

**hipoin**®

High Performance Insulation based on Nanostructure encapsulation of air

***High Performance  
Insulation based on  
Nanostructure  
Encapsulation of Air***

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# HIPIN Collaborative Partners

Call identifier -FP7-2010-NMP-ENV-ENERGY-ICT-EeB  
3 Year Duration, Started in November 2011



ARUP



ENVIRONMENT  
PARK



To develop a nano-based high performance insulation system for energy efficiency

## Silica Aerogels

- Lowest thermal conductivity (0.004 - 0.03 W/mK)
- Lowest density solid ( $0.0011 \text{ g cm}^{-3}$ )
- Lowest optical index of refraction (1.002)
- Lowest speed of sound through a material ( $70 \text{ m s}^{-1}$ )
- Lowest dielectric constant from 3-40 GHz (1.008)

But also: fire retardant properties with different level of transparency.



# Final Expectations



Develop new **affordable technologies** to incorporate aerogels **into a suitable vehicle** that can be applied as **thick paint layers**, as **plaster** or incorporated into **sandwich panels**.

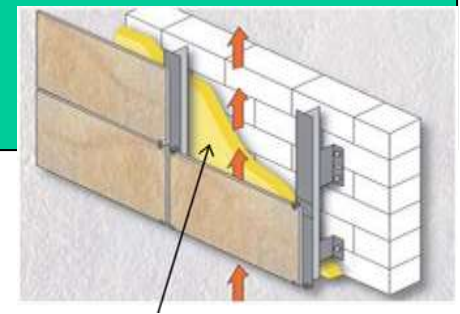
## PAINTS



## PLASTERS



## PANELS





# Challenges

## Challenges

- Aerogel Highly fragile
- High cost
- Choice of aerogel
- Adhesion/compatibility with the matrix
- Right formulation /matrix system

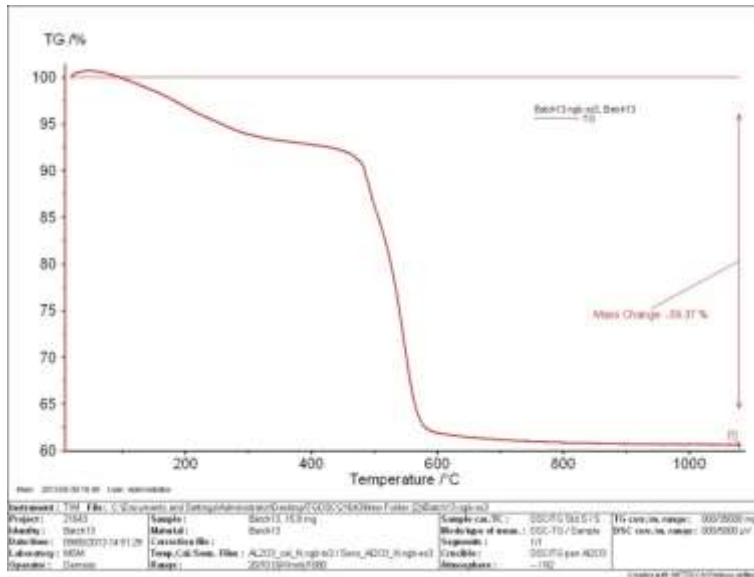
## HIPIN addresses

- ✓ Build Robust aerogel
- ✓ Modify process
- ✓ Functionalization of aerogel
- ✓ Surface treatment
- ✓ Characterise and optimise the right formulation

# Robustness : TES60 with a 60% Silica content

Sol Gel technology used to produce a precursor with a high silica content(60%).

High silica content → thicker aerogel wall, able to handle larger pore → more robust aerogel able to resist the incorporation into matrix.

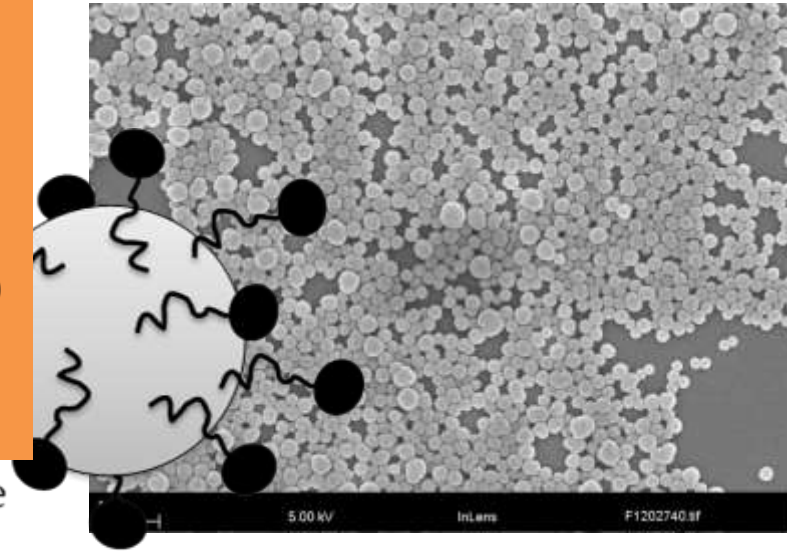


# Multifunctionality by incorporation of Functionalized Stöber spheres

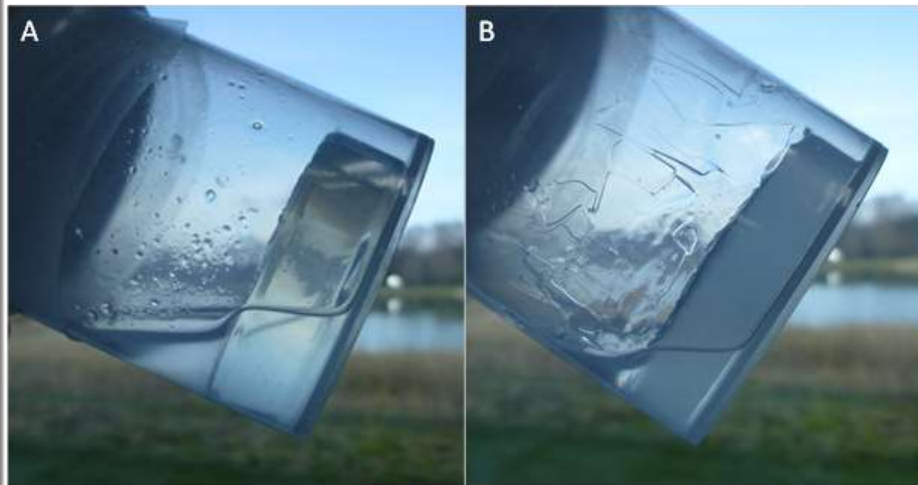
Incorporation of functionalized Stöber spheres (Synthesised by TWI)

(Pure silica spheres 20-200nm diameter) into TES60

→ Adds hydrophobicity to the Aerogel  
**(under patent investigation)**



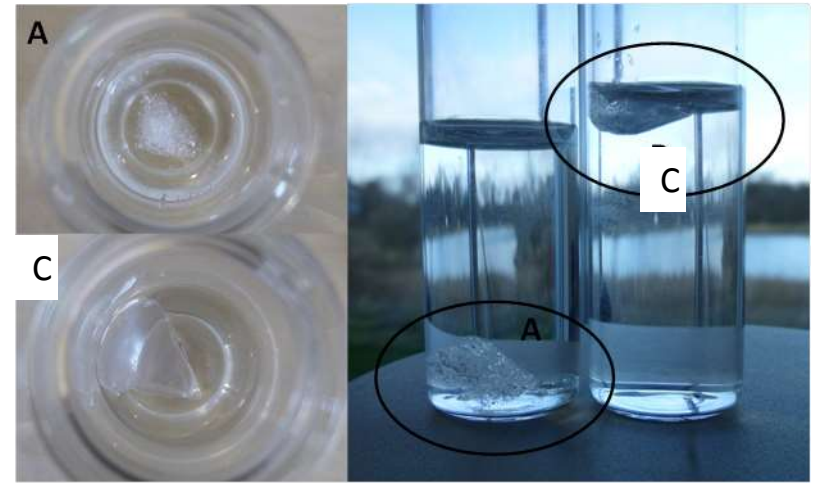
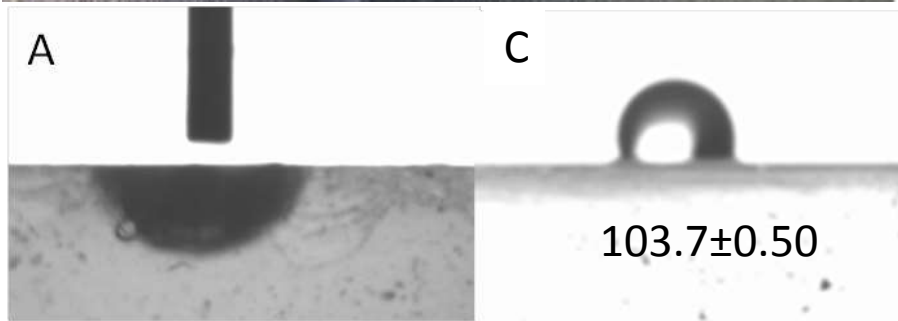
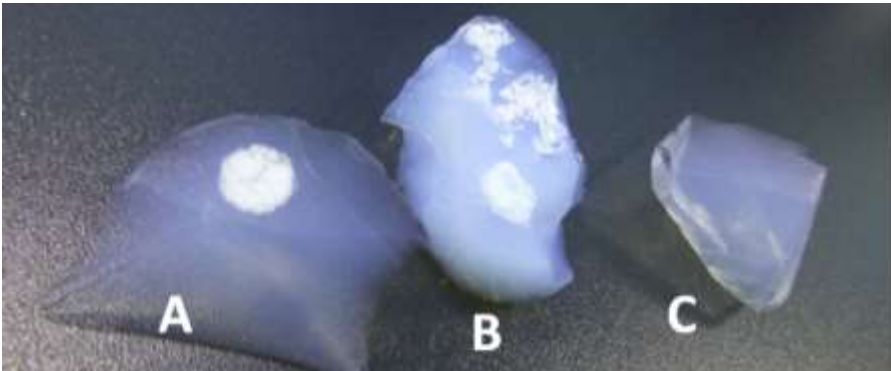
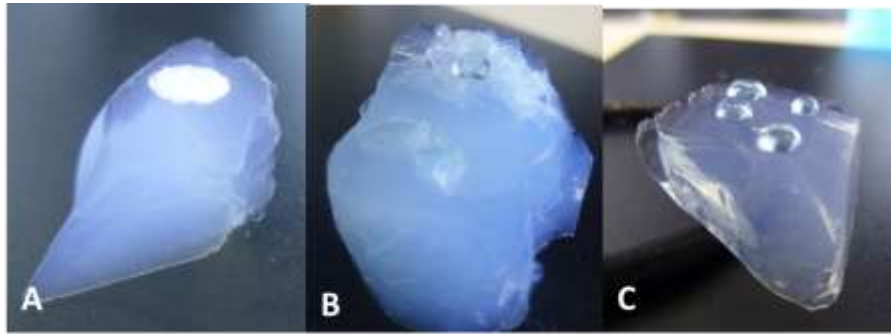
Stöber Sphere



Benefit: High reinforcement of the aerogel wall – Increase of the silica content

Drawbacks:  
loss of opacity

# Hydrophobicity



**A: Standard**  
**B: 06 HIPIN aerogel**  
**C: 16 HIPIN aerogel**

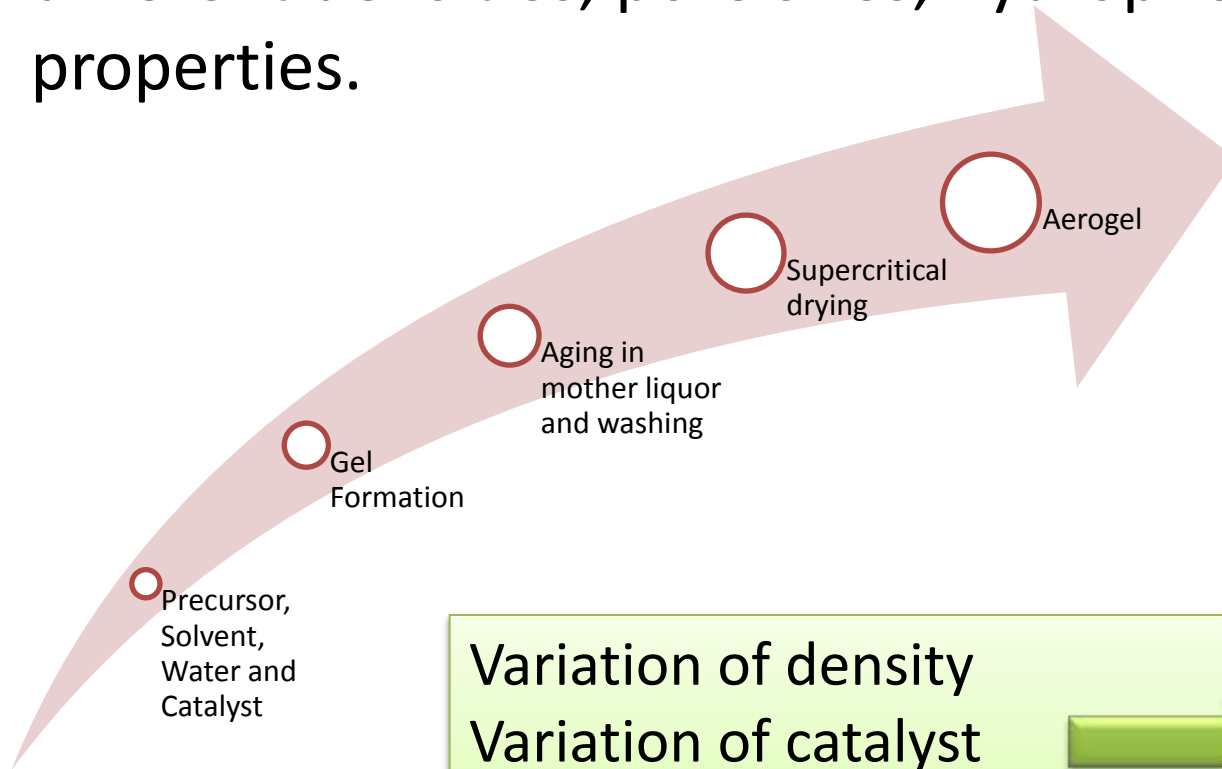
Important to prevent the aqueous system entering the pore structures / break the air encapsulation




# Choice of AEROGELS



Range of Aerogel produced via super critical drying with different densities, pore sizes, hydrophobicity and other properties.



Variation of density  
Variation of catalyst  
Variation of surface treatment

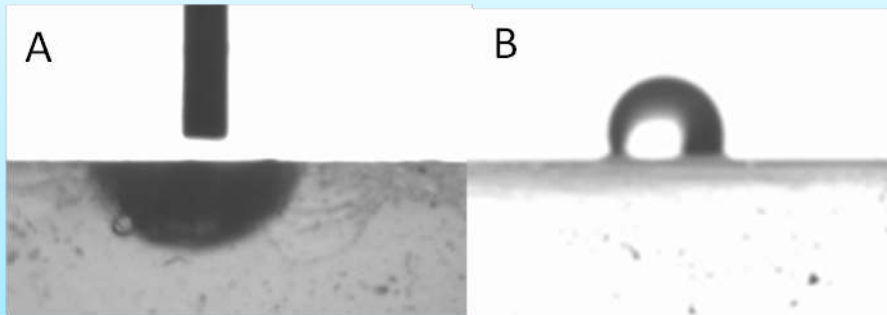


Range of aerogels for incorporation into paint and plaster

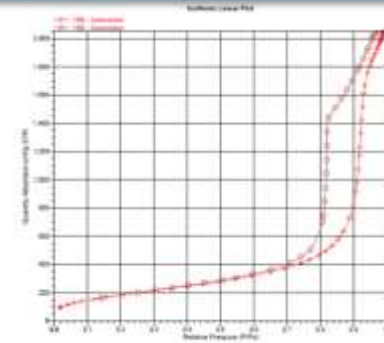
# Characterisation



Contact angle : A-hydrophilic, B-hydrophobic

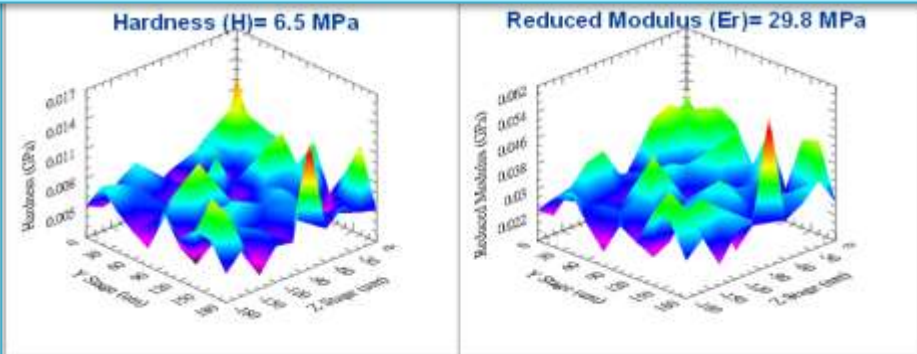


BET analyses: pore size, specific area

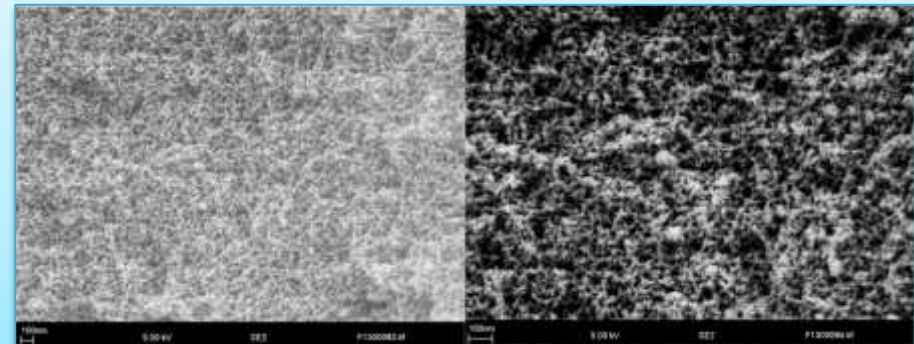


Surface Area  
(m<sup>2</sup>/g) = 650  
Pore Size (Å) = 8

Nano indentation: Hardness and modulus



SEM



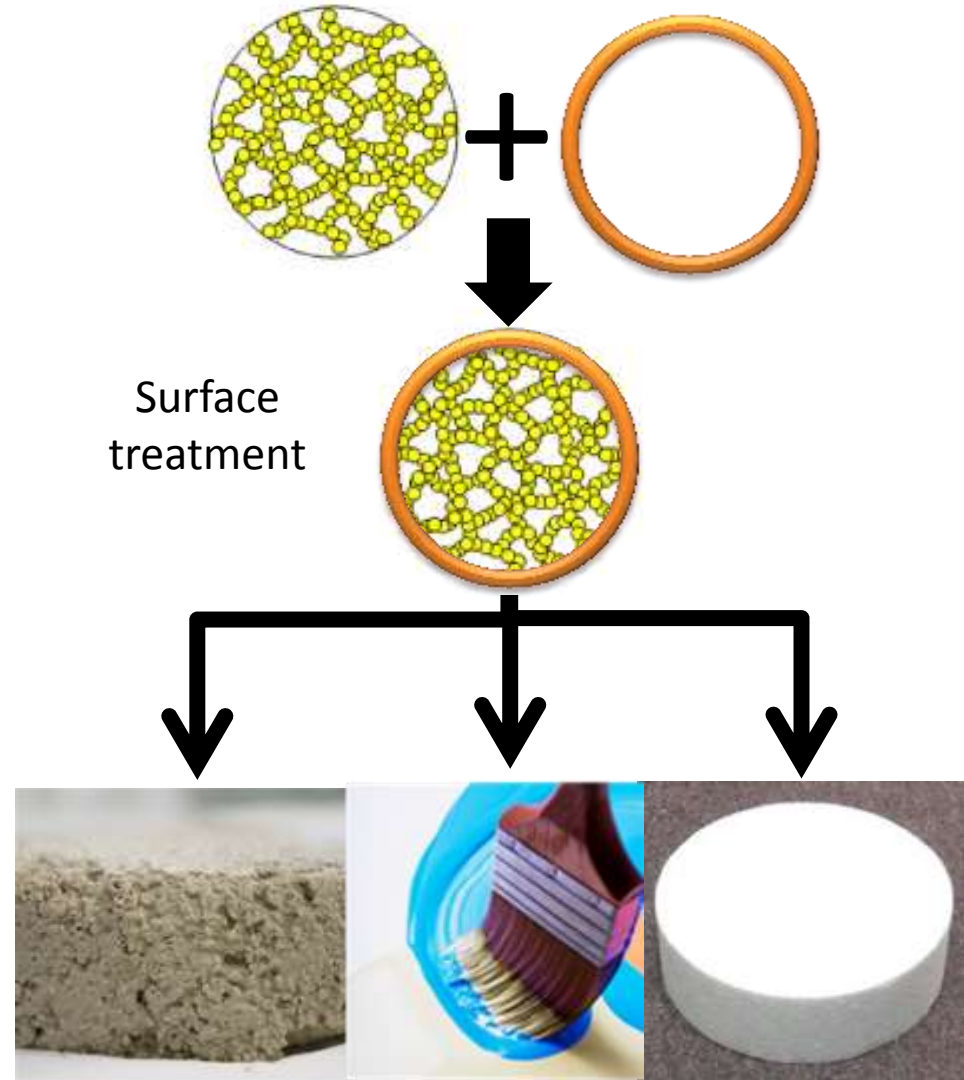
# Incorporation of aerogel into matrix



Hydrophobicity of the aerogel is good to keep the moisture out of the aerogel pores but do not provide compatibility when aerogel will be incorporated into a aqueous matrix

## Surface enhancement to improve compatibility with matrix

Identification of the polymers solvent and deposition/cure parameters for the surface treatment.



# Incorporation of aerogel into Paint



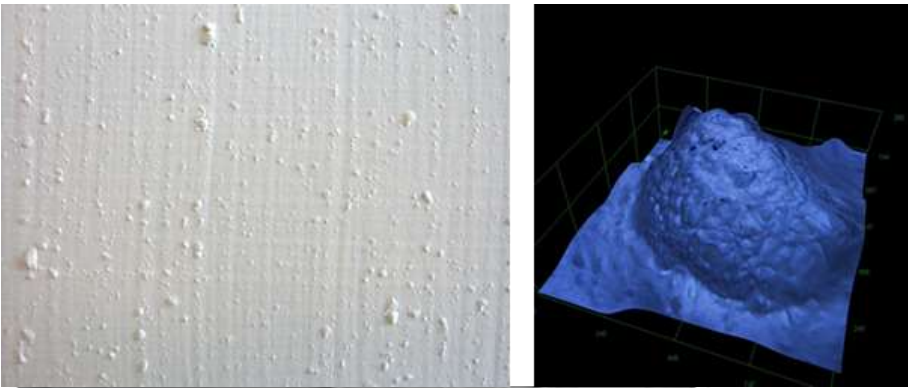
Identified paint that is suitable for both interior and exterior use.

## First stage : hydrophobic aerogels:

→ suitable sheen profile but hydrophobic aerogel create floatation in millbase and bits in the dry paint.

## Second phase: hydrophilic aerogels:

- good incorporation of Aerogel
- but not good enough for decorative paints



*Figure 1 Aluminium Q-panel coated with paint formulation incorporated with aerogel granulates.*



Wet and dry paint properties are encouraging except for low shear viscosity (Gel Strength). Still insulation performance need to be measured.

# Incorporation of aerogel into Plaster



Three stages are critical during the plaster preparation:

**Better than any other products  
in European Market!**



Variation of % of aerogel, binder, aggregates, additives and different types of aggregates and additives

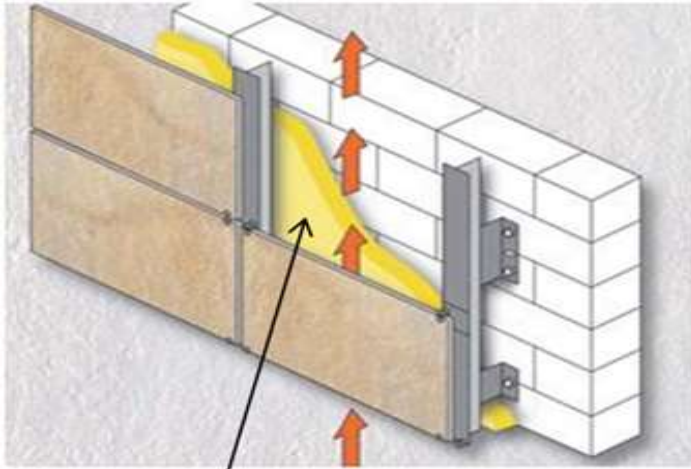


$$\lambda = 39 \pm 5\% \text{ mW}/(\text{m}\cdot\text{K})$$

According to EN 12667



# Use of aerogel into panel



insulating blanket

Aim: To decrease the thicknesses of the insulating blanket (currently 9cm) into insulating panel of about 3 cm.

The insulating blanket must

- allow water transpiration
- must not degrade when exposed to a significant amount of moisture.
- Cost efficient

## Results:

- Mould of Expanded Polystyrene + AEROGEL granulate is possible
- However, the final product tends to disaggregate and to be dusty
- Aerogel surface functionalization is imperative
- production stages and post processing to be developed, like mixing and cutting.



# WALLS FOR DEMONSTRATION



- Surface of about 9-12m<sup>2</sup>
- $\Delta T \geq 10^{\circ}\text{C}$  ( $\geq 15^{\circ}\text{C}$  would provide more accurate measure)
- Repaired from direct sun and atmospheric agent
- No openings (windows, doors) near the test area
- Heated inside 24h/day

# Conclusion



- A precursor to make low cost robust aerogel has been developed.
- Multifunctionality introduced
- Incorporation of HIPIN aerogel into paint , plaster and panels is currently investigated and shows positive results.

## Future work:

- Optimisation of formulation of paint, plaster and panel will be carried out for best performance.
- Evaluation of the thermal properties for each prototype will be carried out on real building.





# Thank you

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