

MSc and Project Tasks within Building Materials Research and Development

Bjørn Petter Jelle ^{ab} and Various Colleagues ^{abc...}

^a Norwegian University of Science and Technology (NTNU),
Department of Civil and Environmental Engineering, NO-7491 Trondheim, Norway.

^b SINTEF Building and Infrastructure,
Department of Materials and Structures, NO-7465 Trondheim, Norway.

**The more we know the more we know we don't know...!
... and the more we want to know... and that's the whole fun of it...!**



General Lecture

Examples of Various Research Fields

- **Development of new thermal insulation materials**
 - From theoretical concepts to experimental results
 - Advanced insulation materials (AIM)
 - Superinsulation materials (SIM)
 - Nano insulation materials (NIM)
 - Hollow silica nanospheres (HSNS)
- **Fenestration of today and tomorrow**
 - Investigating many fenestration aspects
 - Advanced coating materials
 - Smart windows applying electrochromic windows (ECW)
 - New glass materials with reduced weight
- **Accelerated climate ageing and durability**
 - Building materials, components and structures
 - Miscellaneous climate exposures and ageing apparatuses
 - Measuring various properties before, after and during ageing
- **Building integrated photovoltaics (BIPV)**
 - Building envelope
 - PV solar cells

Specific MSc and Project Tasks

- **The Utilization of Electrochromic Materials for Smart Window Applications in Energy-Efficient Buildings**
 - Smart Window Development, Characterization and Testing in Laboratory
 - Comparison of the Energy Saving Potential of Adaptive and Controllable Smart Windows: Photochromic, Thermochromic and Electrochromic Technologies
- **Life Cycle Assessment Comparison of Different Types of Vacuum Insulation Panels**
- **Measurement of Emissivity with FTIR Spectrometer**
- **High Performance and Dynamic Insulation Materials and Solutions**
- **Building Integrated Photovoltaics (BIPV)**
 - Experimental Laboratory Investigations of Building Integrated Photovoltaics with respect to Durability and Robustness
 - The Challenging Pathway towards True Plug-and-Play Building Integrated Photovoltaics
 - Advanced Materials Surface Development for Preventing Snow and Ice Formation on Building Integrated Photovoltaics
- **Building Integrated Photovoltaic-Thermal (BIPVT) Systems**
- **Ageing of Building Materials**
 - FTIR Spectrometry for Characterization of Ageing of Building Materials
 - Accelerated Climate Ageing of Building Materials
- **New Materials Technologies for Buildings of the Future**

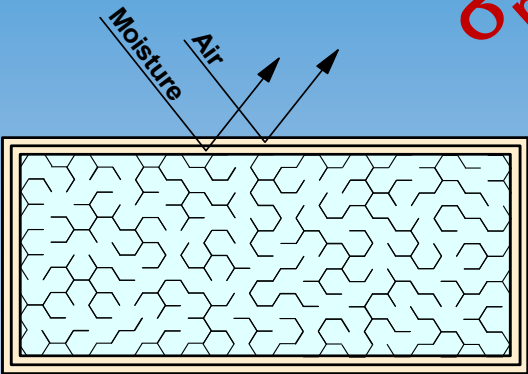
New Thermal Insulation Materials - Concepts

$$\lambda_{tot} = \lambda_{solid} + \lambda_{gas} + \lambda_{rad} + \lambda_{conv} + \lambda_{coupling} + \lambda_{leak}$$

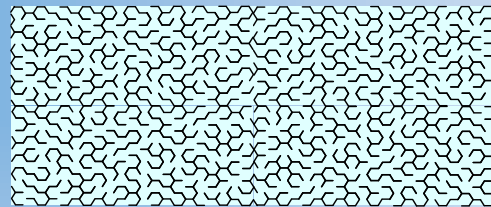
$$\lambda_{gas} = \frac{\lambda_{gas,0}}{1 + 2\beta Kn} = \frac{\lambda_{gas,0}}{1 + \frac{\sqrt{2\beta k_B T}}{\pi d^2 p \delta}}$$

$$Kn = \frac{\sigma_{mean}}{\delta} = \frac{k_B T}{\sqrt{2\pi d^2 p \delta}}$$

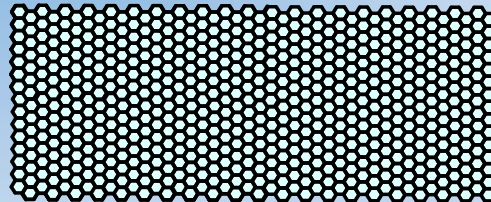
$\sigma_{mean} > \delta$
 \Rightarrow LOW λ_{gas}



VIP

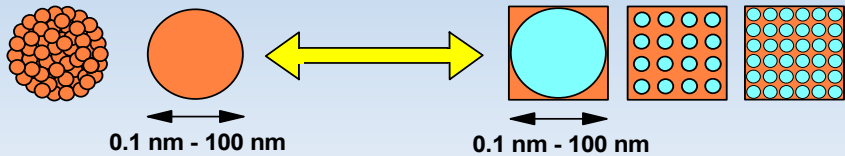


Open Pore Structure



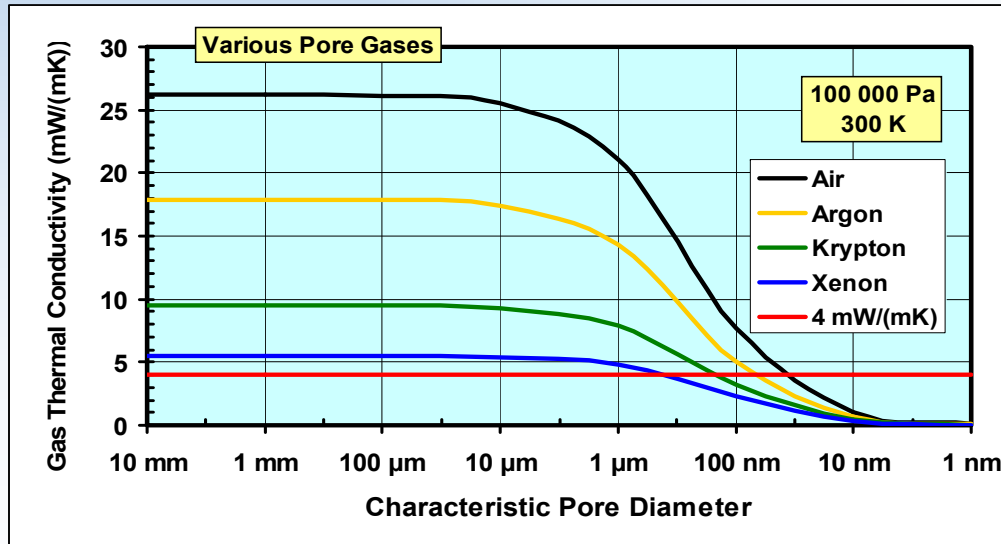
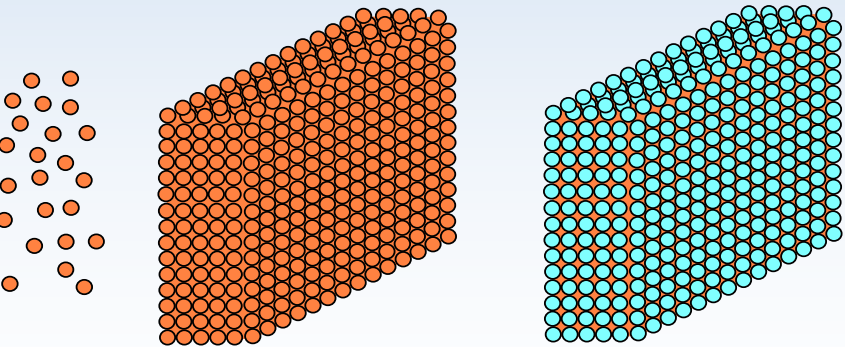
Closed Pore Structure

Nano Particles

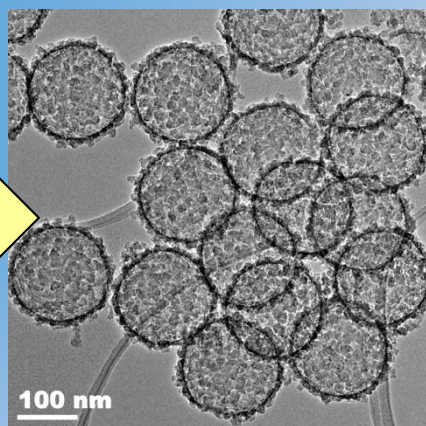
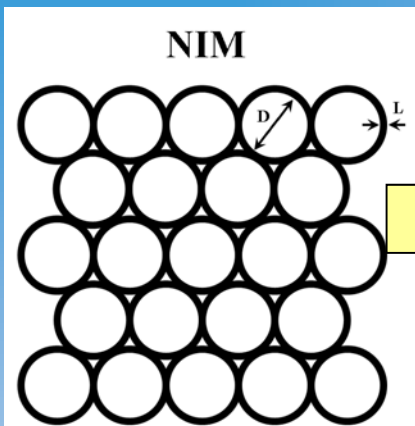


Nano Pores

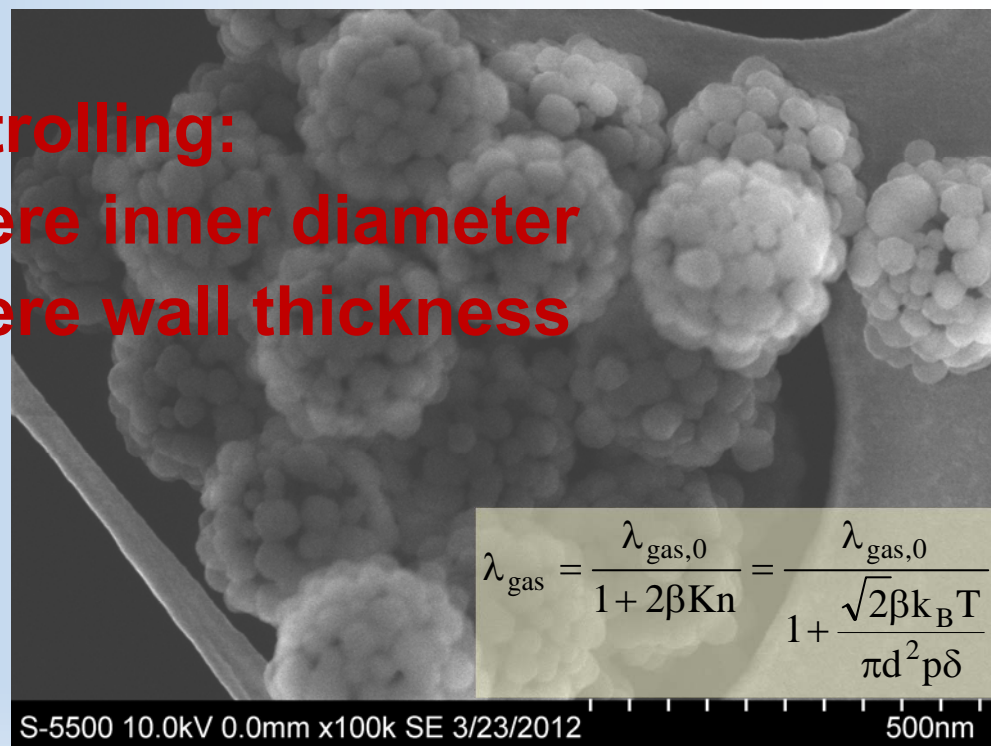
NIM



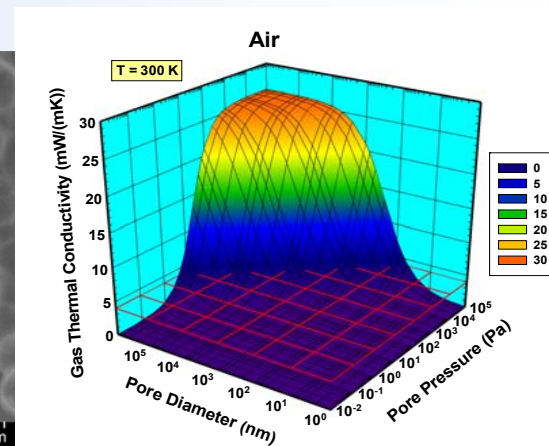
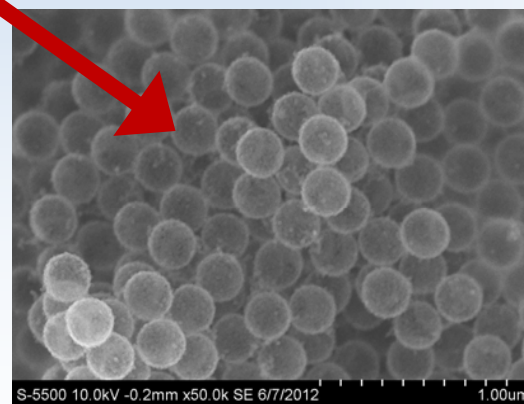
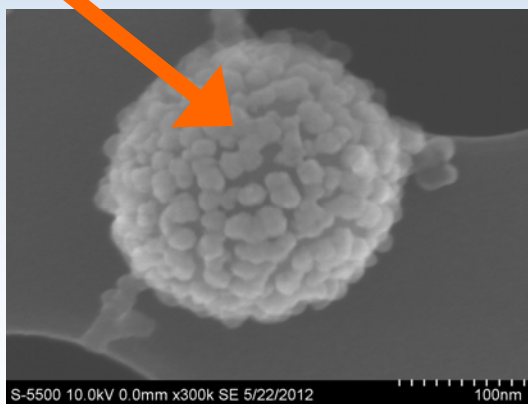
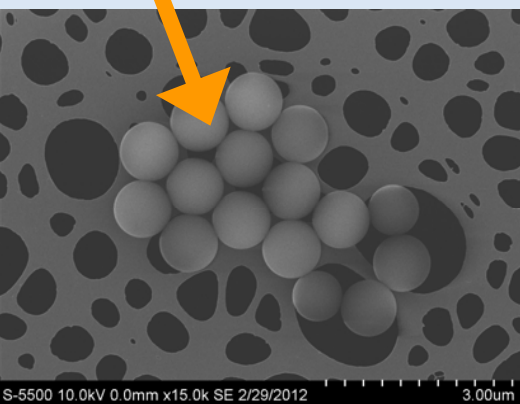
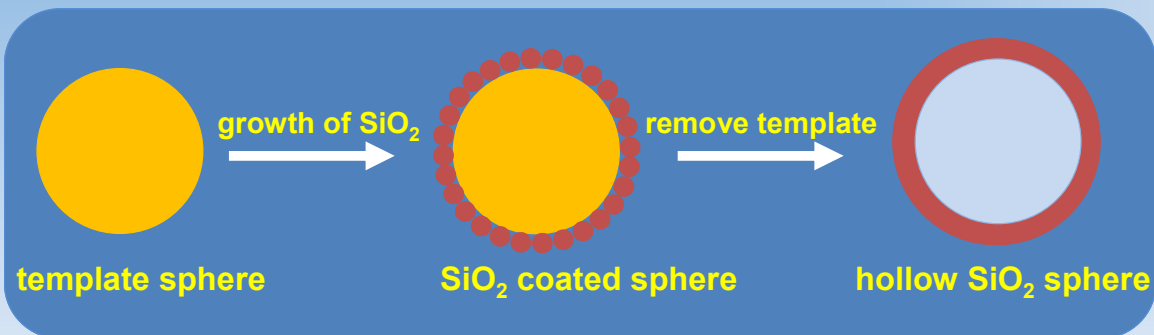
New Thermal Insulation Materials - Experiments



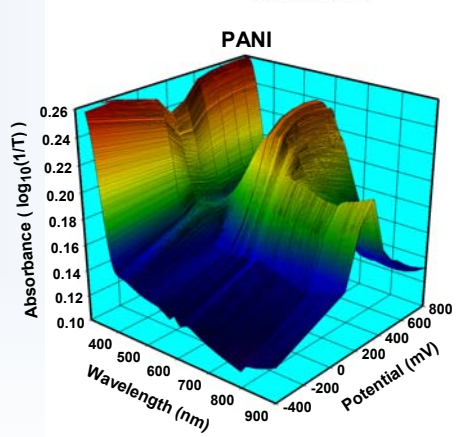
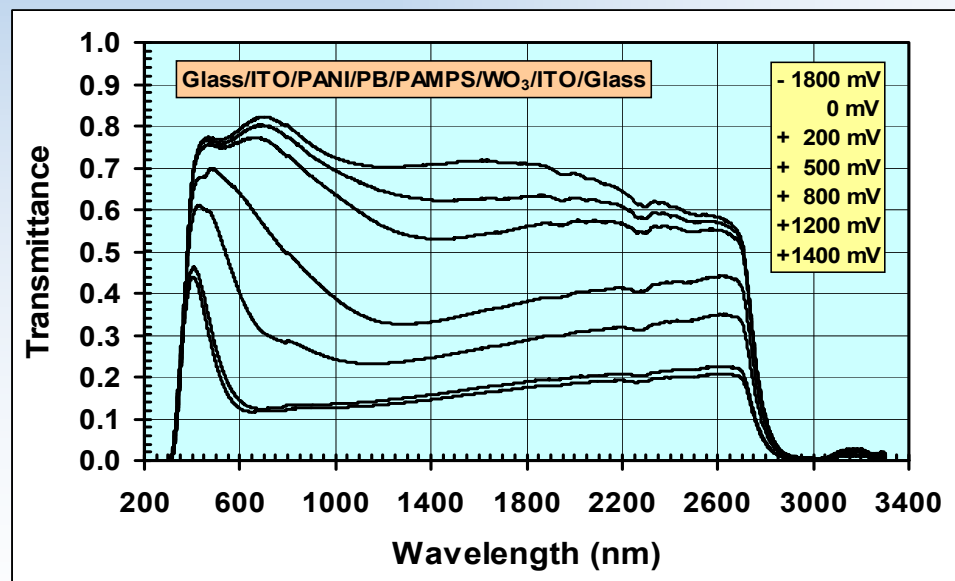
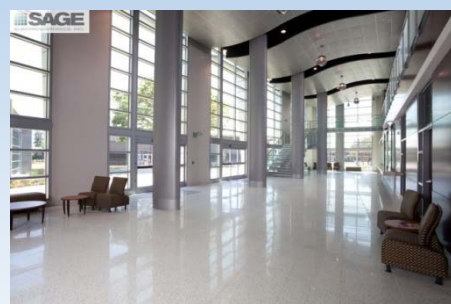
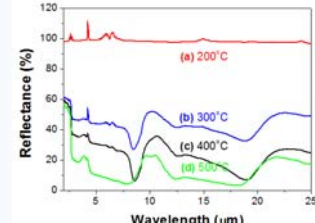
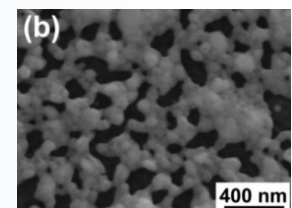
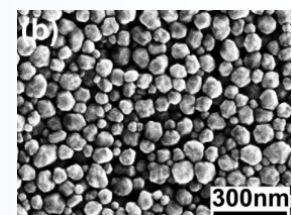
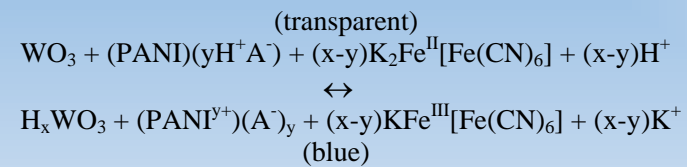
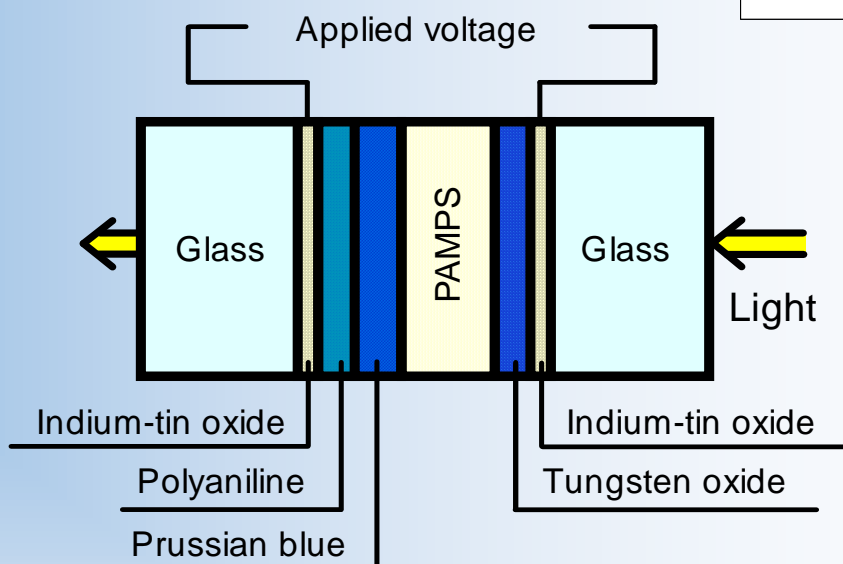
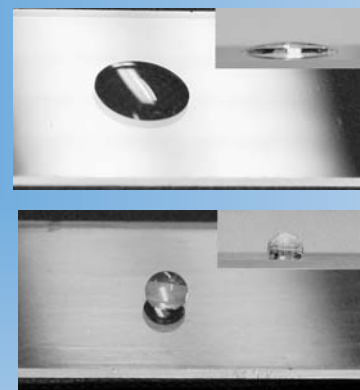
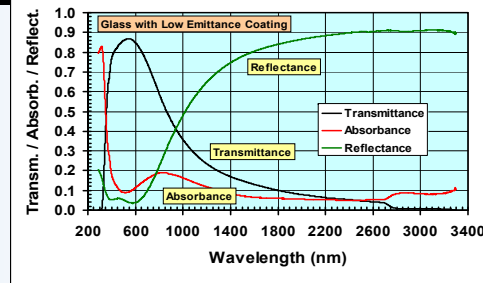
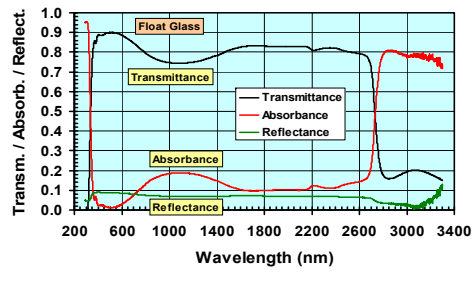
- Controlling:
- Sphere inner diameter
- Sphere wall thickness



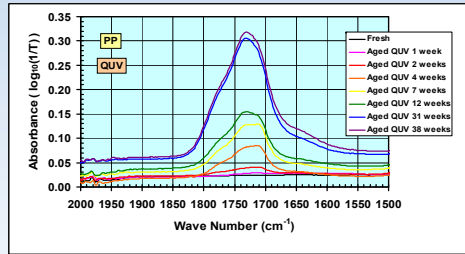
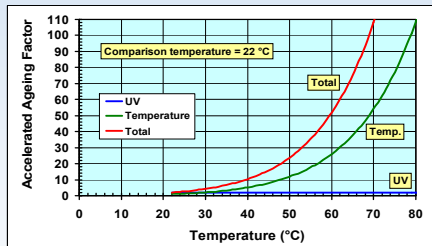
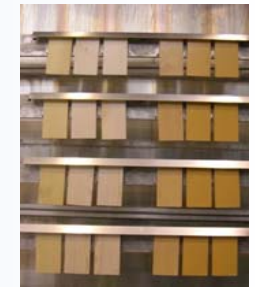
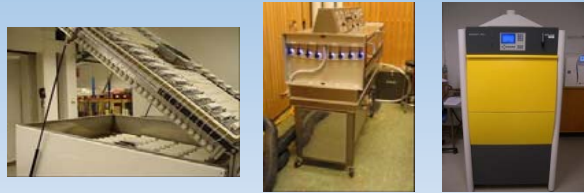
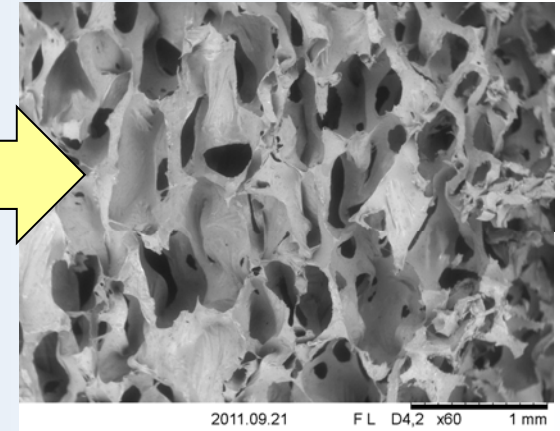
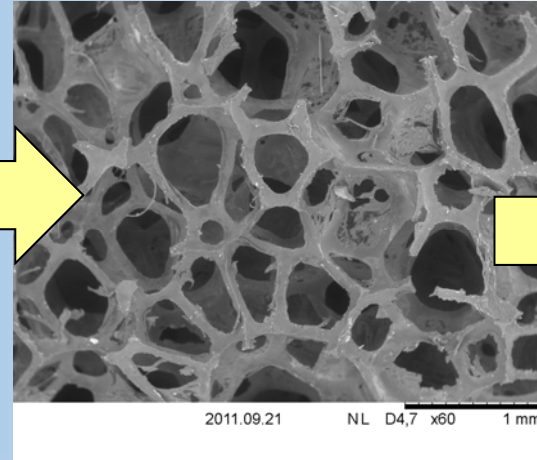
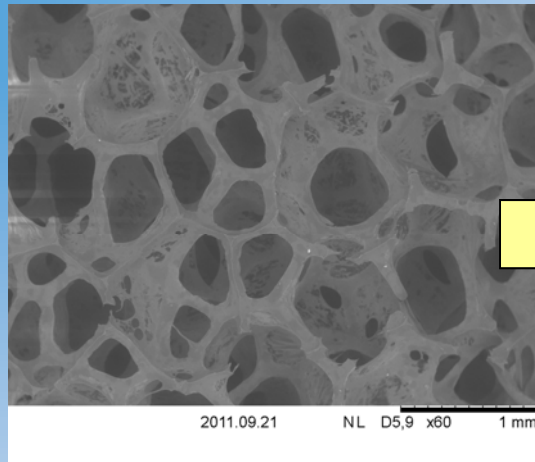
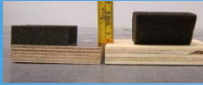
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Fenestration of Today and Tomorrow



Accelerated Climate Ageing and Durability



$$AF_{tot} = AF_{uv} \cdot AF_{temp} = \frac{\Phi_{lab}}{\Phi_{nat}} \cdot \frac{e^{-E_{lab}/(RT_{lab})}}{e^{-E_{nat}/(RT_{nat})}}$$

A simplified total acceleration ageing factor



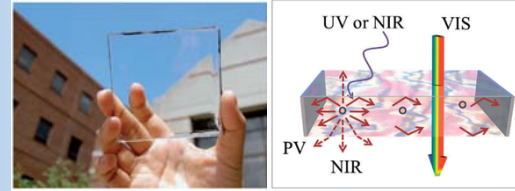
Building Integrated Photovoltaics (BIPV)

■ Fulfil the requirements of both:

- Building envelope.
- PV solar cells.

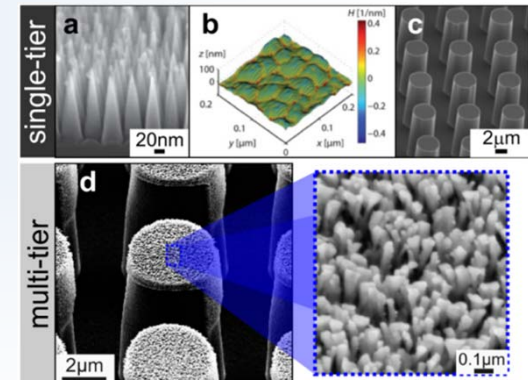
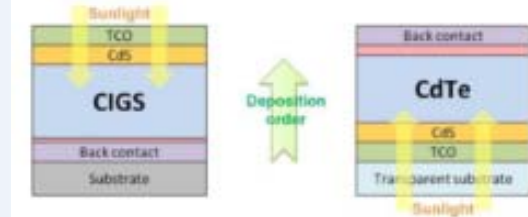
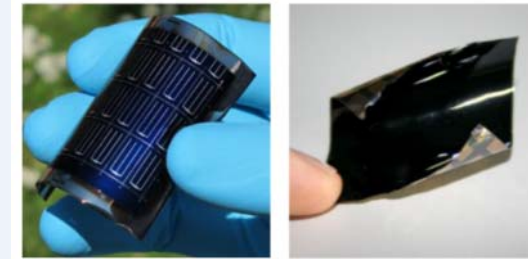
■ Durability in general and vs. climate exposure factors.

■ Rain, air and wind tightness, various building physical aspects like heat and moisture transport, etc.



■ Plug-and-Play BIPV (PaP BIPV):

- Individual panels (e.g. tiles) clicked/snapped together in a single and simple operation.
- Ensuring both satisfactory and durable electrical connections and weather tightness.
- Likewise when removing individual panels.
- Would definitely gain a competitive edge over today's more traditional BIPV products.
- Residential buildings and larger building complexes.
- Erection of new buildings and retrofitting of old ones.
- Contribute to the acceleration of utilization of solar energy by solar cells on a worldwide scale.



- Large-scale laboratory investigations.
- State-of-the-art and future opportunities.

