
ALUMINUM FOAMS



AGENDA

Introduction	Metal foam	Application	Perspective
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- Introduction
 - Fraunhofer Institute
 - Fh-IWU
- Metal foam
 - Metal foam center
 - Metal foam / Production
 - Peripheral technologies
 - Properties
 - Product range
- Applications
- Perspective

Who and what are we responsible for?

Introduction

Metal foam

Application

Perspective

- Generations need translators and people that simply understand both sides of the story...



Who and what are we responsible for?

Introduction

Metal foam

Application

Perspective

- ...business and development too!



Who and what are we responsible for?

Introduction

Metal foam

Application

Perspective

■ ...that's our business!



The Fraunhofer-Gesellschaft

Introduction

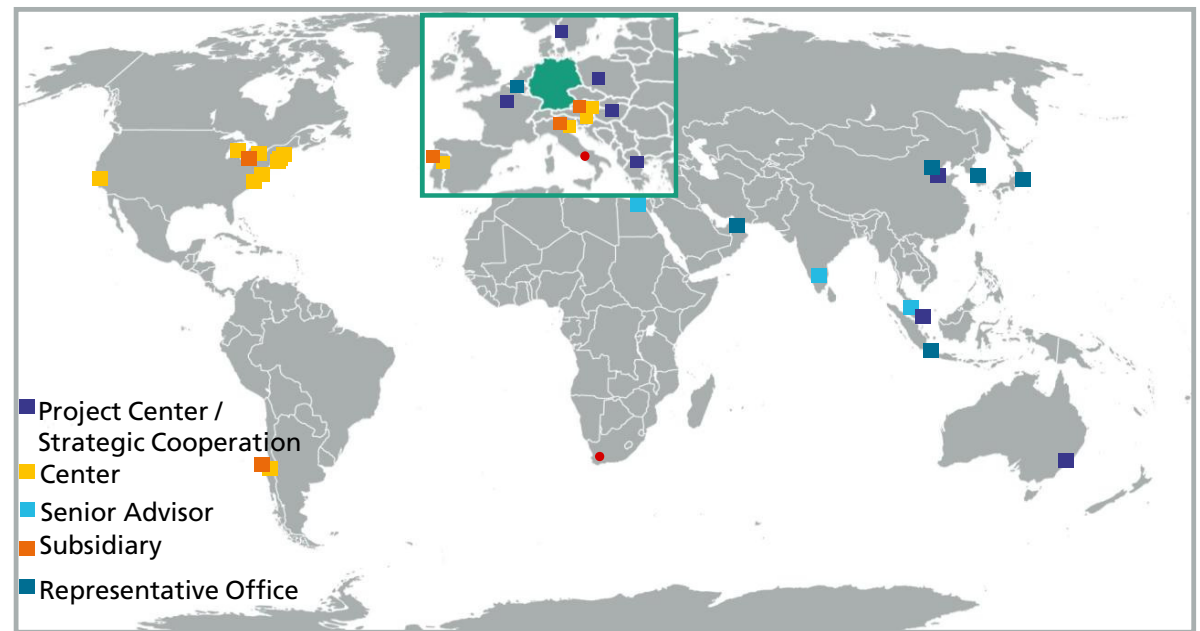
Metal foam

Application

Perspective

- The Fraunhofer-Gesellschaft undertakes **applied research** of direct utility to private and public enterprise and of wide benefit to society.

- 66 Institutes
- more than 22.000 employees
- Research Volume:
~ 1.9 billion euro per year



The Fraunhofer IWU

Introduction	Metal foam	Application	Perspective
■ The Fraunhofer IWU Locations in Germany ■ founded on July 1st, 1991 ■ about 520 employees ■ 34 million euro budget			
		Fields of Expertise - Virtual Reality - Mechatronics - System Technology - Production Systems - Machine Tool Design - Joining Technology - Forming Technology - Process Control Engineering - Generative Technologies - Cutting and Precision Technique	   

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Department Multifunctional Light Weight Design and Metal Foam

Introduction

Metal foam

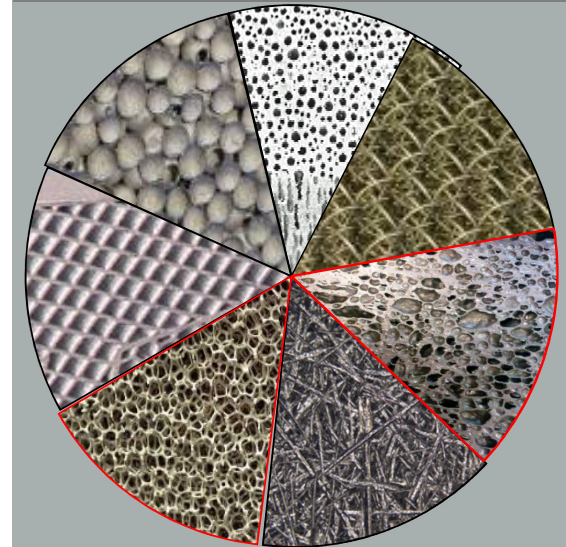
Application

Perspective

■ Metal Foam Center

- Research and production since 1995
- Industrial level on Al-/Zn-Foams
- Research on Steel and Titanium foams
- Serial production of several assemblies for machine tools (welded from sandwiches)
- Developed several standards for property analysis and owner of many patents related to metal foam (e.g. metallic bonding of steel cover sheets to foam core of sandwiches)

Cellular metal structures



Recyclable



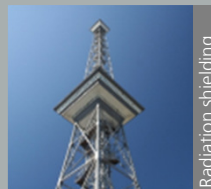
Heat resistant



Vibration damping



Permeable



Radiation shielding



Energy absorbing

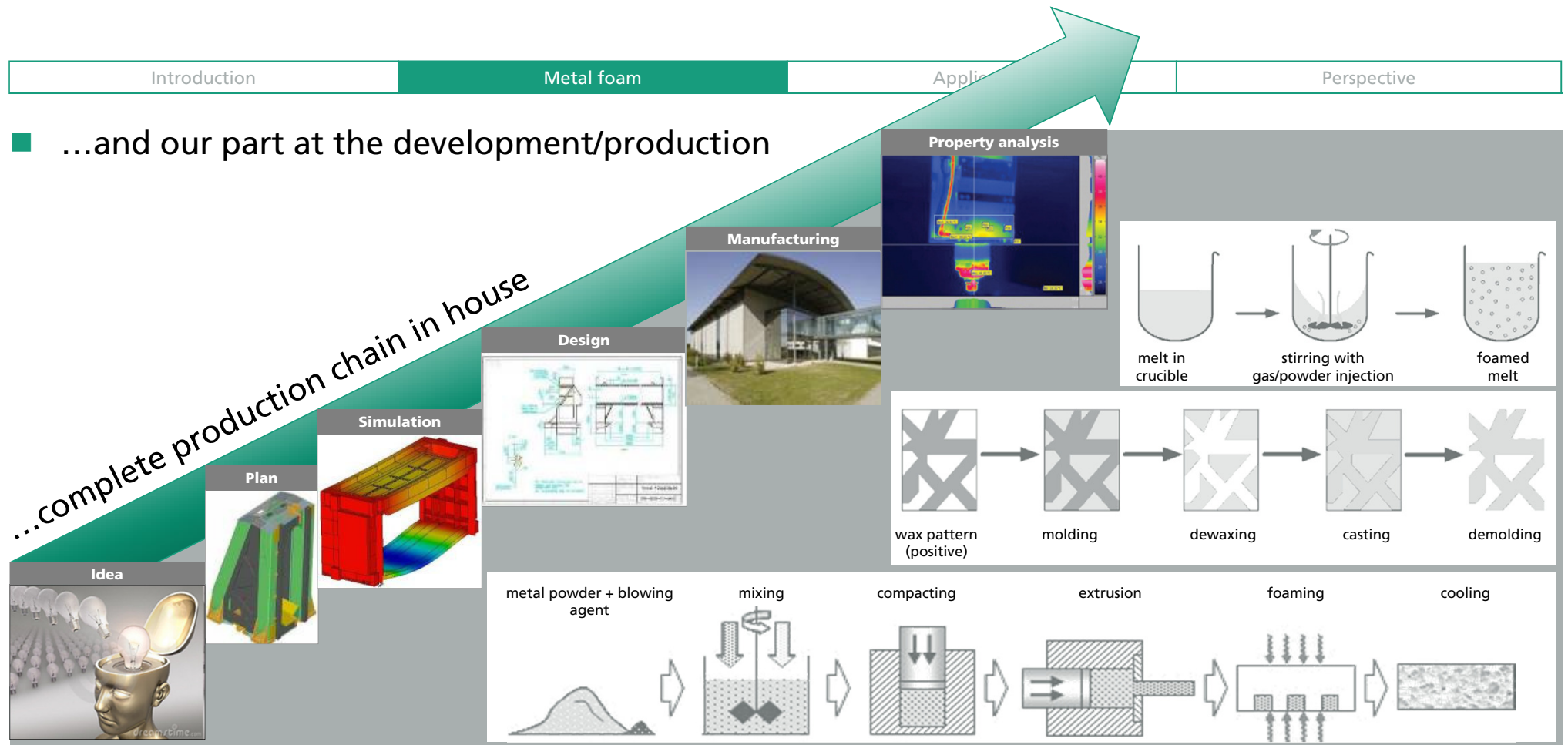


Lightweight

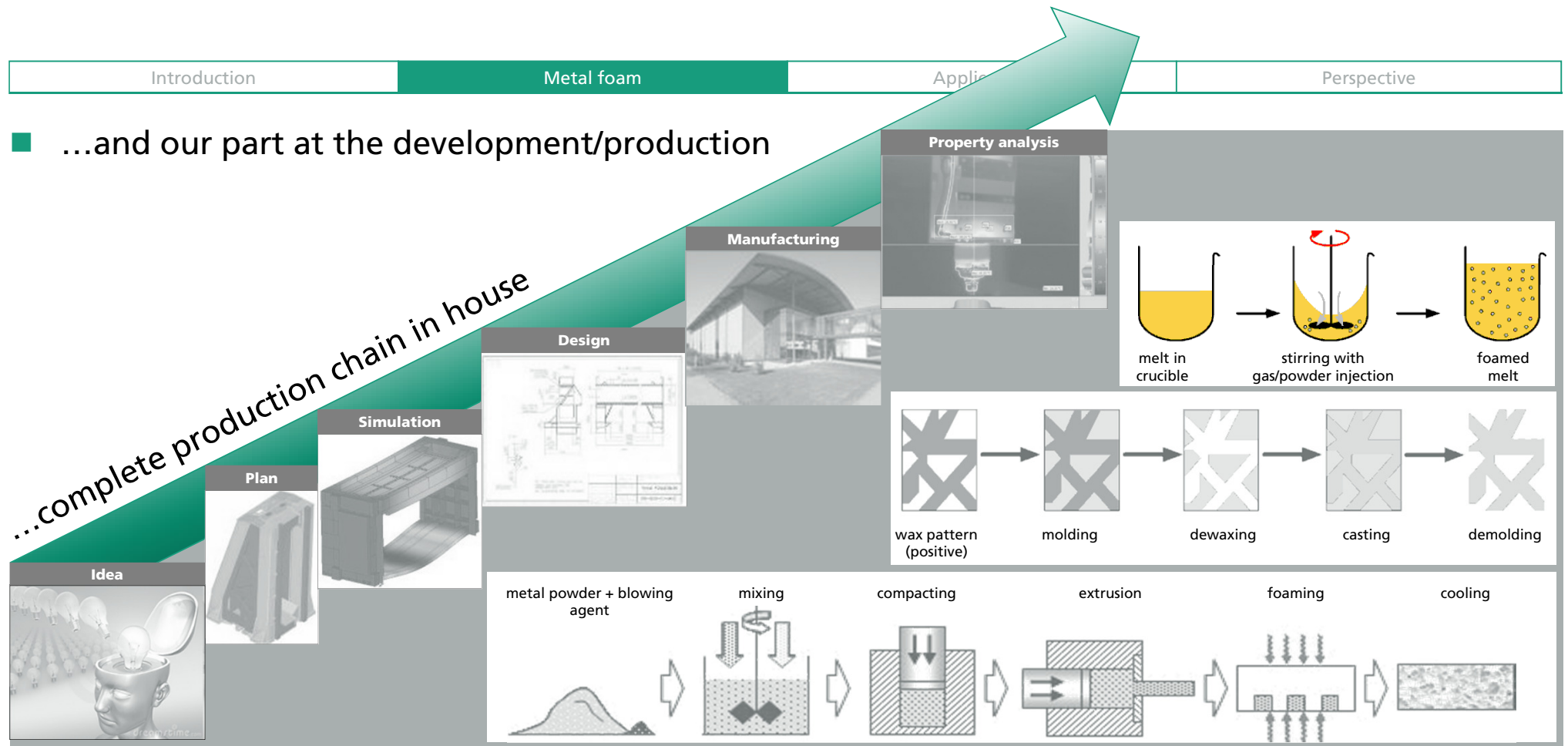


Bending resistant

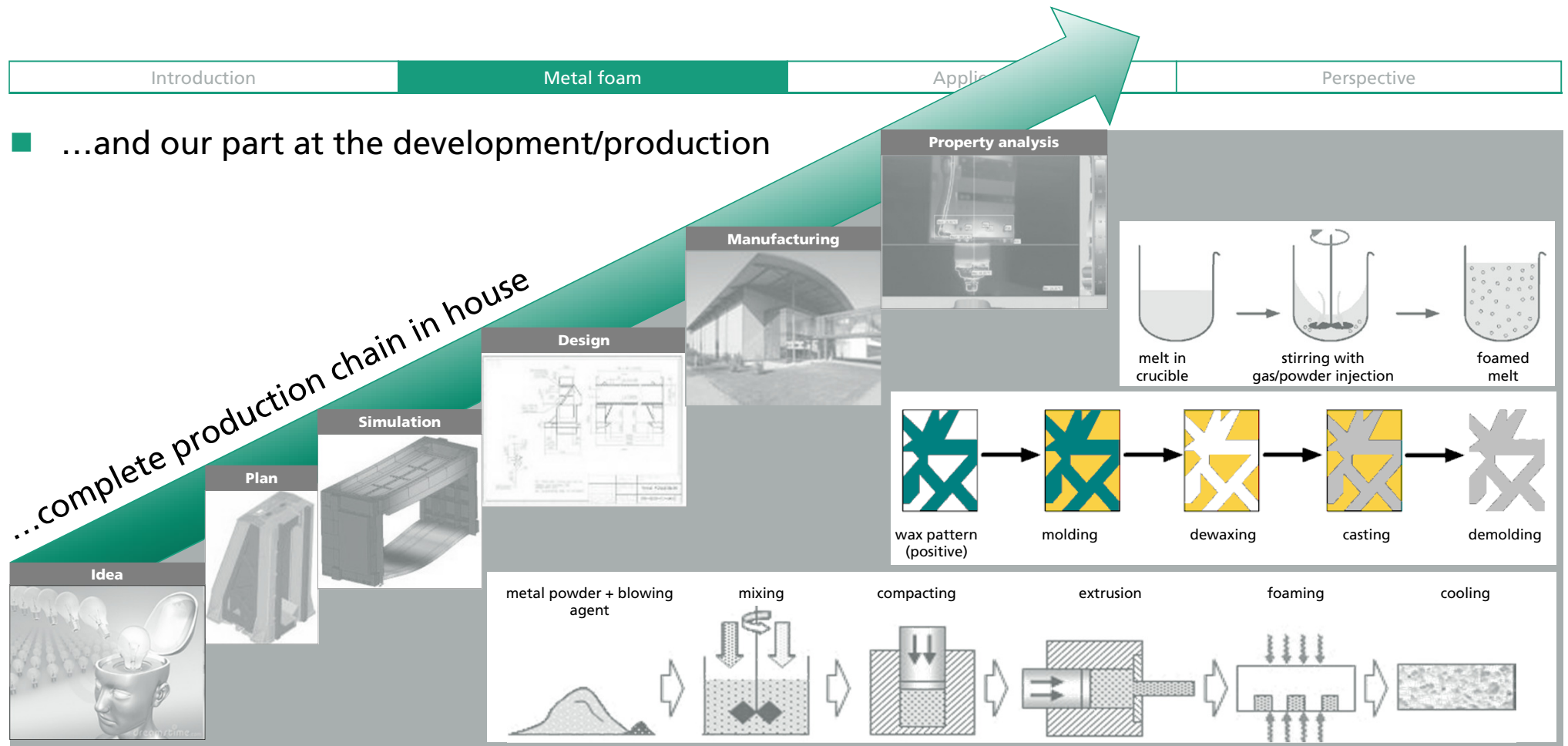
Conventional Metal Foam production (and our part)



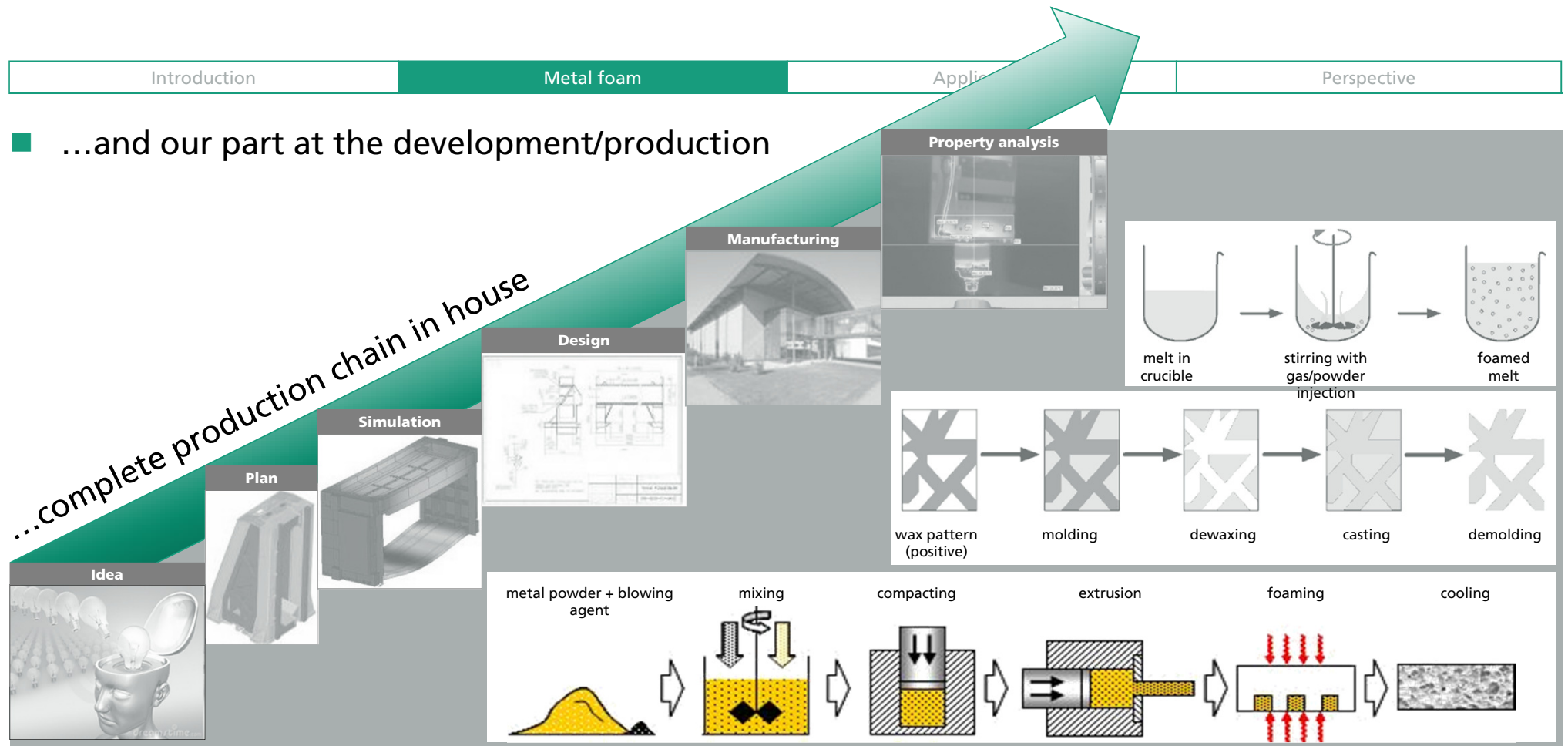
Conventional Metal Foam production (and our part)



Conventional Metal Foam production (and our part)



Conventional Metal Foam production (and our part)



Metal foam

Introduction

Metal foam

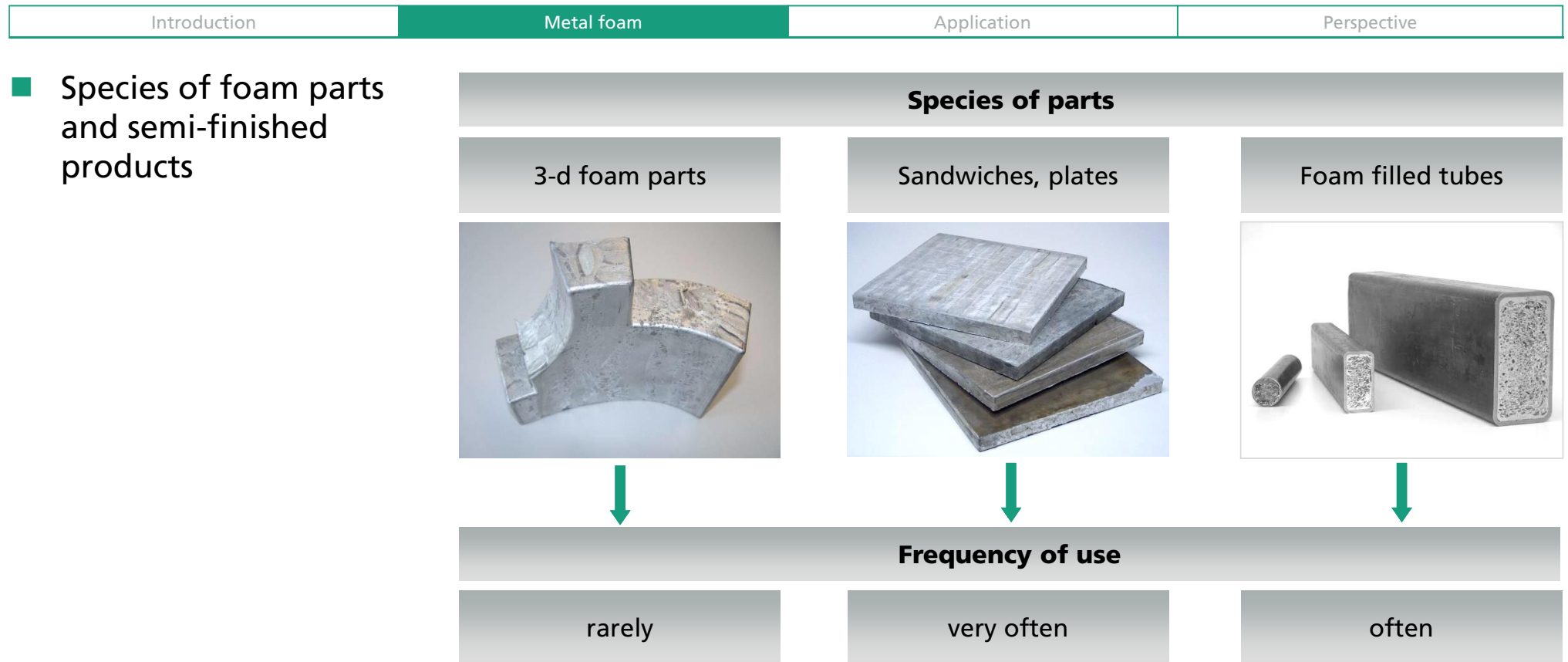
Application

Perspective

The foaming process:



Powder metallurgical process



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Machining of sandwiches

Introduction

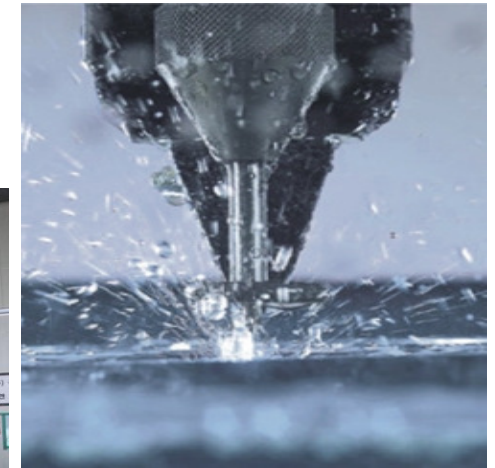
Metal foam

Application

Perspective

In general: Preferred working without cooling liquid (infiltrates into pores)

- Water jet cutting
- Laser beam cutting
- Sawing
- Milling and turning
- Drilling



Mounting

Introduction

Metal foam

Application

Perspective

■ ...by welding (of cover sheets)



WIG-weldseam AFS - AFS (source Karmann)



MIG-weldseam AFS - AFS (source Karmann)

Mounting

Introduction	Metal foam	Application	Perspective
■ ...by screwing and inserts ■ Using one or both cover sheets	 	 	  



Flaig+Hommel Gruppe

Mounting

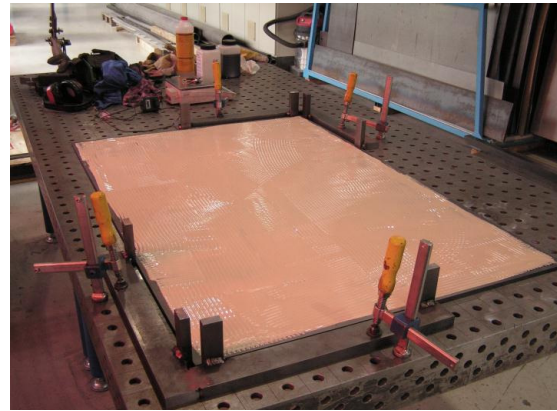
Introduction

Metal foam

Application

Perspective

- ...by gluing
- Foam core assembled
- Cover sheet size depending on application



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4-point-bending test

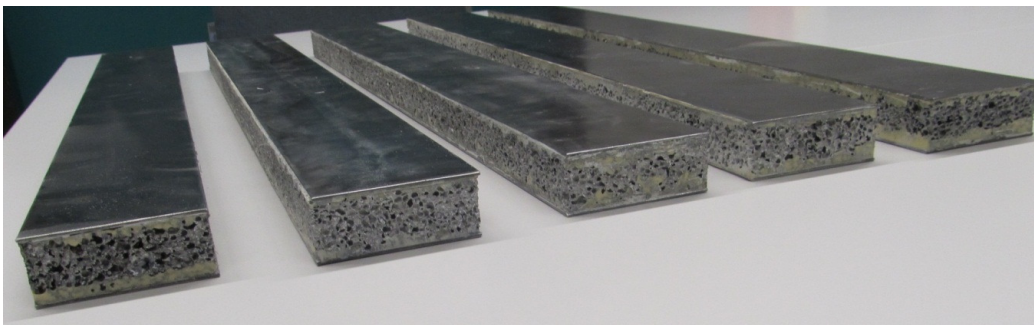
Introduction

Metal foam

Application

Perspective

- Glued steel-Aluminum foam-steel-sandwich
- Dimensions: 816 x 85 x 34 mm³
- Testing speed: $v_{\text{test}} = 10 \text{ mm/min}$
- Preload: 100 N



Bending test - results

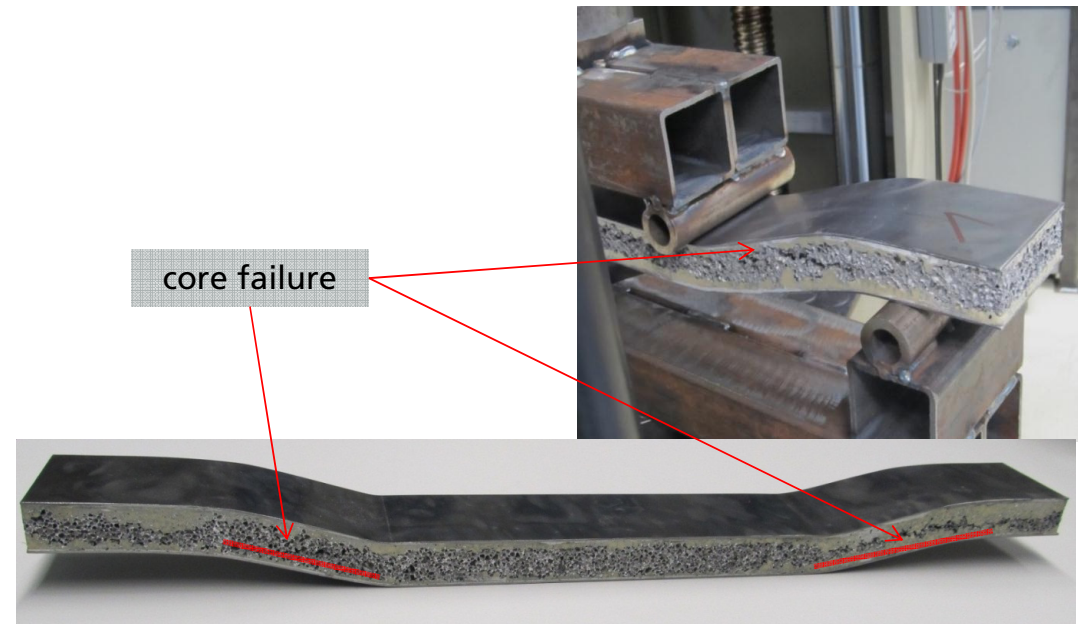
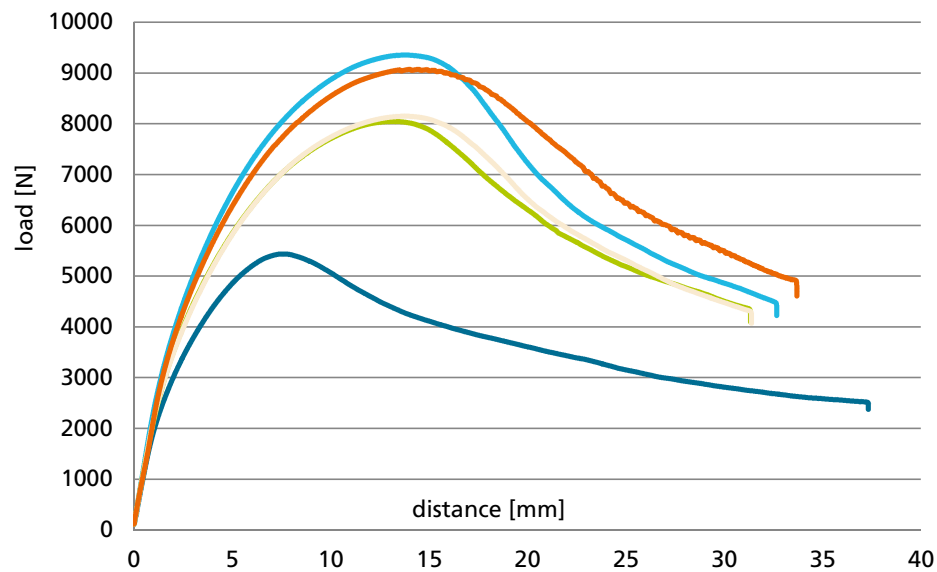
Introduction

Metal foam

Application

Perspective

- Samples after bending test: all samples show core failure on both sides



Drum peel test (DIN 53295)

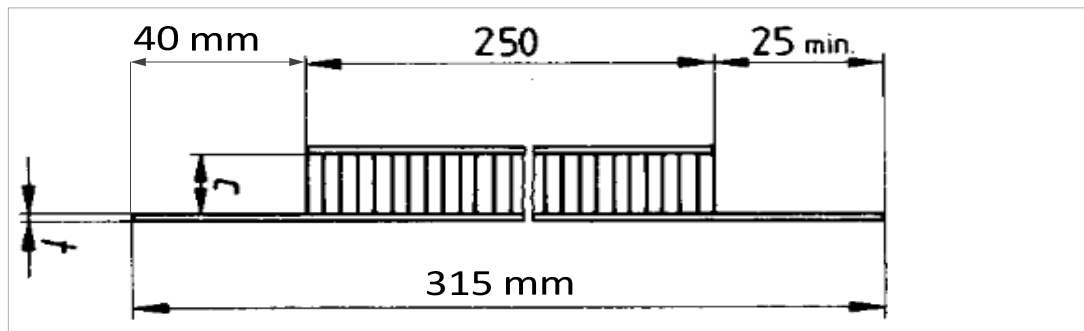
Introduction

Metal foam

Application

Perspective

- Glued and foamed SAS (steel/Aluminum foam/steel-sandwich)
- Dimension: 250/315 x 75 x 34 mm³
- Testing speed: $v_{\text{test}} = 25 \text{ mm/min}$
- Preload: 10 N



Drum peel test (DIN 53295) - results

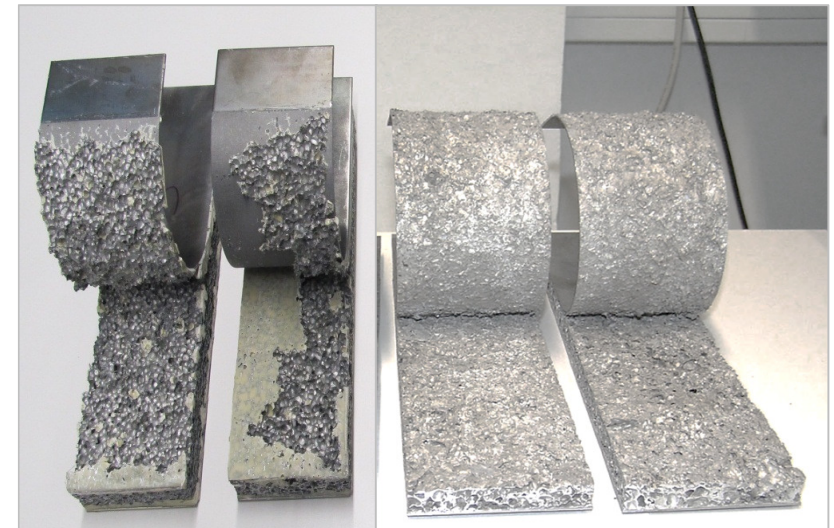
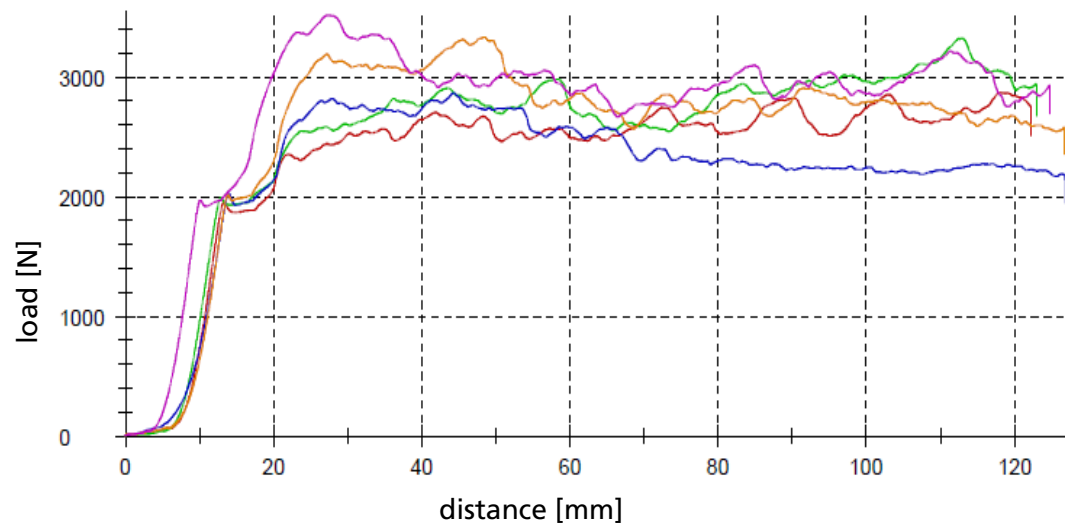
Introduction

Metal foam

Application

Perspective

- All samples with core failure



Tensile test

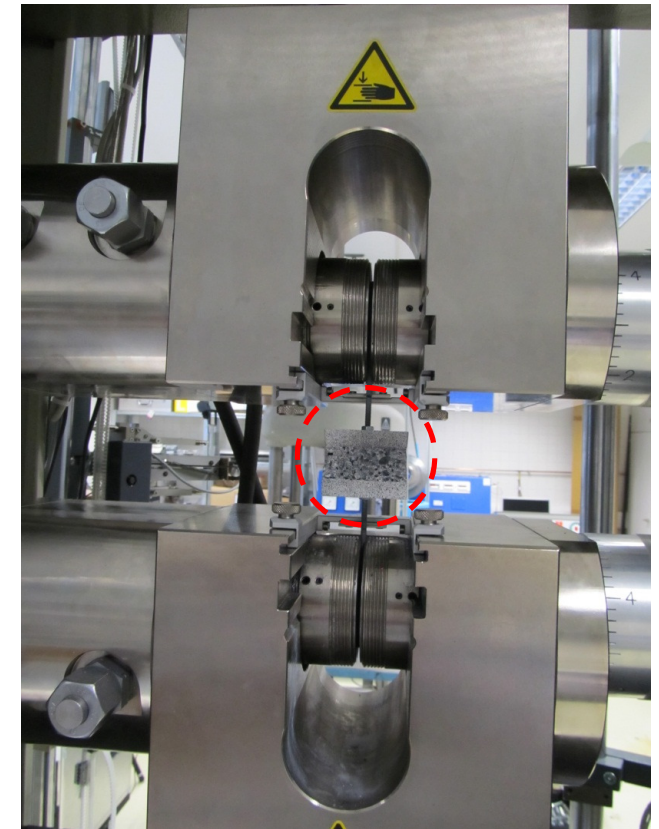
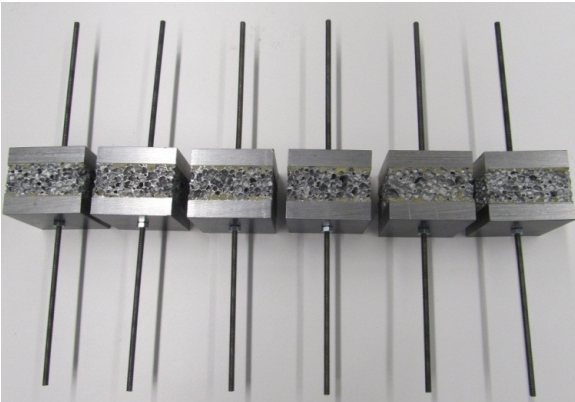
Introduction

Metal foam

Application

Perspective

- Glued and foamed samples of SAS-sandwiches
- Dimensions: 50 x 50 x 40 mm³
- Testing speed: $v_{\text{test}}=10$ mm/min
- Preload: 20 N



Tensile test - results

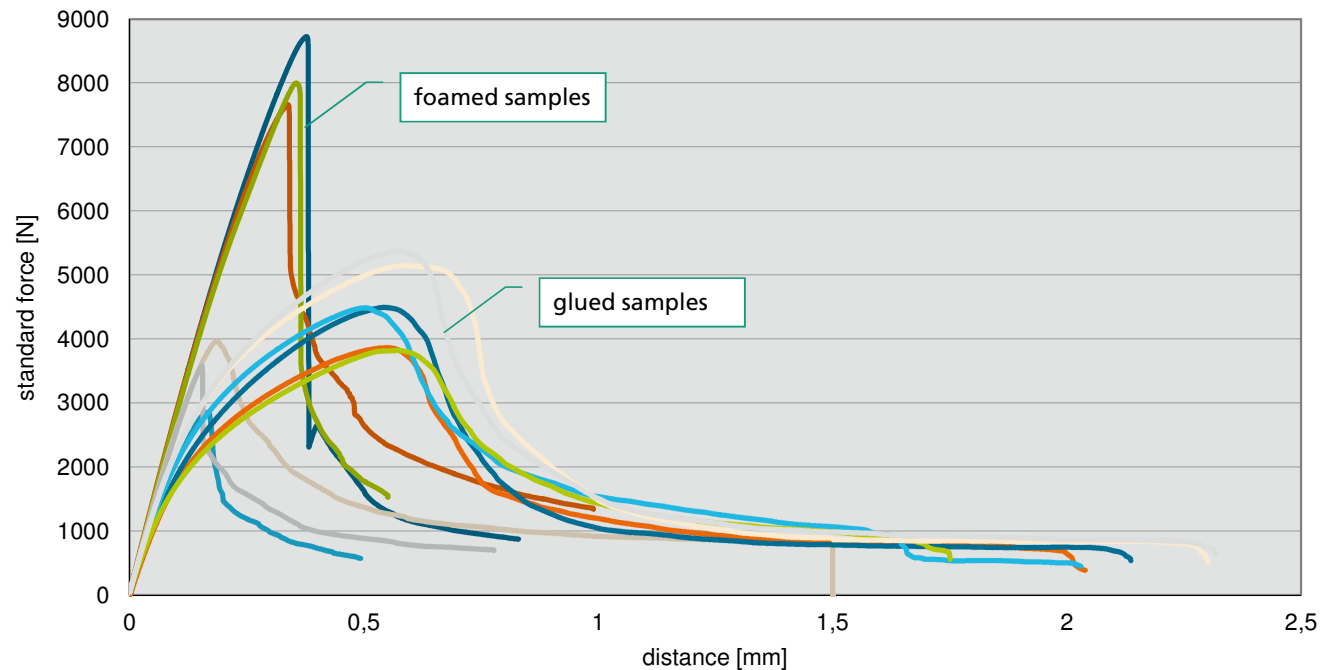
Introduction

Metal foam

Application

Perspective

■ All samples with core failure



Test sample – cooled ceiling panel

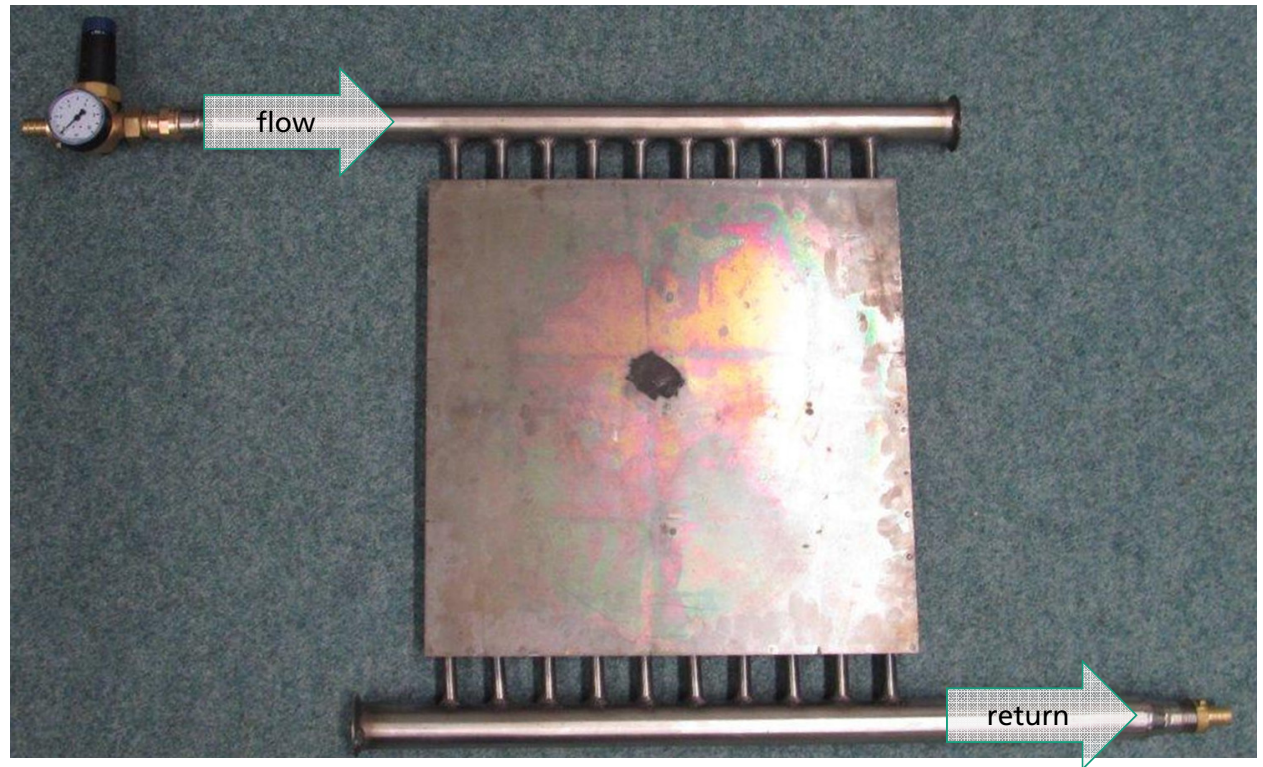
Introduction

Metal foam

Application

Perspective

- SAS – steel/Aluminum foam/steel
2 mm / 26 mm / 2 mm
- Stainless steel tubes Ø 10 mm



Test of thermal behaviour

Introduction

Metal foam

Application

Perspective

- Duration 213 min
- Temperature increasing up to 1100 °C
- Measuring by thermo couples (inside, outside, water temperature)



furnace

flow

sandwich

thermo couple

return

measuring

Thermal simulation

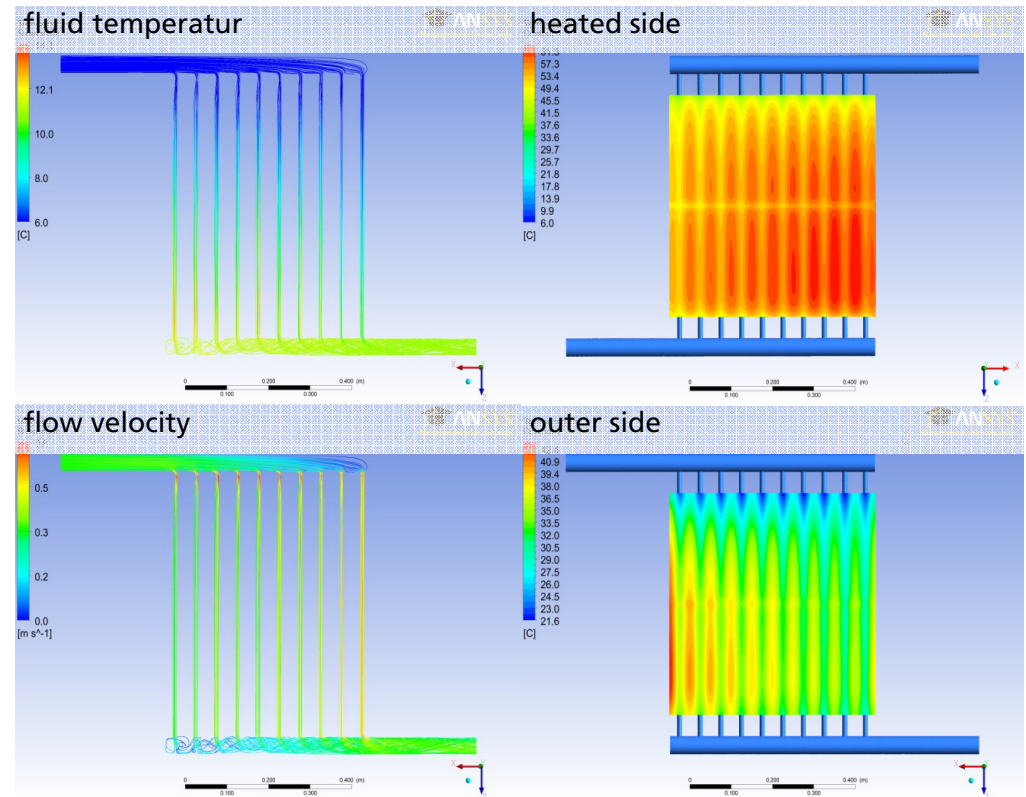
Introduction

Metal foam

Application

Perspective

- 25 l/min water at 6 °C;
- Heated side: convection with 100 W/(m²·K) at 410 °C
- Other surfaces: free convection with 5 W/(m²·K) at 20 °C ambient temperature
- Thermal conductivity of Al-foam 20 W/(m·K)



Burning test

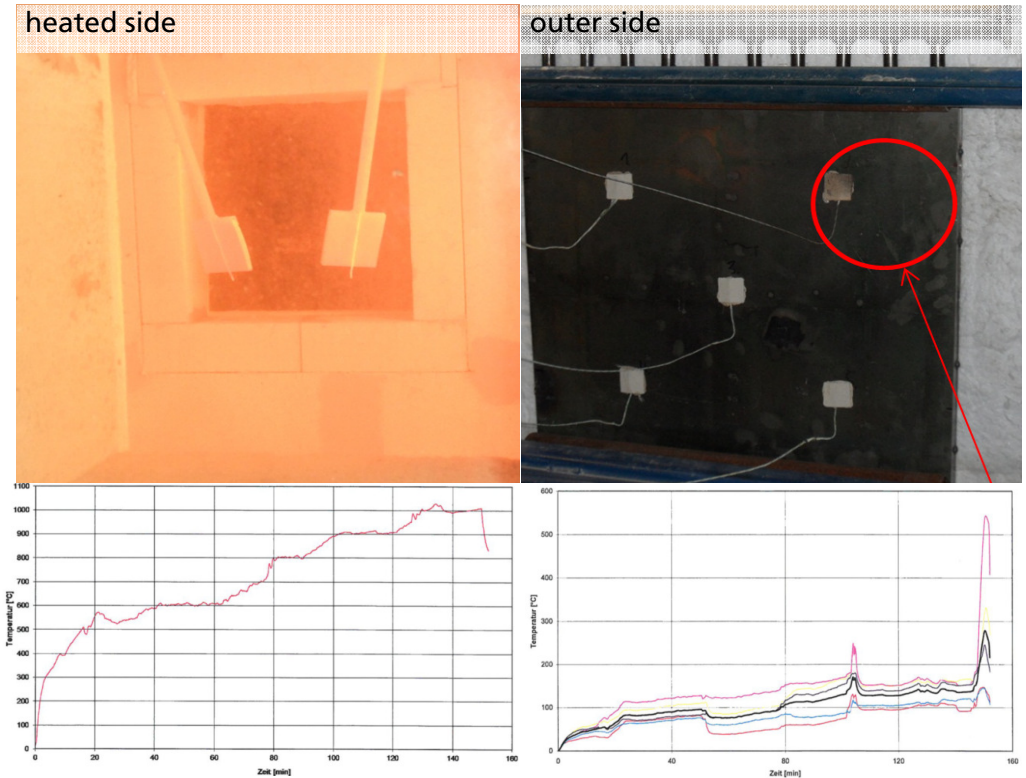
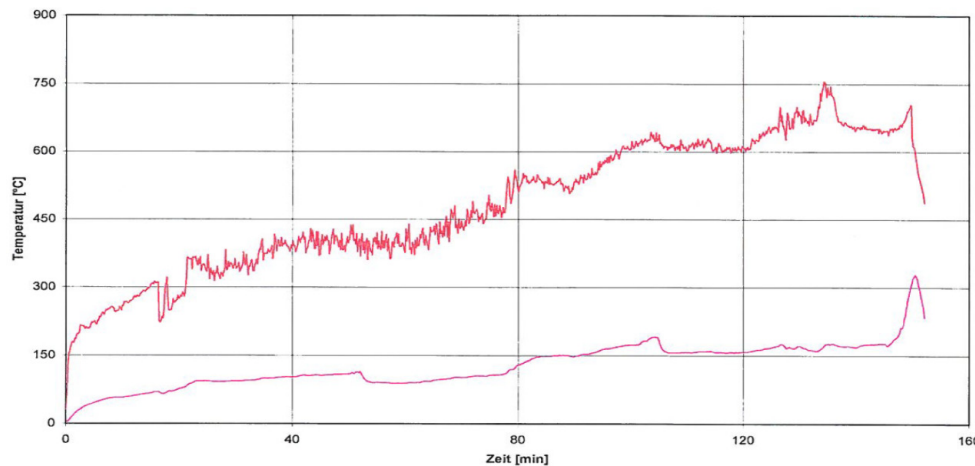
Introduction

Metal foam

Application

Perspective

- Gas fired furnace with panel installed in front
- Burning room temperature 1000 °C
- Test failed based at DIN-testing description because of hotspot above 180 °C



Burning test/heat transfer

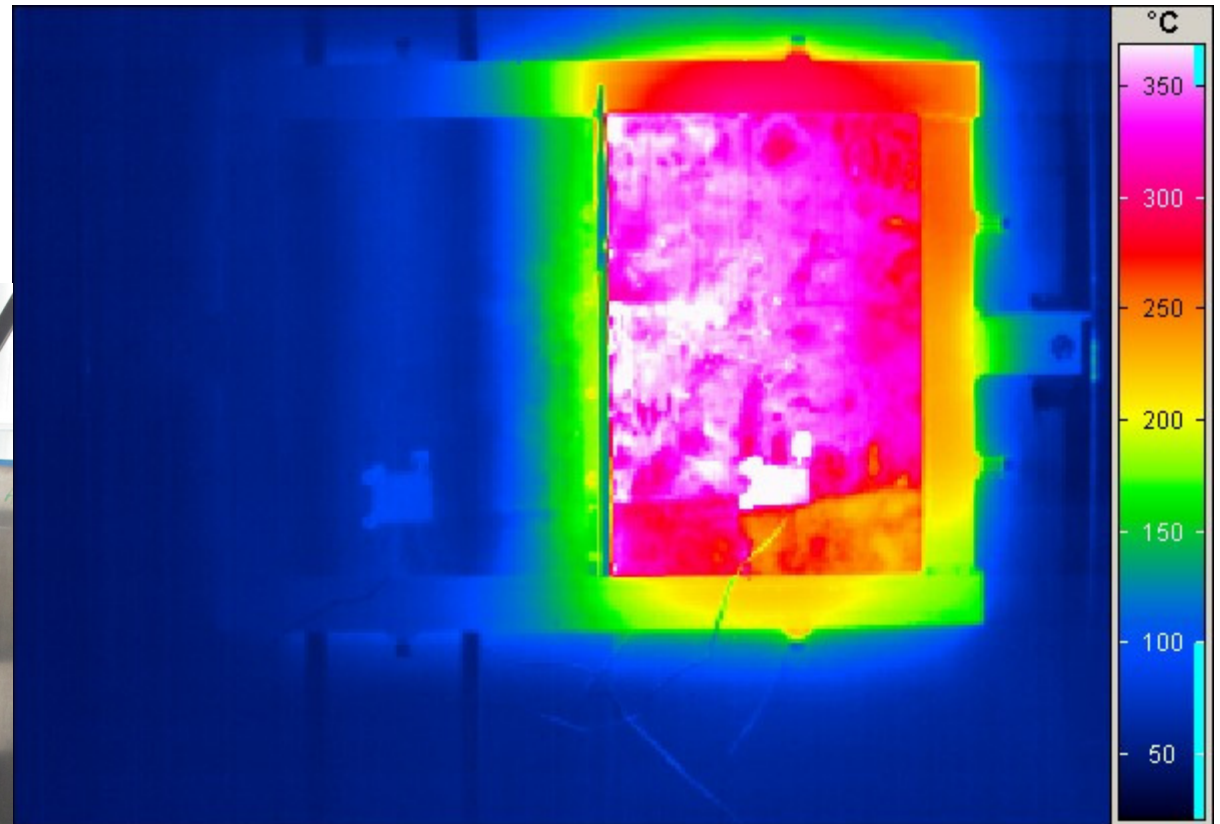
Introduction

Metal foam

Application

Perspective

- Furnace temperature 800°C
- Left sandwich water cooled
- Right sandwich uncooled



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Demonstrator balcony platform

Introduction

Metal foam

Application

Perspective

- Design: Panels made of aluminum foam-steel with rod-steel mesh in the boundary areas and mineral coating
- Advantages: low weight/ installation effort/material requirements, manual installation/upgrades of segmented design possible
- Use: steel construction with balcony plate



terms of delivery:
maximum dimensions

1500 mm x 1000 mm

Ceiling panel – pure Aluminum foam

Introduction

Metal foam

Application

Perspective

- Design: pure Aluminum foam plate (picture 600 x 600 x 10 mm³)
- Advantages: light, with traditional methods, machinable, noise dampening effect, aesthetic appeal
- Use: ceiling panel used for application indoors



terms of delivery:
maximum dimensions

1200 mm x 600 mm

Facade

Introduction

Metal foam

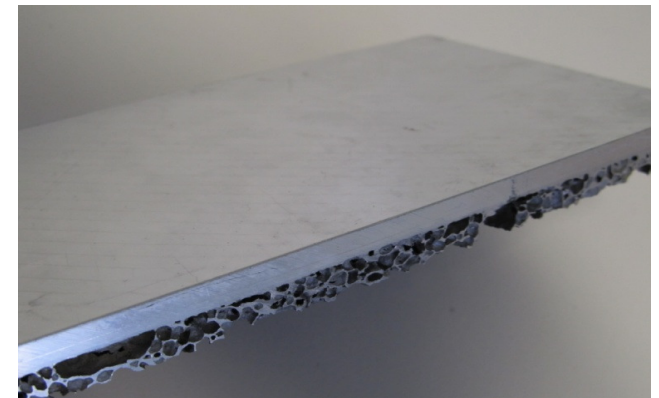
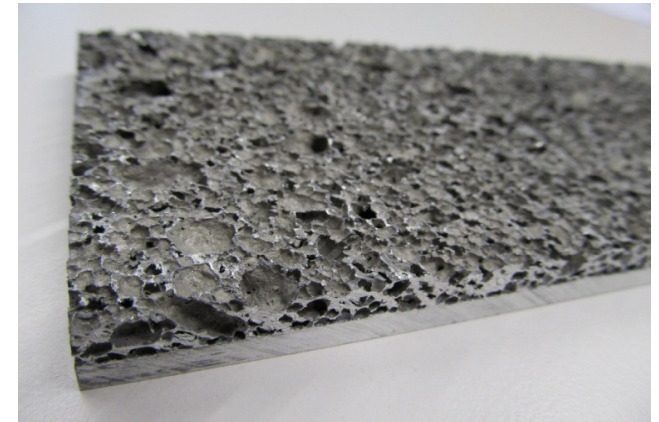
Application

Perspective

- Design: metallic compound between foam and Aluminum sheet
- Advantages: Aluminum sheet can be joined, processed (welding, drilling etc.) with traditional methods, attachment at solid side (screws, weld, studs etc.), foam at visible side
- Use: facade panels

terms of delivery:
maximum dimensions

2400 mm x 1100 mm



Aluminum foam with marble plate

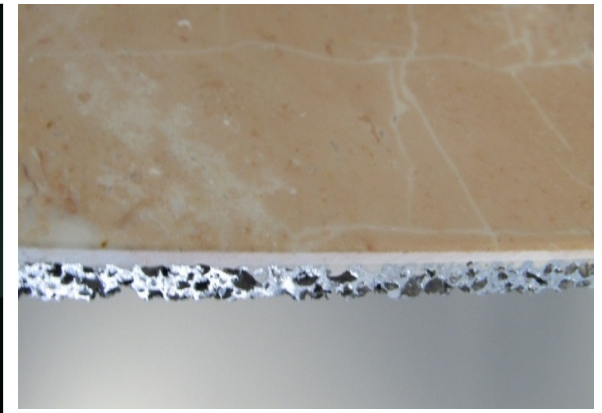
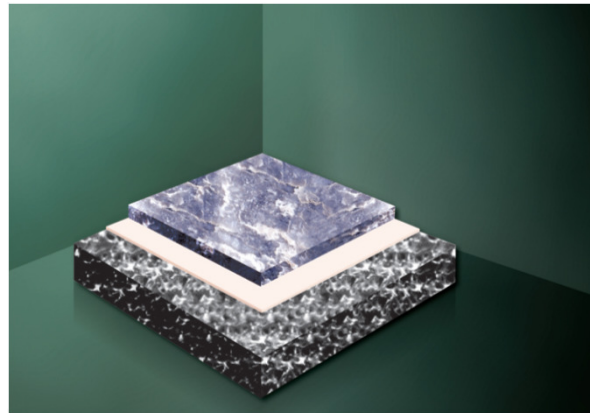
Introduction

Metal foam

Application

Perspective

- Design: Aluminum foam plate glued with marble tile
- Advantages: light, ultra thin, noise dampening effect, different surface design
- Use: covering on floors and elevators, decorative facade- and wall panel elements



terms of delivery:
maximum dimensions

350 mm x 350 mm

Acoustic absorbing panels

Introduction

Metal foam

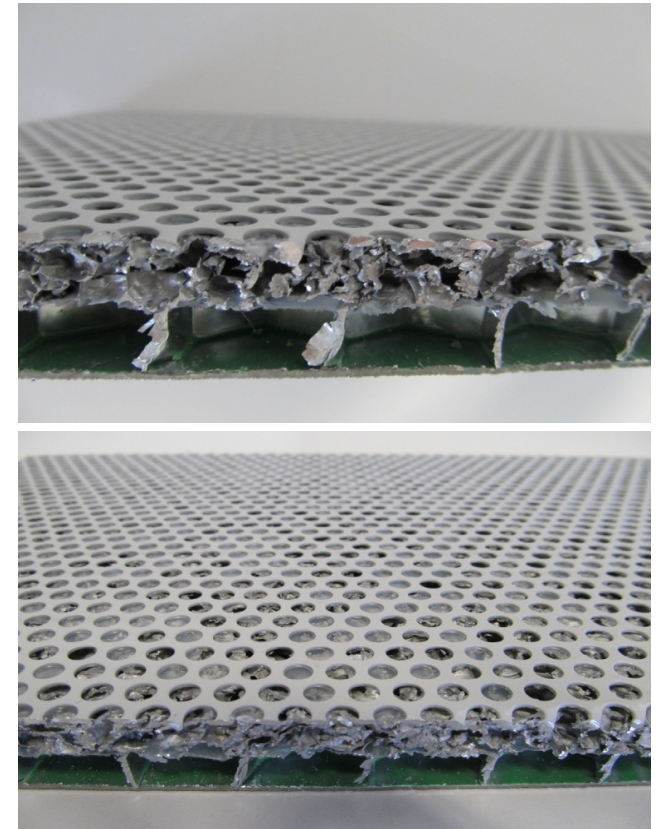
Application

Perspective

- Design: honeycomb structure with Aluminum foam plate, available with or without perforated plate
- Advantages: lightness of the material, easy to install, acoustic insulation
- Use: tunnel building, public buildings

terms of delivery:
maximum dimensions

1200 mm x 600 mm



Ceiling panel SAS (steel/Al-foam/steel)

Introduction

Metal foam

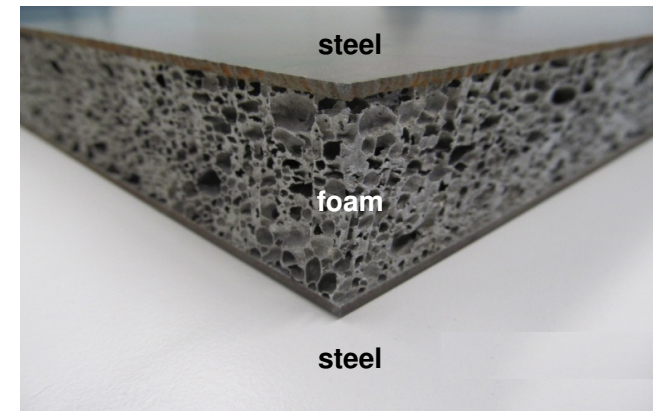
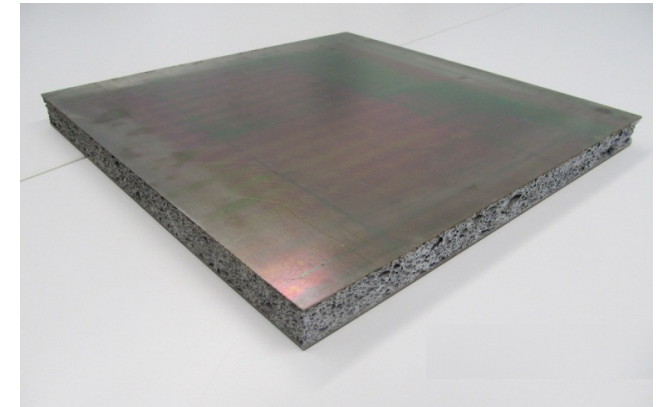
Application

Perspective

- Design: sandwich with Aluminum foam core and steel cover sheets
- Advantages: light, high bending stiffness, temperature resistant, metallic compound between the single layers
- Use: car park ceiling as a substitute for concrete ceilings

terms of delivery:
maximum dimensions

2500 mm x 1250 mm



Thermal storage

Introduction

Metal foam

Application

Perspective

- Design: Aluminum foam panel infiltrated with phase change material (PCM)
- Advantages: heat storage, reduction of thermal peaks
- Use: thermal storage in ceiling panels



terms of delivery:
maximum dimensions

500 mm x 500 mm

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Architecture office

Introduction

Metal foam

Application

Perspective

- Front / Cladding
- Rear ventilated front of the
- North-, East- und Westside
- 126 m² Aluminum foam plates with
- Dimensions 10 x 700 x 2400 mm³,
- Nailed to wooden plates with stainless steel and plastic nails
- No further coating
- Oxide layer of Aluminum as protection of advancing corrosion

Front of the apartment and industry house of the Architecture office Kochanowicz in Bochum



Congress center

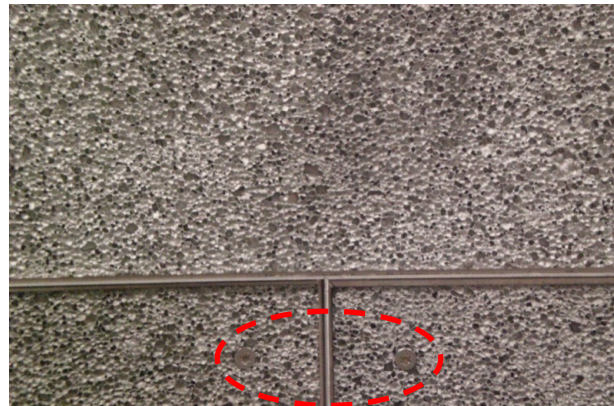
Introduction

Metal foam

Application

Perspective

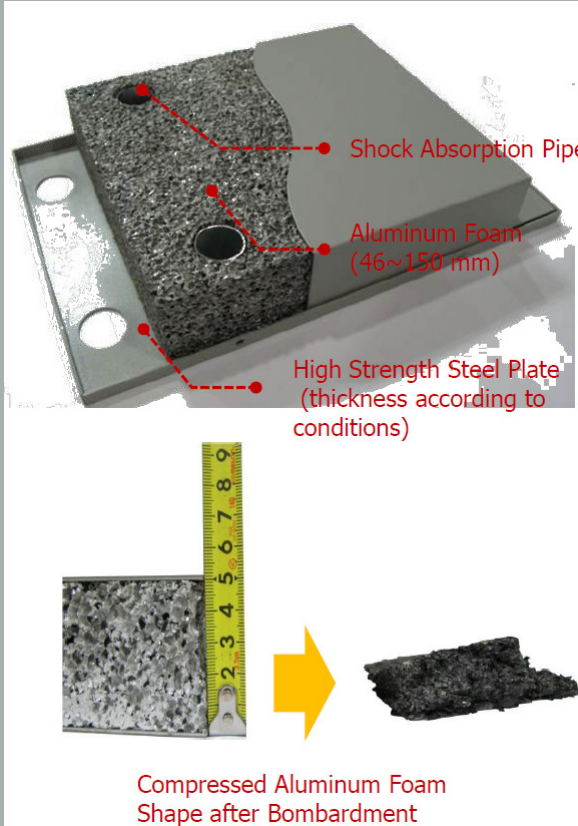
- Congress center in Spain (Mallorca)
- Simple fixation by screwing



Fh-IWU = partner and European distributor for Foamtech

Introduction	Metal foam	Application	Perspective
Company Name: Foamtech Co., Ltd. / Foamtech Global Co., Ltd. Established Date: March 2nd, 2001 Business: Foamed metal, blast mitigation panels, transportation material and others Location: Head Office: 1538-5, Younglim Bldg 4F, Seocho-dong, Seocho-gu, Seoul, Republic of Korea Factory 1: 1226-2 Naengcheon-ri, Oedong-eup, Gyeongju-si, Gyeongsangbuk-do, Republic of Korea (Area: 13,932m2, floor space: 3,564m2) Factory 2: Qinbi Industrial park, Hongdong County, Shanxi, China (Area: 33,043m2, floor space: 9,533m2) Factory 3: Doha, Qatar, to be constructed by 2014 			

Blast mitigation

Introduction	Metal foam	Application	Perspective
 Shock Absorption Pipe Aluminum Foam (46~150 mm) High Strength Steel Plate (thickness according to conditions) Compressed Aluminum Foam Shape after Bombardment	► Blast Mitigation Panel Structure (In case of 50 mm thick) ▪ Front : 1.6 mm thick high strength steel plate ▪ Middle: 46.8mm thick aluminum foam ▪ Rear: 1.6 mm thick high strength steel plate ► Blast Mitigation Panel Benefits ▪ Outstanding absorption of physical shock from bombardment ▪ Ultra-light with core density of $0.20 \sim 0.30\text{g/cm}^3$ (A metal that can float on water) ▪ Easy to work, and shortened work period ▪ 100% nonflammable and EMP shield – prevention of flame damage		

Alustone

Introduction

Metal foam

Application

Perspective

Ultra-light Natural Marble → Composite Aluminum Foam and Natural Marble

1,200mm
(max. 1,600mm)

600mm
(max. 1000mm)

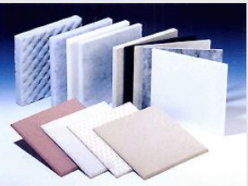
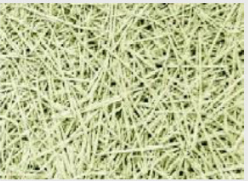
6mmT Aluminum Foam

3mmT Natural Marble /
Tolerance: ± 0.5mm

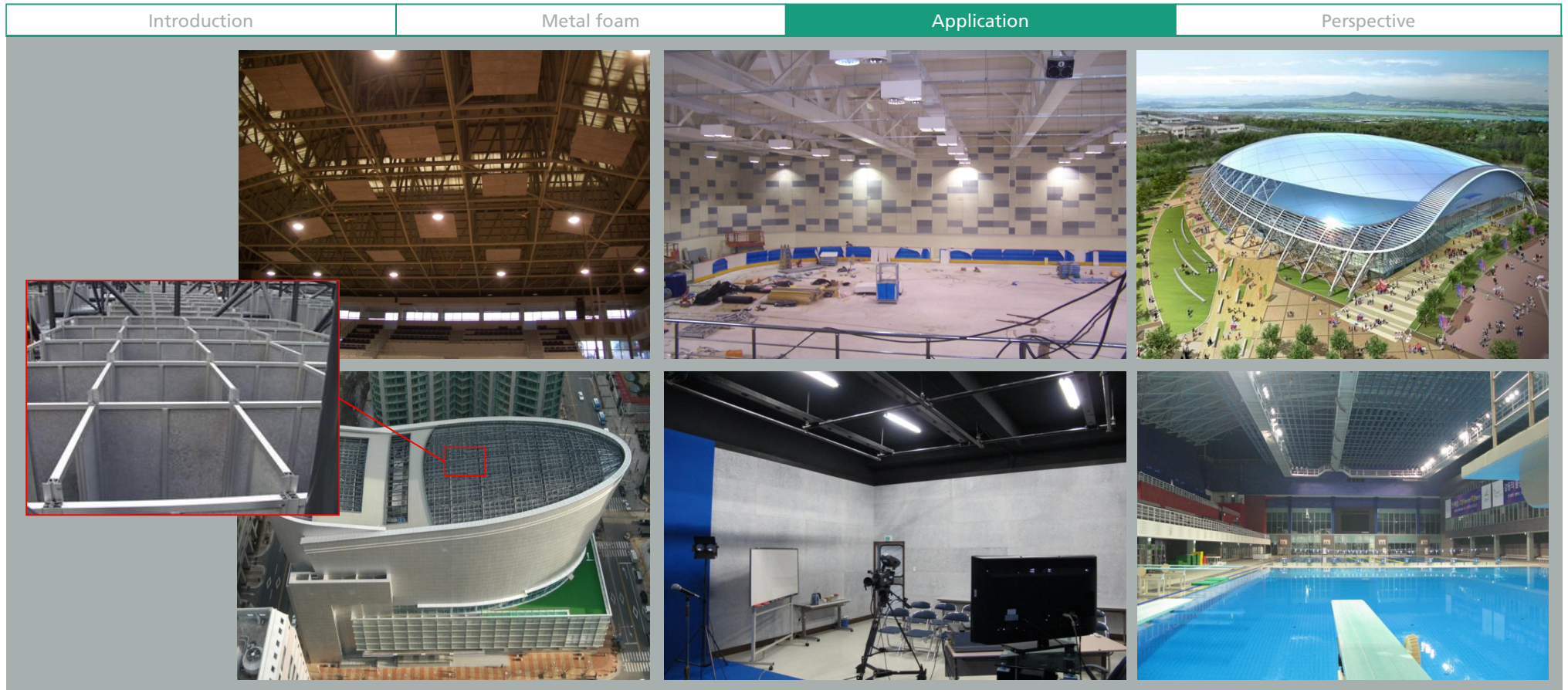
Bianco Carrara	Aristone	Arabescato	Mocha Cream	Botticino Classico
Crema Marfil	Marron Emperador Dark	Marron Emperador Light	Rojo Alicante	Sunny Beige
Rainforest Brown	Nero Marquina	Delicato Cream	Volakas	White Travertine
Beige Travertine	Yellow Travertine	Red Travertine	Rosso Verona	Brown Tini

Item	Alustone	Composite Marble Panel	Natural Stone
Weight in kg/m ²	11.5	25 ~ 28	54
% Relative to Natural Marble	21	46 ~ 52	100

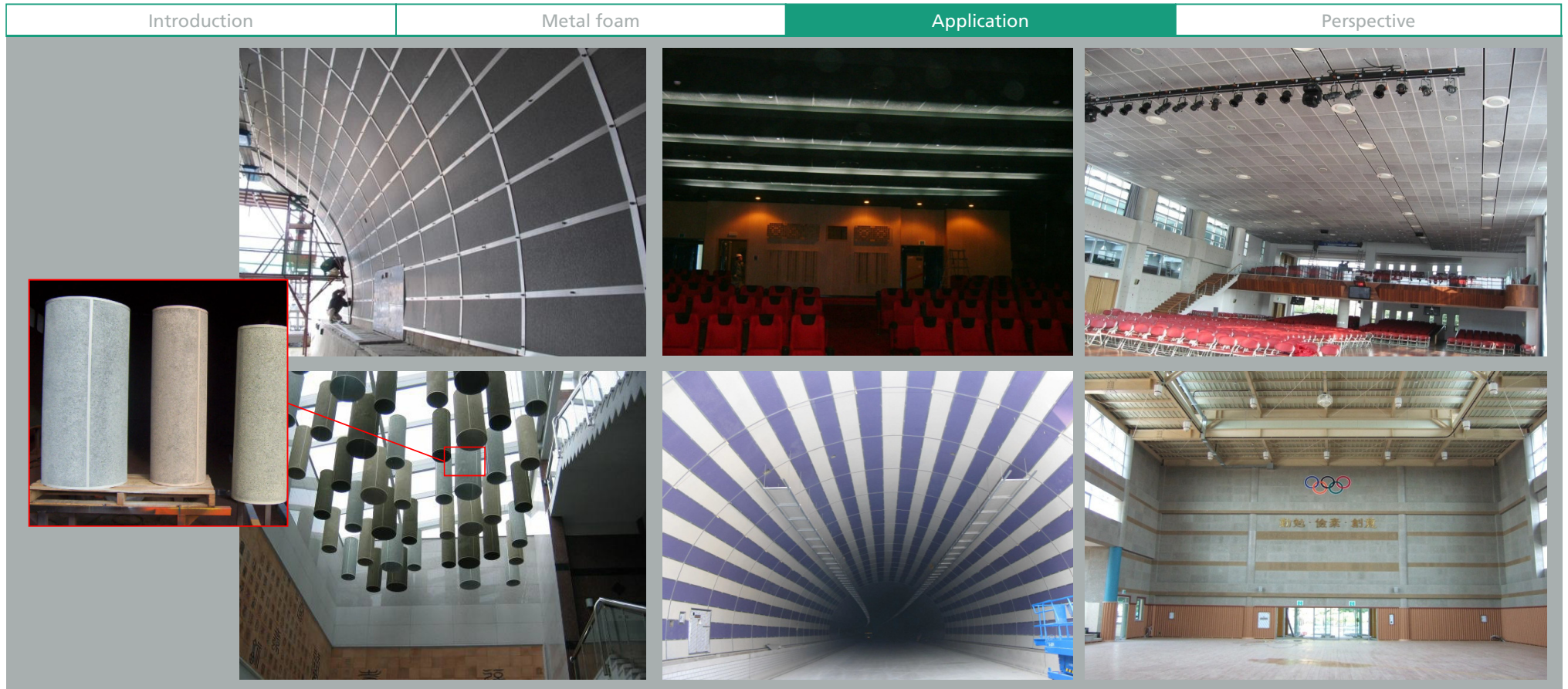
Acoustic Absorbent

Introduction		Metal foam		Application	Perspective
Item	Aluminum Foam	Polyester	Glass Wool	Wood Chip	
Shape					
Material	Aluminum	Polyester	SiO ₂ and Mineral	Wood and Cement	
Short Term Acoustic Absorptivity (NRC based)	0.6 ~ 0.7 or more	0.5~0.7 or more	0.6~0.7 or more	0.5 or more	
Long Term Acoustic Absorptance	Performance maintained	Performance decreased	Performance decreased	Performance decreased	
Eco-friendliness	100% Recyclable Eco-friendly	Not recyclable Easy to incinerate Generates small quantities of minute particles	Not recyclable Not incinerable Causes air pollution by scattering	Not recyclable Easy to incinerate	

Acoustic Absorbent



Acoustic Absorbent



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Open porous foams with PCM

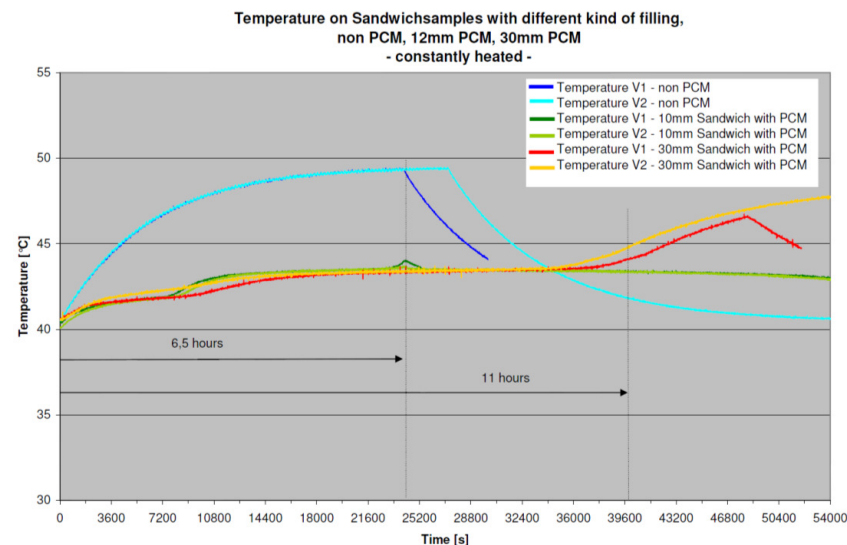
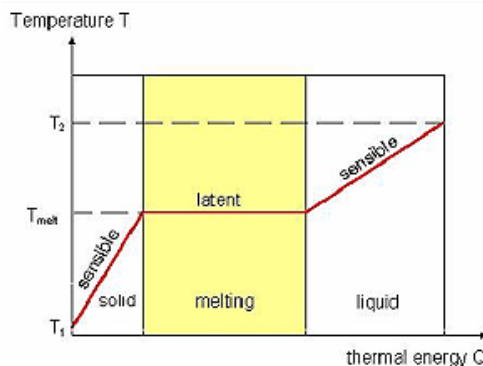
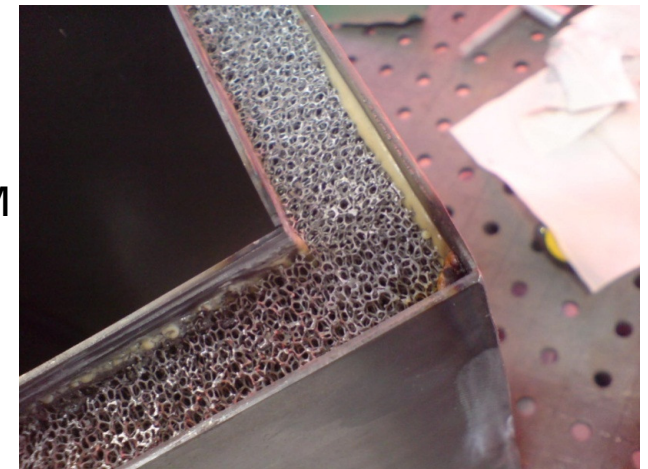
Introduction

Metal foam

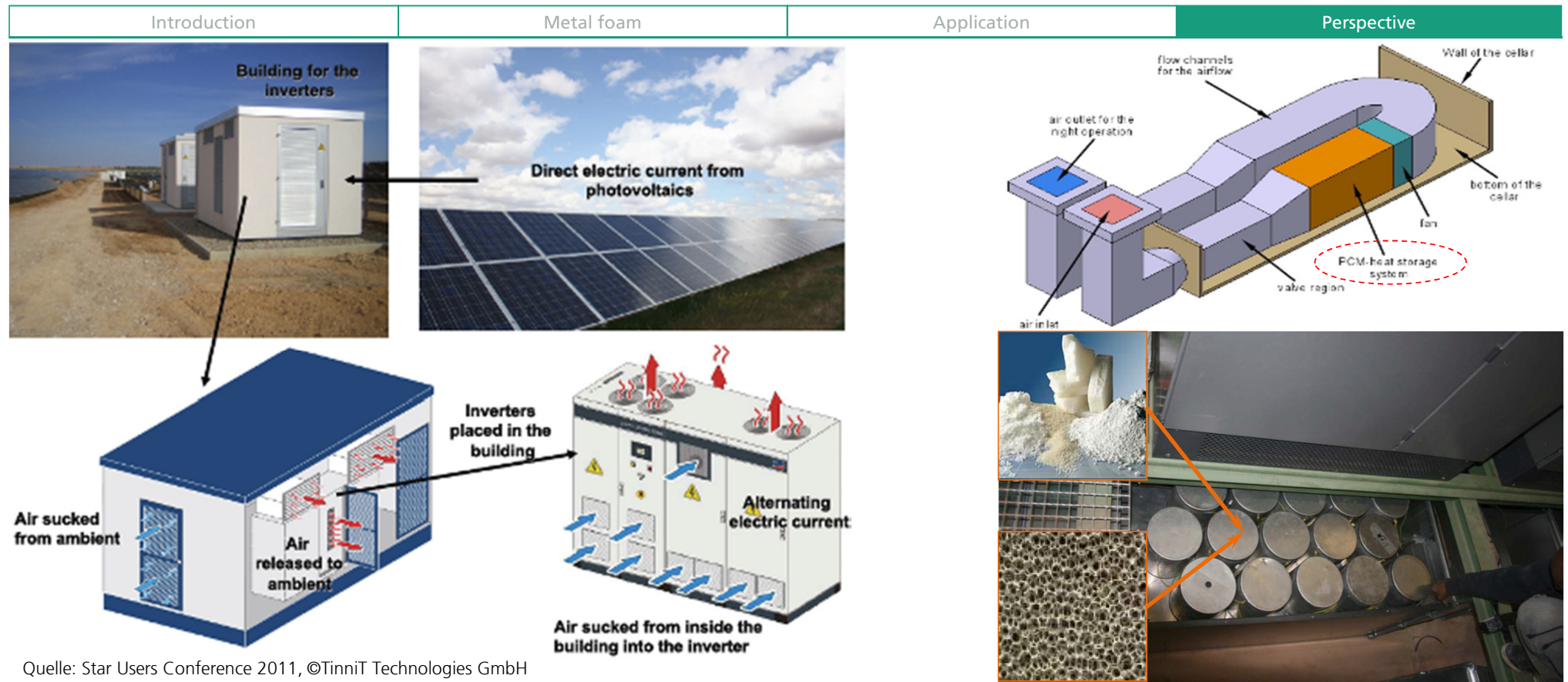
Application

Perspective

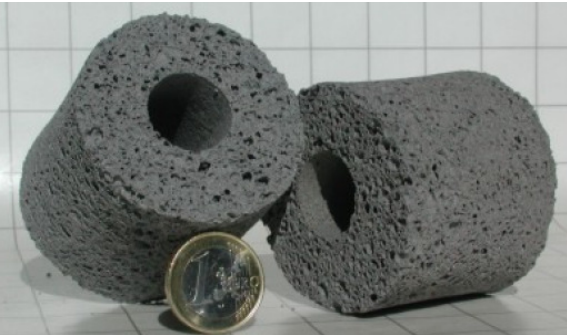
- Open cellular structure filled with PCM
- Climate control within ceilings or walls
- Equalises the temperature by controlled melting/solidifying of PCM



Open porous foams with PCM



Steel foam

Introduction	Metal foam	Application	Perspective
■ Project just started ■ Objective: heat and flame resistant foams ■ Aimed density: 1,5 g/cm³ at mechanical properties better than solid Aluminum ■ Field of application: machine tools, ship building and fire protection doors			  

Ideas of architects

Introduction

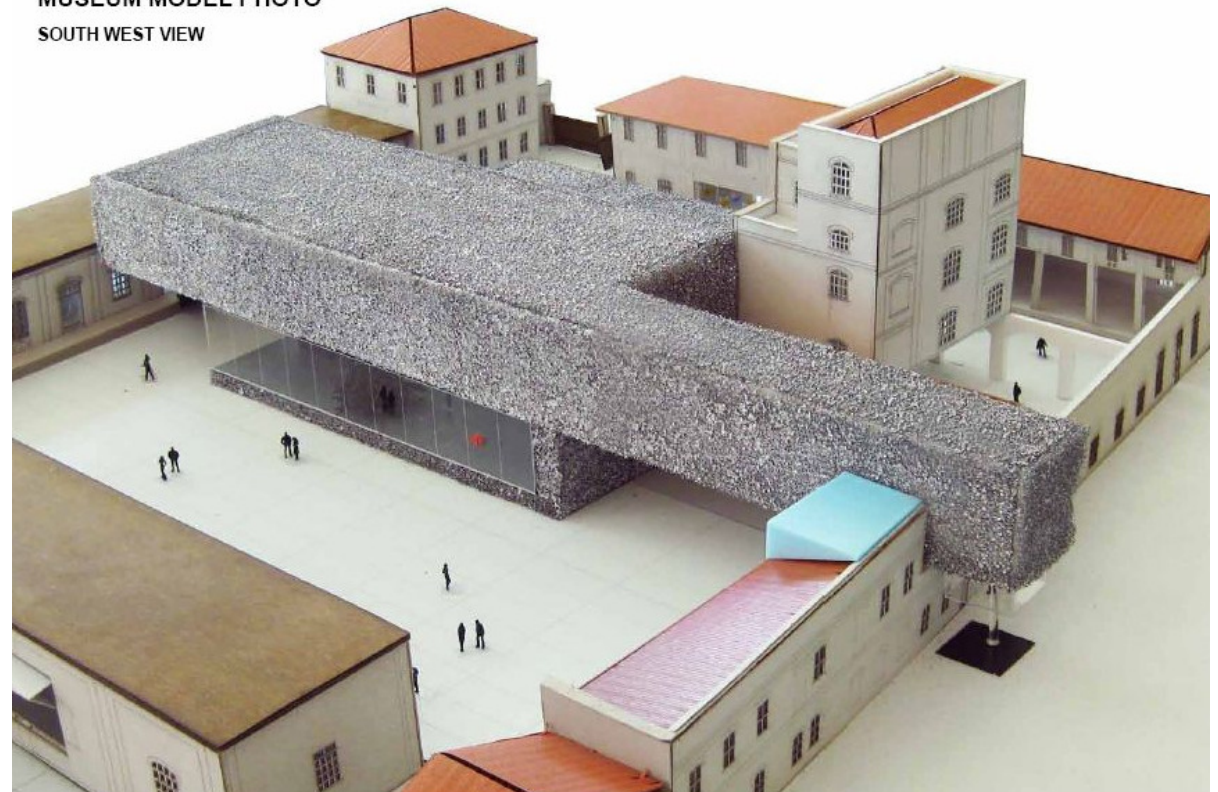
Metal foam

Application

Perspective

- Feasibility study done
- Quote for several thousand m²
- Status ...waiting for the order

MUSEUM MODEL PHOTO
SOUTH WEST VIEW



End

Introduction	Metal foam	Application	Perspective
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Thank you for your attention!

...for further questions:

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