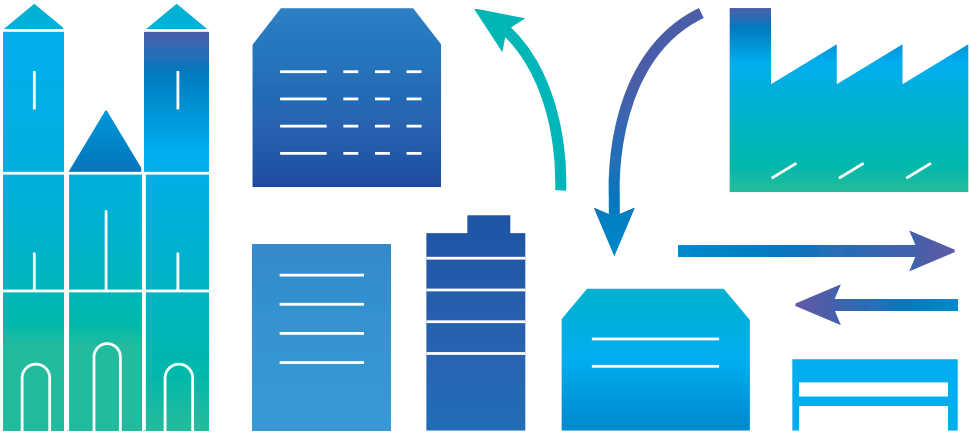
2016

EeB PPP Promising Technologies

Advanced Materials Solutions



ENERGY EFFICIENT BUILDINGS

AN ECTP COMMITTEE FOR INNOVATIVE BUILT ENVIRONMENT

AEROGEL BY BASF AS INSULATION SOLUTION

Advanced Materials Solutions

The BEEM-UP project has developed and deployed a multidimensional methodology within the whole process of refurbishment where building owners, technology providers, construction companies and researchers collaborate to demonstrate successful methods for deep retrofit with the potential for large-scale replication. One of the technologies, a multilayer aerogel board developed by BASF for insulation, which is thinner than standard EPS and has high fire resistance, was deployed within the demo sites and shown to raise the quality of dwellings. This solution can be used as a new exterior insulation system or as a repair system for damaged and already existent insulation systems.

The BEEM-UP project has demonstrated that reducing the energy consumption by more than 75% through deep energy refurbishment is indeed feasible in the long term. With respect to translucent pre-fabricated facades like Aerogel / Silica-Gel, demonstration objects have been implemented mainly in Switzerland so far. For fulfilling the European 20-20-20 targets the rate of retrofitting has to be significantly increased. Corresponding BPIE study of 2011 shows the way, how to go ahead with respect to multi-family houses. Aerogel solutions are used mainly in new eco-buildings for the time being. The advantage is that although the thickness of the insulation consists in a couple of centimetre, the k-values are in order of 0,06 W/m2K and 0,14 W/m2K. This product is a promising niche within a highly competitive market.

- **High insulation achieved with little material**
- **K-values in order of 0,06 W/m2K and 0,14 W/m2K**

- Technical completion: between 3 to 5 years
- Can be used in new constructions
- Can be used in renovation/retrofitting
- Compatible with existing solutions

Project: BEEM-UP, Building Energy Efficiency for Massive market Uptake
www.beem-up.eu

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BEEM-UP

HIPIN AEROGEL

Aerogel based on the high silica content precursor (TES58)

Aerogels provide an innovative option for improved thermal performance for the existing building infrastructure. Incorporation of aerogel into plaster and panels has been challenging due to its fragility. A high silica content aerogel provides a means to meet the insulation needs of retrofits as well as new buildings. The same insulation performance can be obtained at lower thickness, thereby providing an opportunity for space optimization.

Silica-based aerogels have very low thermal conductivity (0.01-0.02 W/(m.k), typically) and can thus potentially be used for high performance insulation materials. However, their fragility has limited application in building products, making widespread use in the construction section not feasible in the past. In this sense, the insulation concepts developed by the HIPIN project involve the development of a high silica content aerogel precursor, which can provide a cost-effective route to a robust aerogel. The precursor developed during the project contained 58% silica and was made into both hydrophilic and hydrophobic aerogel by a cost-effective method. This high silica content precursor was developed and contained 58% silica (TES58), much greater than the traditionally used TEOS precursor, which is 28% silica. Methods for making both hydrophilic and hydrophobic aerogel had been investigated.

The thermal performance of 3 building products incorporating the HIPIN aerogel was validated not only via a lab evaluation of the thermal conductivity of these products but also via demonstrators set up during the project. Thus, the aerogel containing paint, plaster, and panels were tested under commercially relevant conditions. Results validate the insulation benefits of the products, showing the robustness and scalability of the process developed.

- 58% silica content
- Opportunity for space optimization
- Very low thermal conductivity

- Technical completion: between 1 and 2 years
- Can be used in new constructions
- Can be used in renovation/retrofitting
- Compatible with existing solutions

Project: HIPIN, High Performance Insulation Based on Nanostructured Encapsulation of Air
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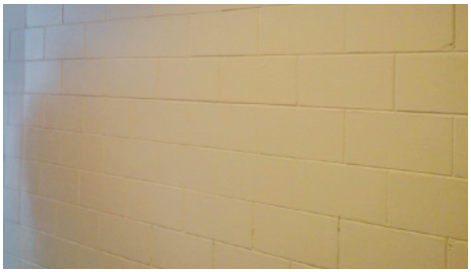
THERMAL INSULATING PAINT FORMULATION CONTAINING HIPIN AEROGEL

Advanced Materials Solutions



- 24% lower thermal conductivity than standard paint
- 0.49 W/(m.k) thermal conductivity

- Technical completion: between 1 and 2 years
- Can be used in new constructions
- Can be used in renovation/retrofitting
- Compatible with existing solutions

A thermal insulating paint developed within the HIPIN project containing HIPIN aerogel provides a statistically significant lower thermal conductivity than standard paint. This paint formulation can provide enhanced insulating properties compared to standard similar materials (thermal conductivity 24% lower than standard paint), without affecting any of the other paint properties (e.g. gloss, sheen, abrasion resistance, etc.). The optimised formulation of this paint with aerogel provides thermal performance via a thin layer of paint (about 250 microns).

This material provided a quantitative assessment of thermal performance benefits during the demonstration stage of the HIPIN project. The thermal conductivity of the HIPIN paint is 0.49 W/(m.K), compared to 0.64 W/(m.K) for a standard paint.

In general terms, this paint provides insulation and heating energy reduction benefits from a decorative paint, sufficient to deliver noticeable and marketable heating energy savings. These savings are reflected into the environmental performance of the final product, reducing the Global Warming potential and the Primary Energy Demand compared to similar insulating paints in the current market.

Project: HIPIN, High Performance Insulation Based on Nanostructured Encapsulation of Air
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GLAZING VERSION 1: SEALING AND WEIGHT REDUCTION OF WINDOW
Advanced Materials Solutions

MEM4WIN introduces a novel IG-Unit for quadruple glazing containing ultra-thin glass membranes dedicated as frameless openable windows for direct application in facades. Due to this approach, the new quadruple insulated glass unit with novel spacer technology reduces weight by more than 30% and costs by 20% and at the same time lowers the U-value down to 0.3 W/m²K.

Tempered thin glass provides new possibilities. Lightweight, flexible and durable glass units without optical distortions and lower stress for the spacer system are ideally suited for use in modern architecture with highly energy-efficient windows/facades. The developed window presents the following advantages:

- Lower breakage losses due to thin glass sheets of enormous strength and flexibility.
- Lower distortions in façade in the event of alternating climate loads due to the thinner inner panes, which act as a flexible membrane.
- Lower stress on spacer bars in different climatic loads due to flexible membrane effect.
- Lower loads on fittings and frames due to weight reduction.
- Improved working conditions for window construction employees.
- Higher transmission (+1% for each mm glass thickness saved, less absorption through thinner glass).
- More than 16 % Lower carbon footprint due to a 2mm thermally treated glass compared to a 4mm float glass.

A new approach of air cushion transportation within tempering furnaces enables tempering of thin glasses without any roller waves, proven already in glass thicknesses reduced down to 1.8 mm. These thin glasses are used preferably in new solar module applications, enabling weight reduction as well as higher transmission. This technology is patent pending by LiSEC and more than 30 installations within Europe and Asia are already existent. Due to the reduced thickness, this development allows energy savings for the tempering of up to 40%. No contact is made, thus higher quality can be achieved and there is no wear. With the new air cushion tempering furnace, LiSEC demonstrated in experiments that the glass thickness could be reduced down to ~ 0.9 mm.

- **Reduces weight by more than 30%**
- **Lowers the U-value down to 0.3 W/m²K**
- **40% energy savings for tempering**
- **Glass thickness reduced down to 0.9 mm**

- Technical completion: less than 1 year
- Can be used in new constructions
- Can be used in renovation/retrofitting
- Compatible with existing solutions

Project: MEM4WIN, Ultra-thin glass membranes for advanced, adjustable and affordable quadruple glazing windows for zero-energy buildings
www.mem4win.eu

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MEM4WIN
ADVANCED TECHNOLOGIES FOR SMART WINDOWS

GLAZING VERSION 2: REPLACING ITO WITH CVD GRAPHENE

Advanced Materials Solutions

MEM4WIN's innovative glazing technology replaces indium tin oxide (ITO), a common material used as a transparent conductive layer in electrical devices, with graphene synthesized via chemical vapor deposition (CVD) and uses a roll to plate process for the transfer. Graphene has a higher transparency than ITO and is a promising candidate for cost reduction, and for overcoming the shortage of indium supply. The roll to plate process developed within the project is an easy and fast process to transfer CVD graphene from copper foils onto glass. This process will make it possible to handle graphene layers for mass production. As a result of this technology, graphene layers are capable of meeting the required minimum conductivities of 10-5S.cm-1 (for charge extraction layers) and area conductivities of 0.05S.cm-1 (for electrodes) while still providing transparencies of more than 80% over the whole visible and near infrared region.

Within the framework of the MEM4WIN project, successful transfer on glass plate of CVD graphene grown on copper was achieved. The investigation and optimization works have led to a reliable CVD process for the preparation of defect free graphene. The developed transfer process has enabled the preparation of graphene on glass at lab scale. Four layers of graphene were grown and doped by CNR on glass and showed a resistivity around 25 Ω/m and a transmittivity above 90%.

Within the project, a new CVD tool was developed. This new tool allows a significant throughput increase for the production of high quality monolayer graphene. This new equipment is capable of producing 400cm2/h of monolayer graphene. The concept for this new system is fully scalable and could be used to produce very large area graphene > 1x1m.

First integration in OPV cell of graphene transferred on glass was realized. This attempt showed that with CVD Graphene, it is possible to make functional solar cells and that the optical density is good. The OPV cell tested consisted of a layer stack of ZnO, P3HT: PCBM, and HIL were coated and a 300 nm Ag electrode was evaporated. The first trial gave 40%FF and 0.8% efficiency, which is very promising. With the optimized transfer process and with graphene doping, a stable sheet resistance of 35Ω/m at a transparency of 90,2% were obtained with a 4-layer-graphene sample (5x5cm).

- 35 Ω/m sheet resistance
- 90% transparency
- Growth of 6x6 monolayer graphene at a rate of 400cm2/h

Technical completion: between 3 to 5 years
Can be used in new constructions

Project: MEM4WIN, Ultra-thin glass membranes for advanced, adjustable and affordable quadruple glazing windows for zero-energy buildings
www.mem4win.eu

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MEM4WIN
ADVANCED TECHNOLOGIES FOR SMART WINDOWS

This technology brochure highlights the highly promising innovations from selected co-funded European projects under the 7th Framework Program (FP7).

The Energy-Efficient Buildings (EeB) Public Private Partnership (PPP) is a joint initiative of the European Commission (EC) and the Energy Efficient Buildings Committee of the European Construction Technology Platform (ECTP).

This initiative aims at promoting research on new methods and technologies to reduce the energy footprint and CO2 emissions related to new and retrofitted buildings across Europe.

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ECTP
INNOVATIVE BUILT ENVIRONMENT

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