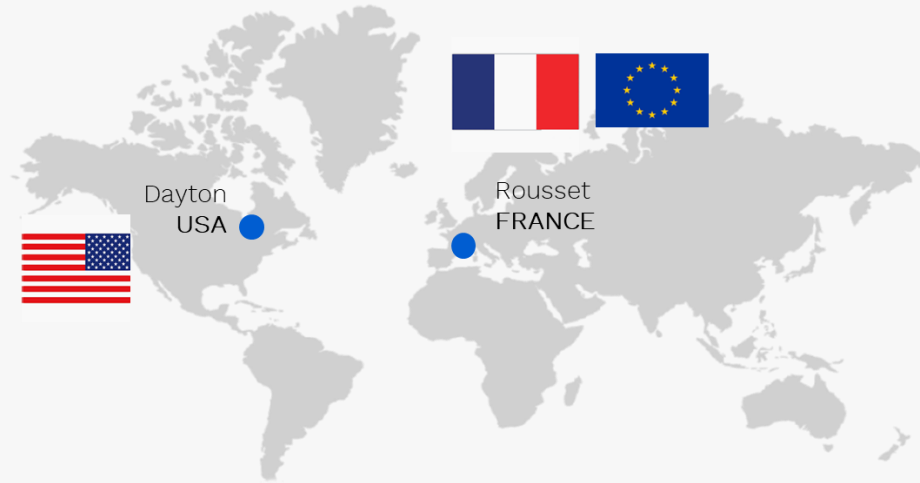
 N A W A H



Industrial pioneer

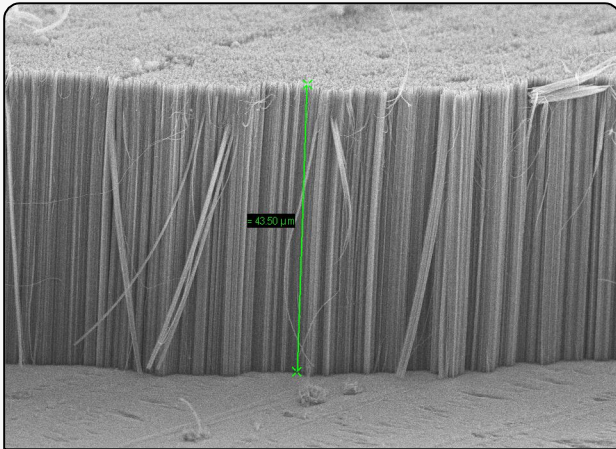
Supplier of Nano-engineered materials  
at the industrial scale

## International Footprint and production ramp-up

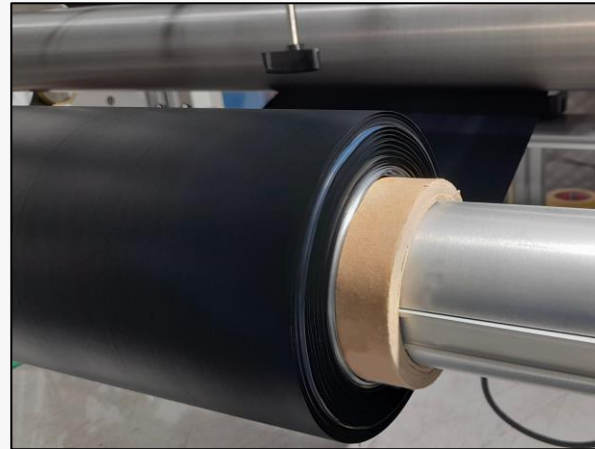


## Core Activity: Vertically Aligned Carbon Nanotubes (VACNT):

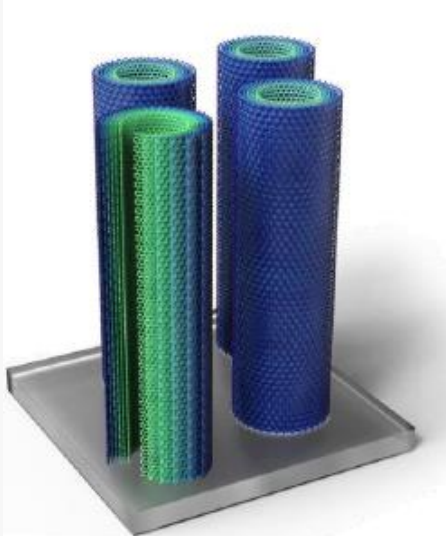
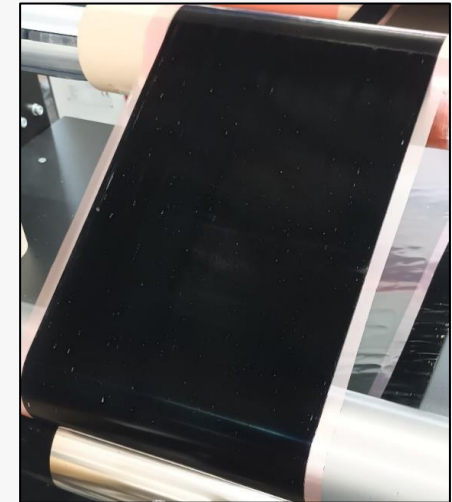
**3D Structured nanomaterial**



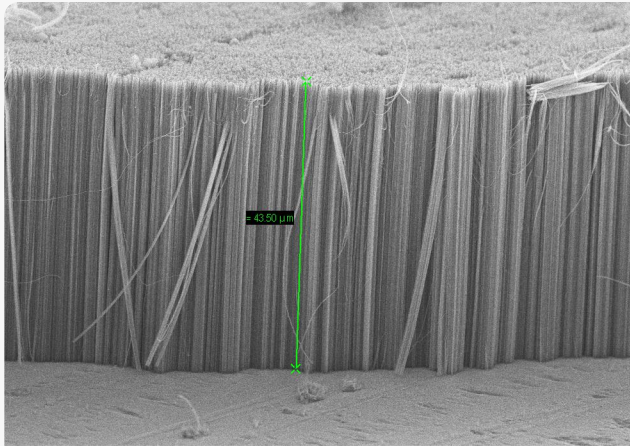
**Produced in rolls as a thin film**



**Which can be transferred to functionalize surfaces and/or interfaces**



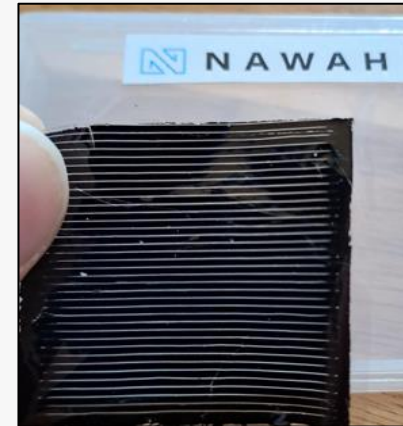
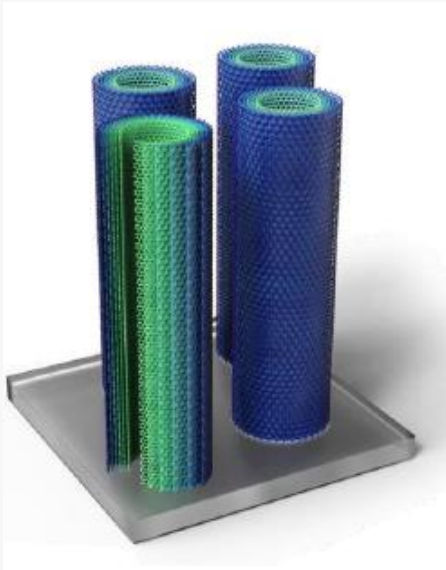
## Core activity: **3D structured** Nanomaterials



### One base-structure: vertically aligned carbon nanotubes

- « thin film » : thickness 1 – 100 μm
- Pure carbon (no binder)
- High porosity: 95 – 99 %
- High external surface area: about 500 m<sup>2</sup>/g
- Nano-porosity : 20 nm average distance in between nanotubes

### Which can be micro-structured at will





## Core activity: 3D structured **Nanomaterials**

Capacity to coat this base structure with almost every element from the periodic table

### Eléments :

- Al, Mg, Ti, Pt, Pd, Au, ...
- Oxydes, nitrides, ...

### Nanoparticules :

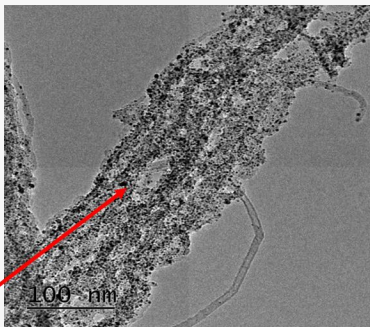
- Tunable diameters
- Tunable loadings
- Alloying capabilities
- Nano-engineering capabilities (core-shells, nanocages ...)

### Surfaces:

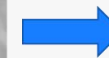
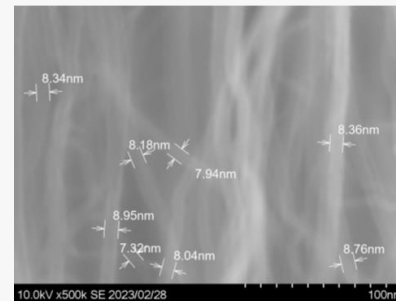
- Today 30x30 cm<sup>2</sup>
- Tomorrow: roll-to-roll

### Conformal thin layers:

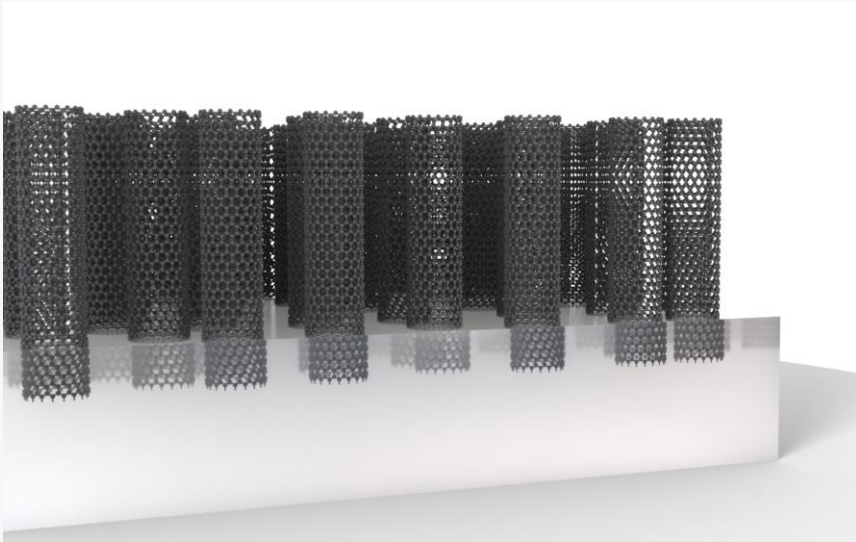
- High temperature protection
- Electric insulation



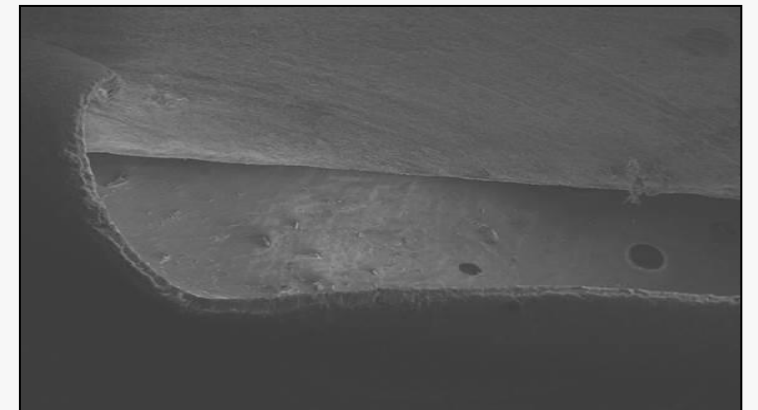
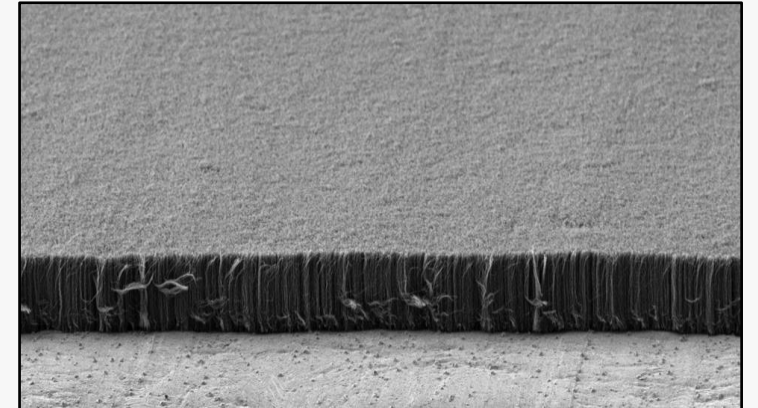
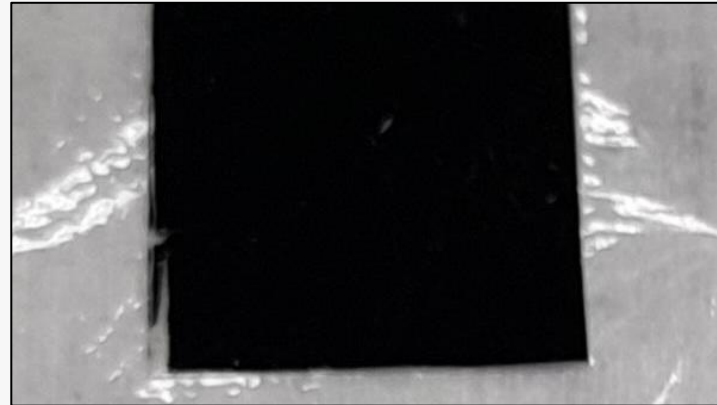
Platinum  
Nanoparticles



*Vertically aligned carbon nanotubes are homogeneous by construction and can be transferred to surfaces*

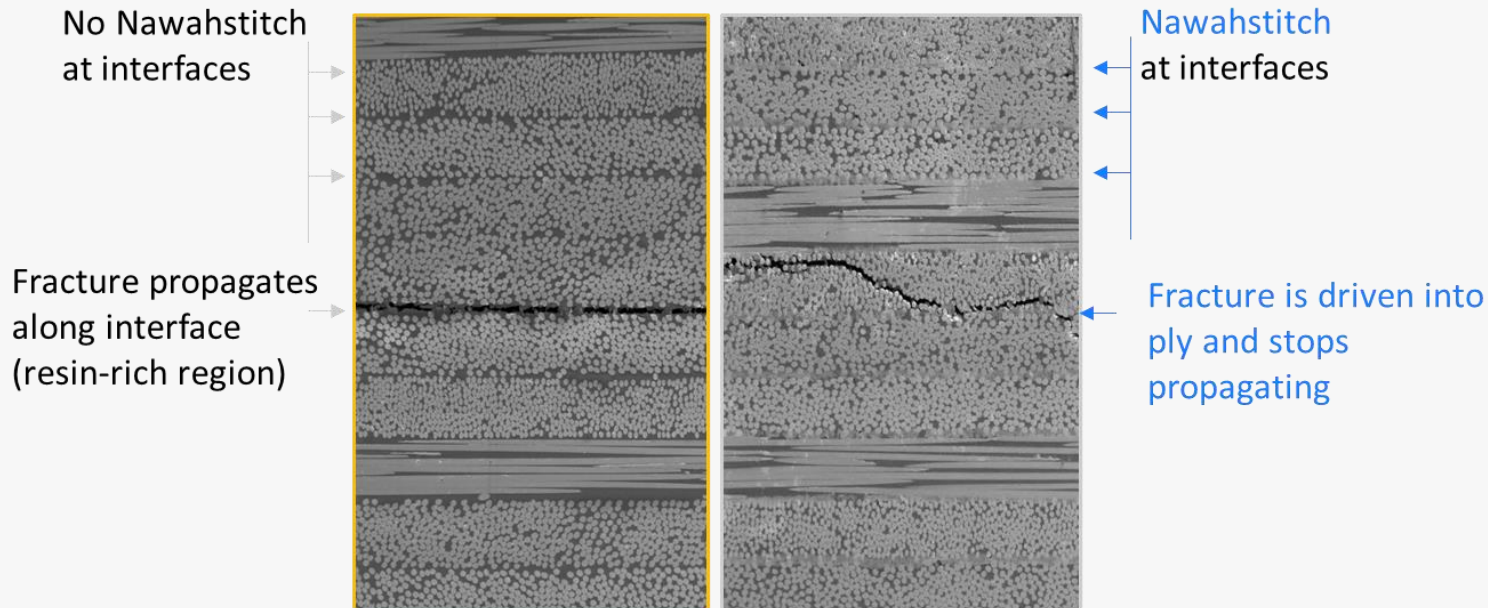
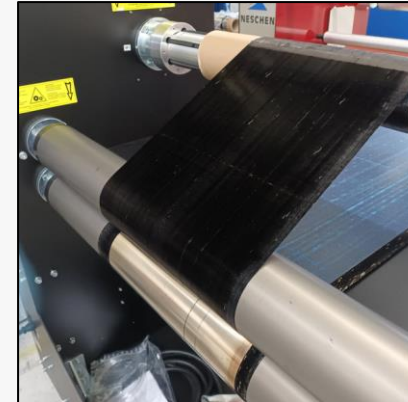


Available in 100s m<sup>2</sup>  
Industrialization on-going



# More durable composites by efficient nano-integration

- Direct lamination of an homogeneous layer of VACNT on top of a prepreg
- Thickness of the VACNT layer can be adjusted to actual interlaminar thickness



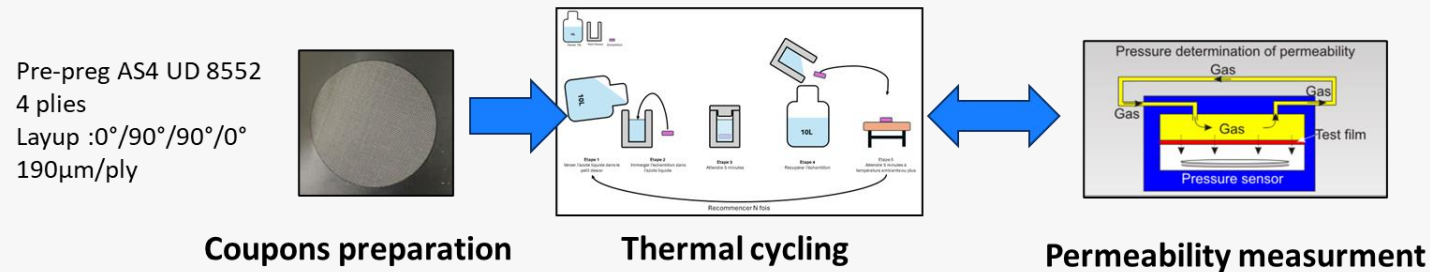
## Benefits:

- Higher Impact damage tolerance (+900%)
- Longer service life (X5 to X40 shear fatigue cycles)
- No additional volume
- Negligible additional mass (1 gsm material)

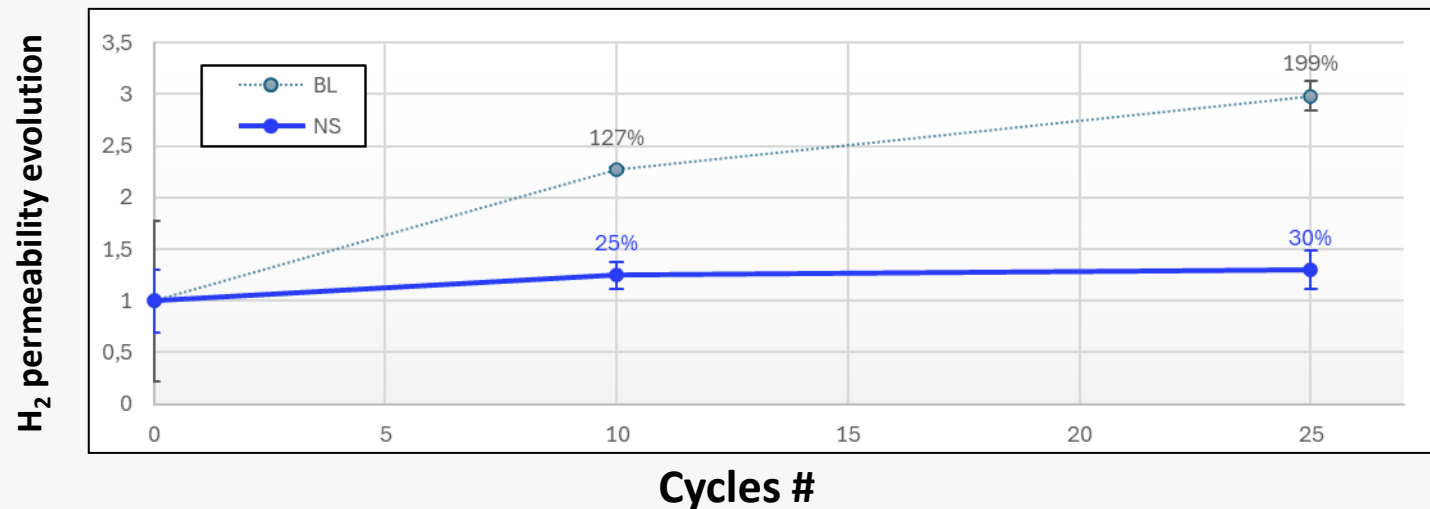


## Permeability to hydrogen use case

- Direct comparison of baseline & NAWAHStitched samples



- Evolution of permeability with thermal cycling



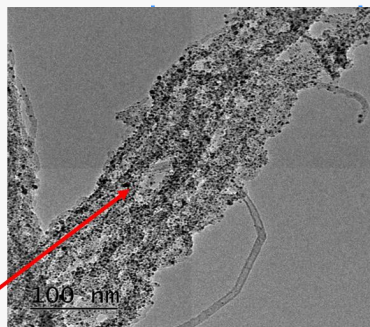
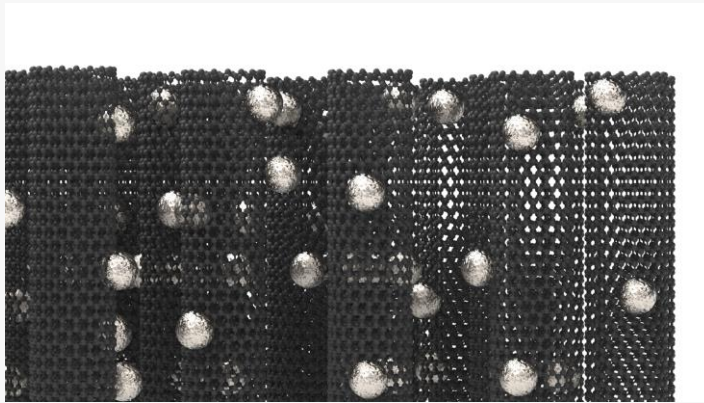
**Clear benefit from NAWAHStitch incorporation**

**X 1.3 increase in permeability**

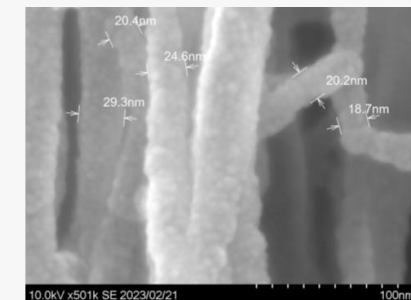
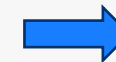
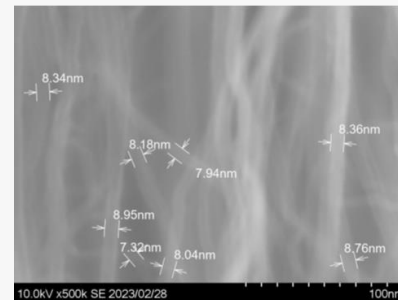
**VS**

**X 3 for baseline sample**

# *Vertically aligned carbon nanotubes can be functionalized at the atomic scale*



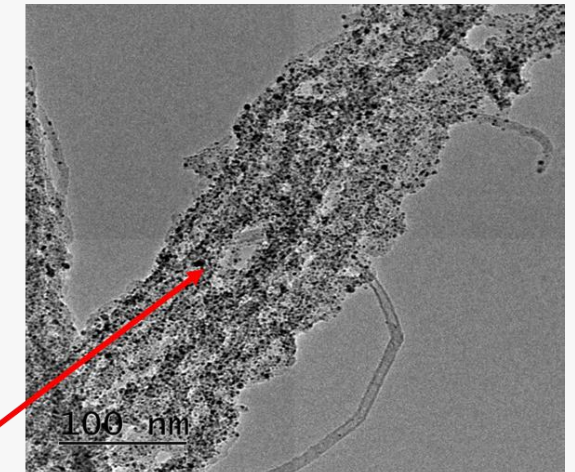
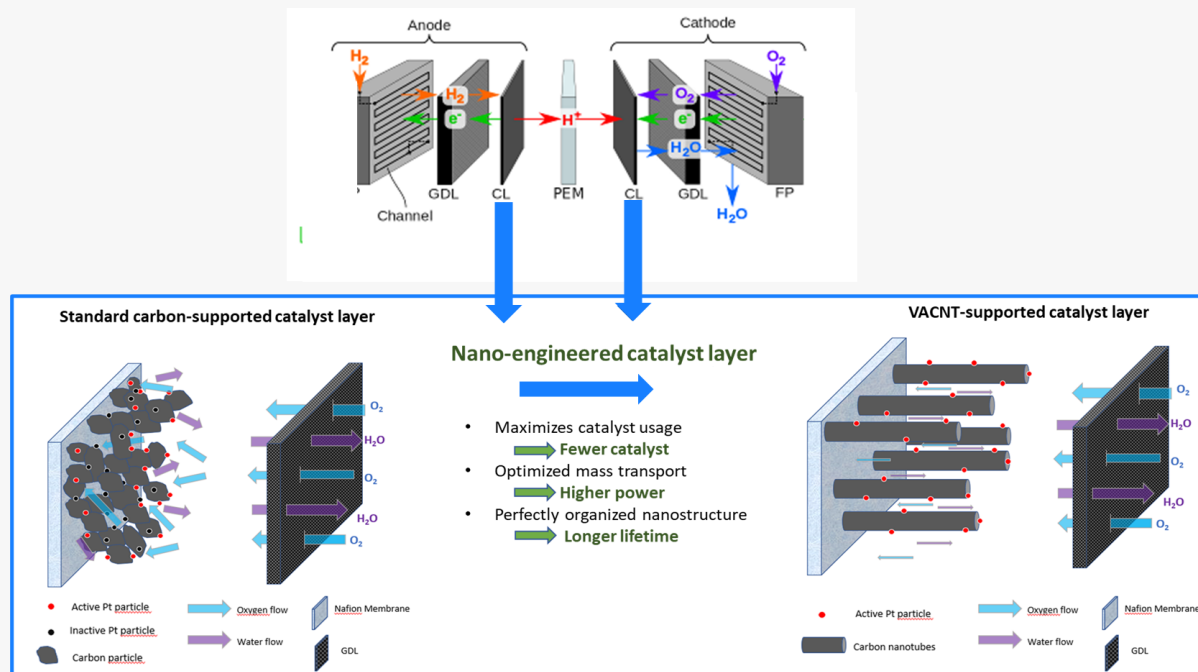
Platinum  
Nanoparticles



**Samples available < 1 year**  
**Scale-up < 2 years**

# Structured active layers for more efficient fuel cells

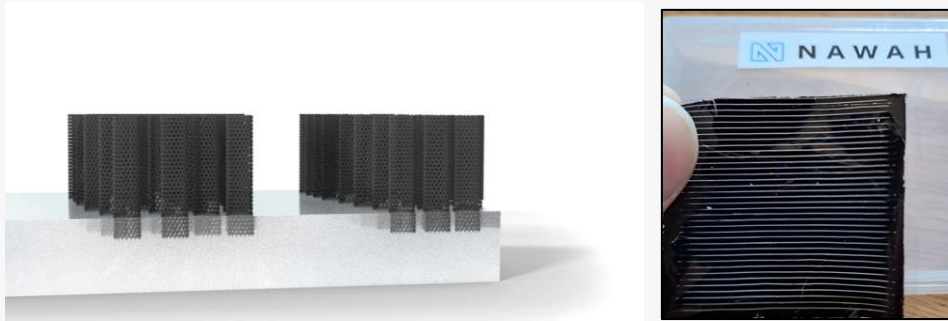
- PEMFC performances are limited by mass transport
- Architected active layers with pillar structure are optimal
- VACNTs have been demonstrated as a very efficient support for Platinum catalysts



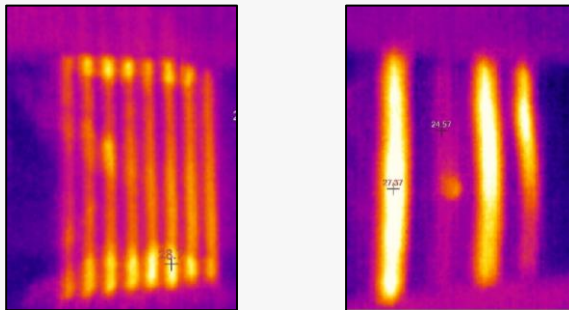
Platinum Nanoparticles

# Embedding sensors in structures : smarter materials

- Micro-structuration of nanotubes layers can allow to real time monitoring of electrical signals



- Example: localization of defect by infrared camera



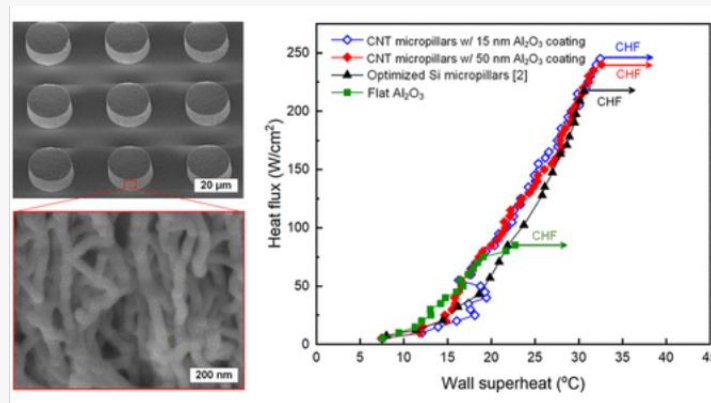
- Combination with fonctionnalisation can offer access to electrochemical signals within structures
- **Without trade-off on mechanical properties**



# Lighter and more efficient heat transfer

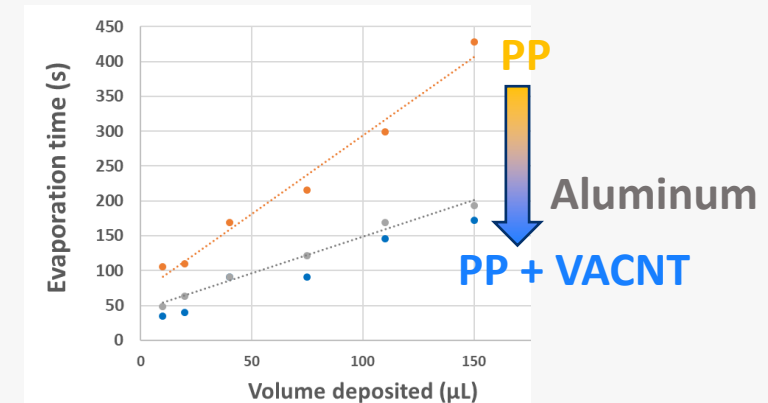
- VACNT offer large surface area and very good electrical conductivity in the Z-direction
- They can significantly enhance evaporators efficiency H. S. Ahn, Journal of Heat Transfer, Volume 128, Issue 12 **2006**
- Their integration into plastics increase the thermal conductivity through the plastic while ensuring homogeneous wetting

Combination of micro-structuration and full covering with oxide to reach very efficient pool boiling (litterature)



H. Zhao, ACS Appl. Nano Mater. **2019**, 2, 9, 5538–5545

Preliminary evaluation of several materials for evaporator heat transfer (internal)



- Carbon faces however durability challenges in oxydative conditions and at high temperatures
- Full covering with an oxide or nitride layer allows high-temperature utilization

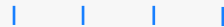
## | Key Takeaways

- NAWAH is a supplier of an advanced nanomaterial at **industrial scale**
- NAWAH can transfer the nanomaterial to many types of materials
  - Thermosets
  - Thermoplastics
  - Metals
  - ...
- NAWAH can custom the nanomaterial properties to match with application
- NAWAH can functionalize the nanomaterial with different kinds of other materials (metals, oxides, ...)
- Samples can be shipped to perform feasibility/ functional tests and POCs

NAWAH



Merci / Thank you



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