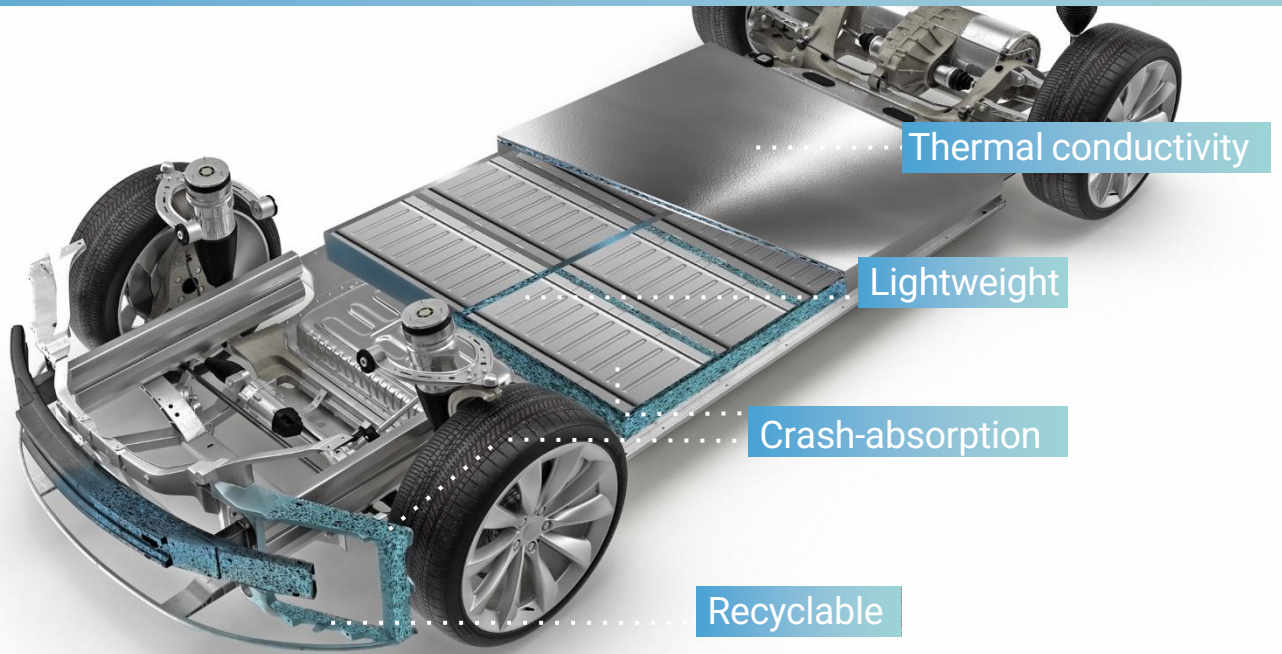
Havel metal foam

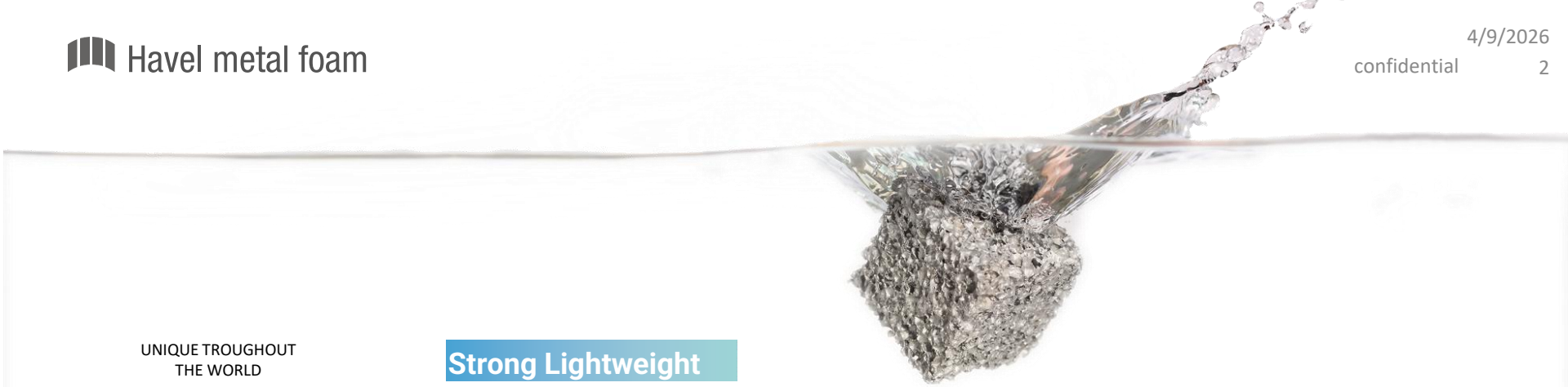
Strong lightweight
www.havel-mf.com

Thermal, Crash, and Vibration Protection for Batteries

Metal Foam Technology for an optimize protection and containment of lithium Ion Batteries



Sandwiches · Panels · Foam filled profiles · 3D shaped elements



UNIQUE TROUGHOUT THE WORLD

Series production
For 4 aluminum foam types

Strong Lightweight

With our Havel Lite ® series, Havel metal foam has specialised in the development and production of aluminum foam and aluminum foam sandwiches – a highly innovative lightweight material.

We have worked togehther with the Fraunhofer Institute for Machine Tools and Forming Technology to develop unique production technology that uses this modern material on an industrial scale. Innovative lightweight construction solutions can be realised for various sectors using the versatile Havel Lite® range.

Development | FEM calculation | Product solutions | Series production | Processing

Advantages of aluminum foam

Low weight

Our 2+1 advantages

+

Excellent mechanical durability

The product has a number of advantages

- Non-falmmable, fulfils the protection standard (DIN EN 45545-2)
- Can be welded
- 100 % recyclable

- Excellent vibration-damping behaviour
- Noise-absorbing
- Good electromagnetic shielding
- Can be repaired

- Further mechanical processing to carry out (drilling, sawing, milling, welding)
- Various alloys possible
- Foam-filling possible for components (SAS only)

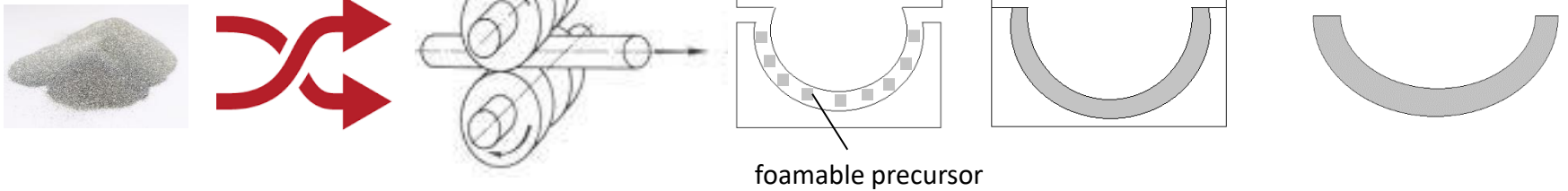
- Noise protection and insulation
- Energy absorption/ good crash behaviour
- Vibration reduction

- Metallic bonding
- Radiation-shielding
- Integration of tubes for cooling and heat circulation

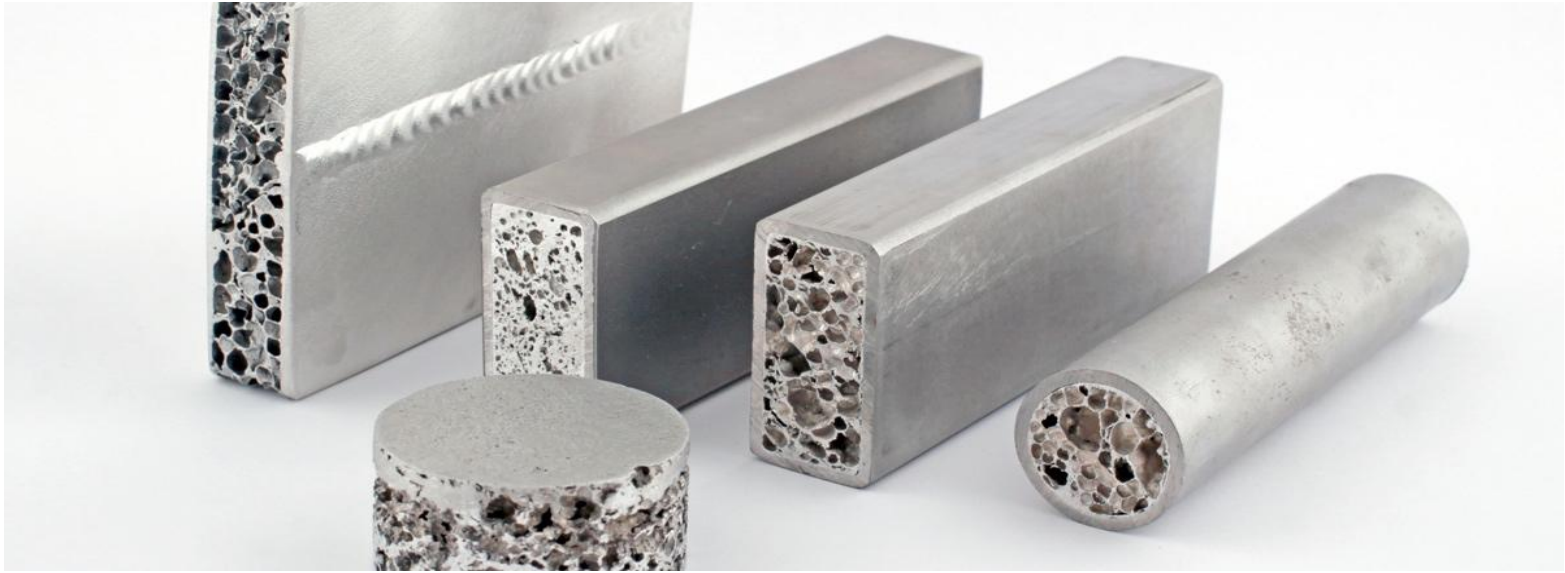
=

New and cost-efficient solutions for lightweight construction made of aluminum

Powder metallurgical manufacturing of HavelLite®



Al-powder + foaming agent → mix → rolling → Cuting and placing of foamable pre-cursor → foaming → Demolding and cooling down

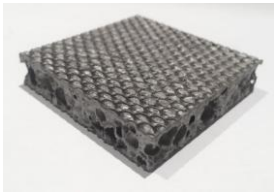


Product solutions

Sandwiches | Panels | Foam-filled profiles | 3D formed parts

Havel Lite® AFP

Pure aluminum foam panel with cast skin as outer layer



Steel wire mesh improves the tensile strength of the foam

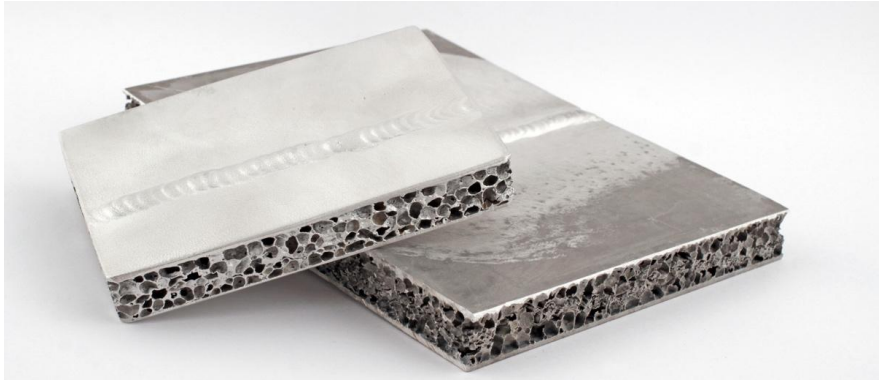
Very high Aluminum foam panel

Coated Aluminum foam panel

Pure Aluminum **F**oam **P**anels

- Manufacturing from a height of a few millimeters up to a thickness of 75 mm possible
- Aluminum foam panels with steel mesh inserts are very tensile and less brittle
- Lighter than sandwiches and far more favorable than e.g. carbon

Havel Lite® Sandwiches



Welded aluminum foam sandwiches

Aluminum-**A**luminum foam-**S**andwiches

AAS

Havel Lite® Aluminum foam
with aluminum sheet cover layers

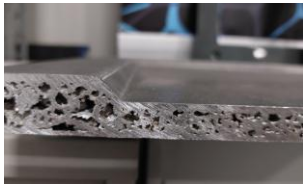
Steel-**A**luminum foam-**S**andwiches

SAS

Havel Lite® Aluminum foam
with steel sheet cover layers

Production technology:
directly embedded fasteners

Processing options:
Drilling, Welding, Milling



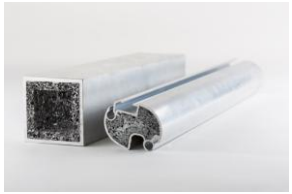
3D-shaped sandwich:
Thickness variation in one plate

- Metallic bond
- Non-flammable
- 100% recyclable
- Repairable
- Strong vibration damping
- Different alloys / coatings possible
  (e.g. paint, high-pressure laminate, wood)
- Embedding of fasteners, rails or threaded inserts
  (only with SAS)
- Copper sheet cover layers are also possible

Havel Lite® Foam-filled profiles

Foam-filled steel profiles

Foam-filled profiles Bending test



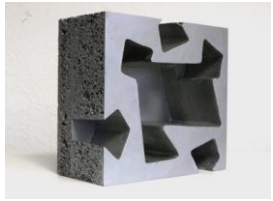
Foam-filled aluminum profiles

Foam-filled steel profiles

- Excellent damping properties, while reducing weight
- Filling of profiles and cavities with metal foam
- Improved vibration damping properties for fast moving components
- Higher accuracy and speed during further processing

Havel Lite® 3D formed parts

Shock absorber element

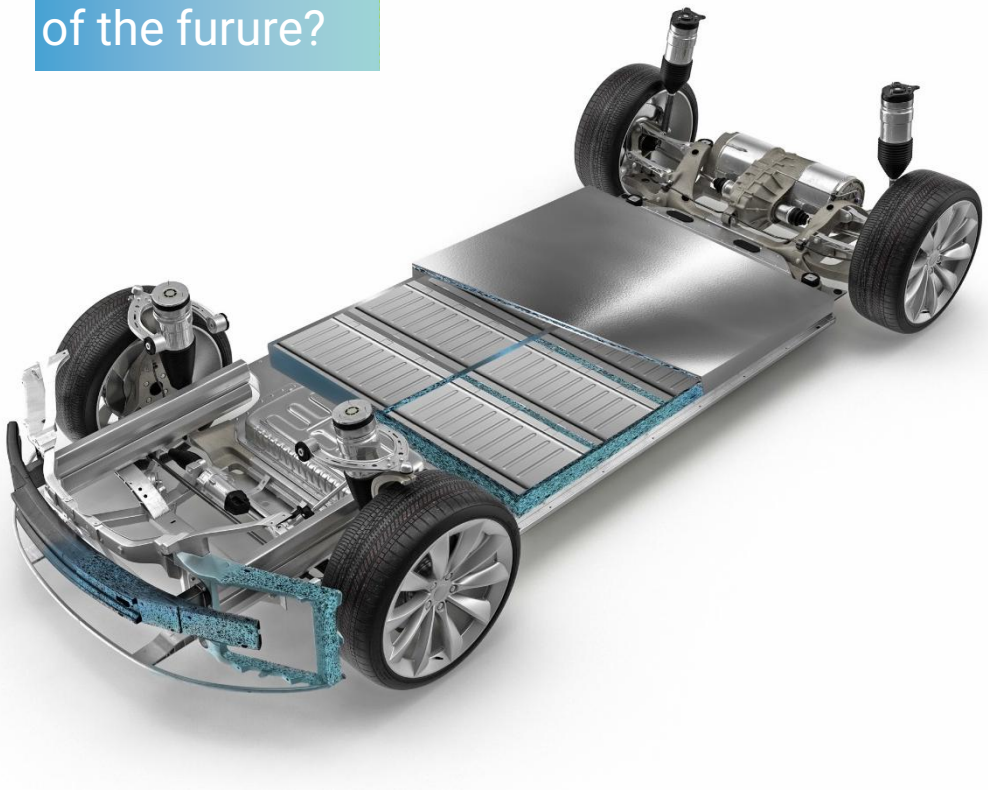


Drink holder

3D element

- Almost every geometric shape possible
- Non-flammable, no smoke
- Long lifetime
- 100% recyclable
- High energy absorption
- Good crash behavior
- Noise and vibration damping
- Extremely light
  with densities of approx. 0.7 g / cm³

Battery box
of the furure?



Made of aluminum foam for the automobile industry

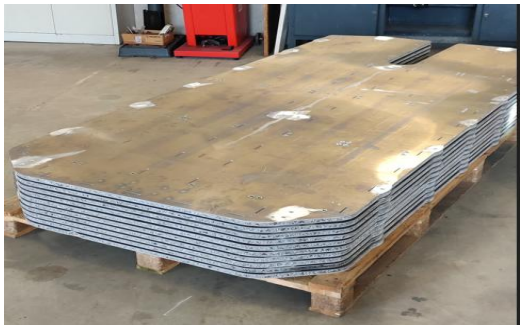
The use of lightweigt components is increasingly gaining importance for the production of vehicles. Forward-looking developments of electrically driven vehicles only reach the efficiency goals through the consistent usage of extremely light materials such as aluminum.

Aluminum foam combines many advantages such as extreme lightness, formability, recyclability as well as amazing absorption and conductivity and is therefore ideal for the automobile industry of the future. A trendsetting development of the Havel metal foam is the battery box for electric vehicles. Low weight, good crash behaviour, high stiffness and possibilities for temperature regulation predestine these newly development vehicle components for use in modern automobile manufacturing.

Possible applications

Complete battery box

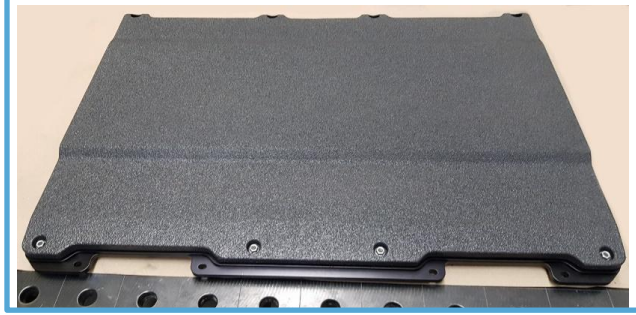
Active/passive thermal management

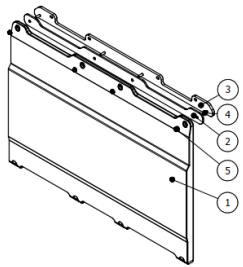


Underbody protection

Battery partitions

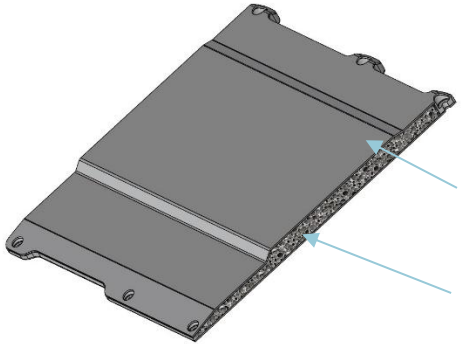
Possible applications: Side crash element





Boundary conditions for simulation

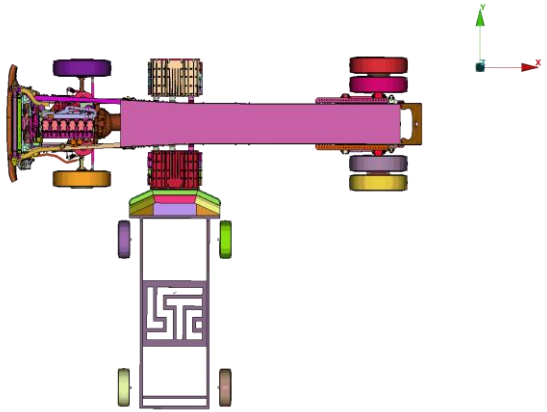
Loads from IIHS:	side impact
Impact velocity:	13.9 m/s
Impact angle:	90°
Total mass of barrier:	1500 kg
Resulting energy:	144.6 kJ



Sandwichplatte foamed in shape
→ Mounting holes drilled

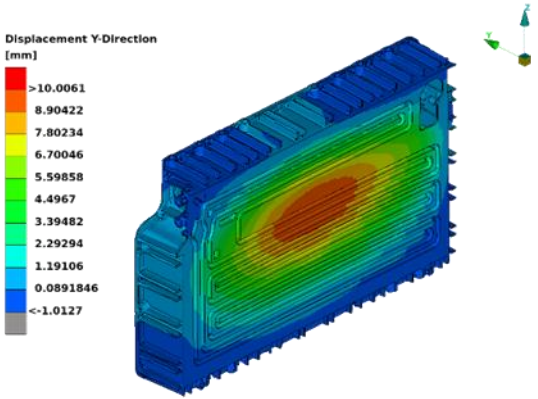
Cover sheets: 3mm EN AW-6082

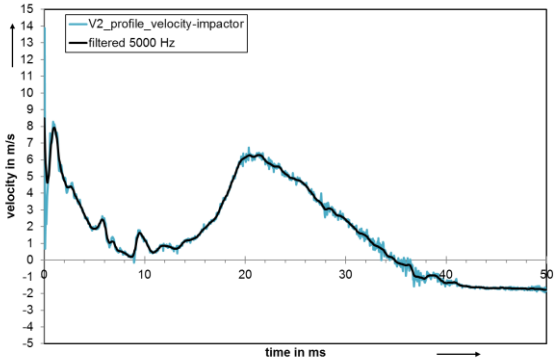
Core: Aluminum foam AlSi10

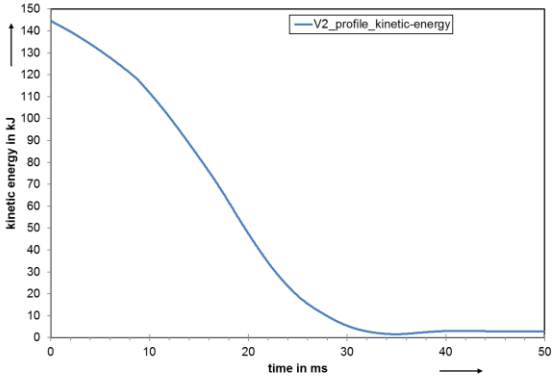


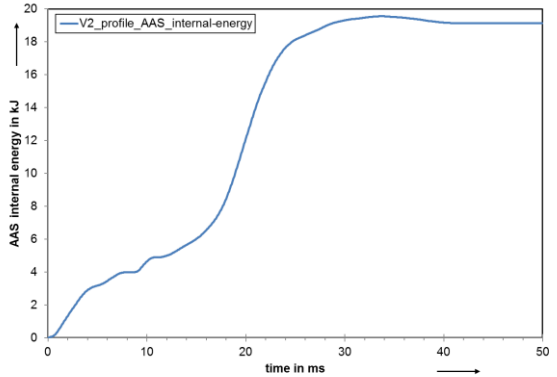
Simulation results

- Whole kinetic energy from impact transferred into the system
- Spring back of bumper
- Dissipated energy of AAS: 19,7 kJ
- Deformation of the battery housing within tolerance





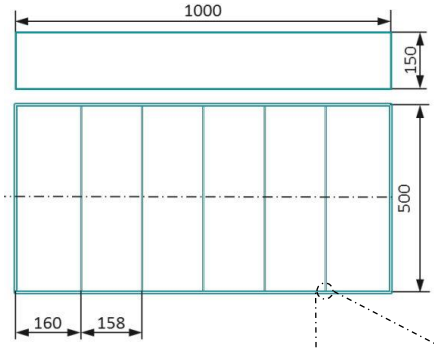




Possible applications: Side crash element

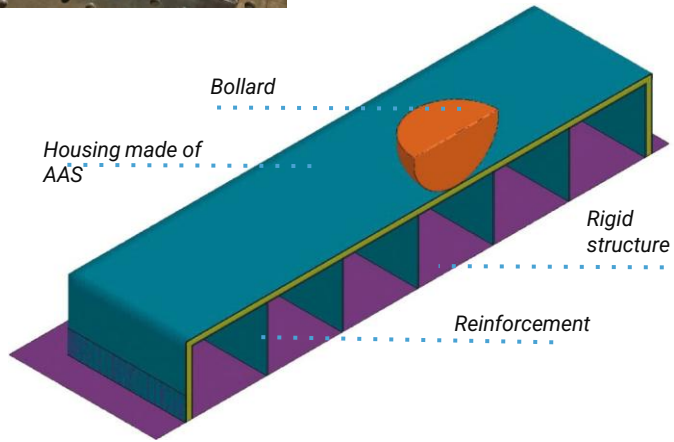
Physical impact test

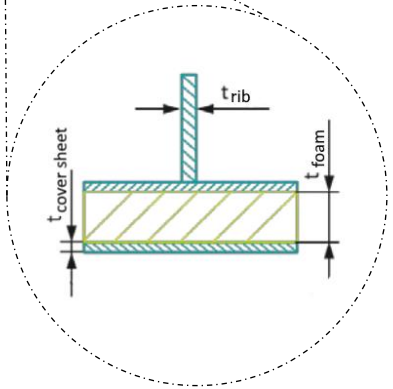
Possible applications: Battery box



Bollard test

	AAS 22-2-2 (Experiment)
Displacement:	
Impact side	Max. 25,2 mm
Battery side	Max. 16,4 mm
Compacted by:	Max. 8,8 mm

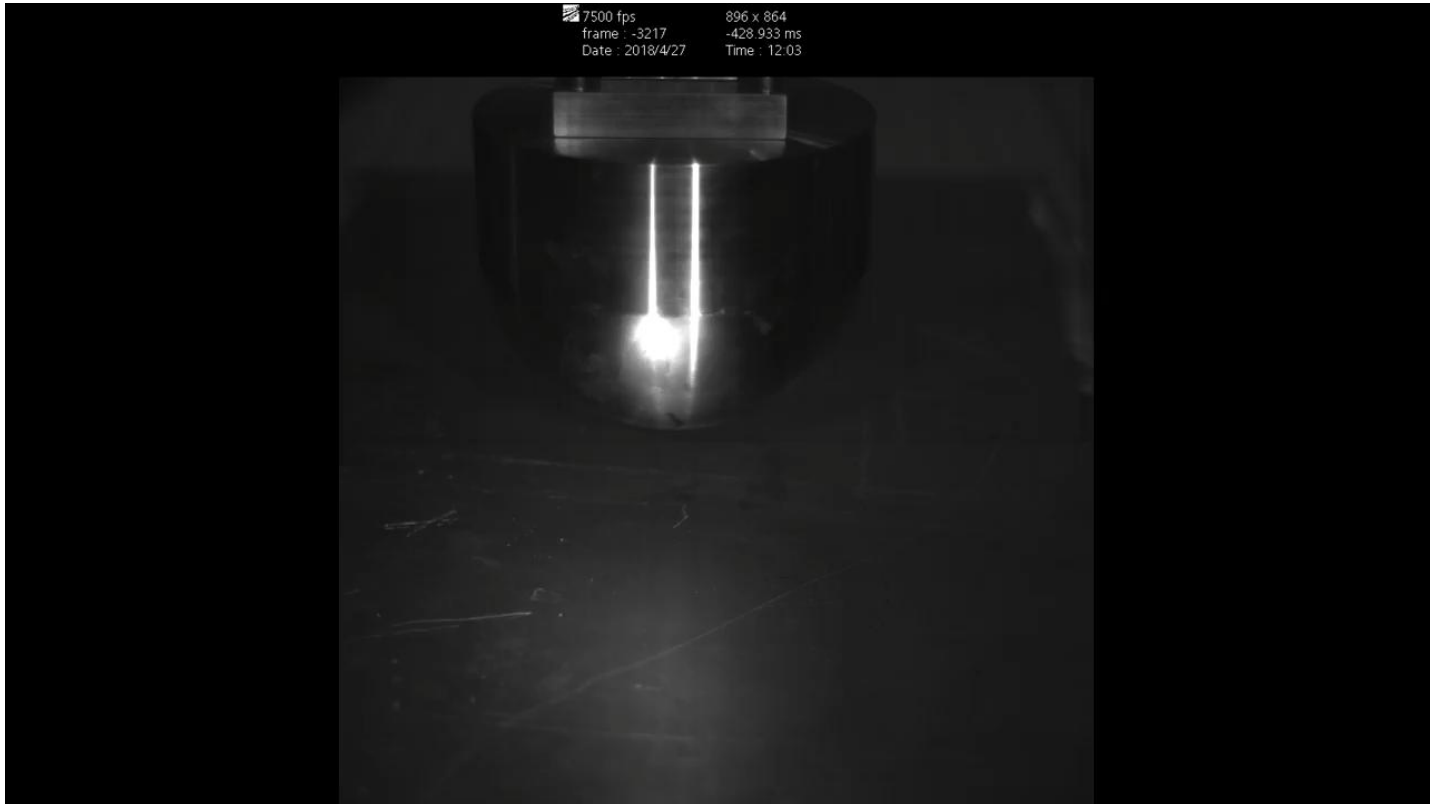




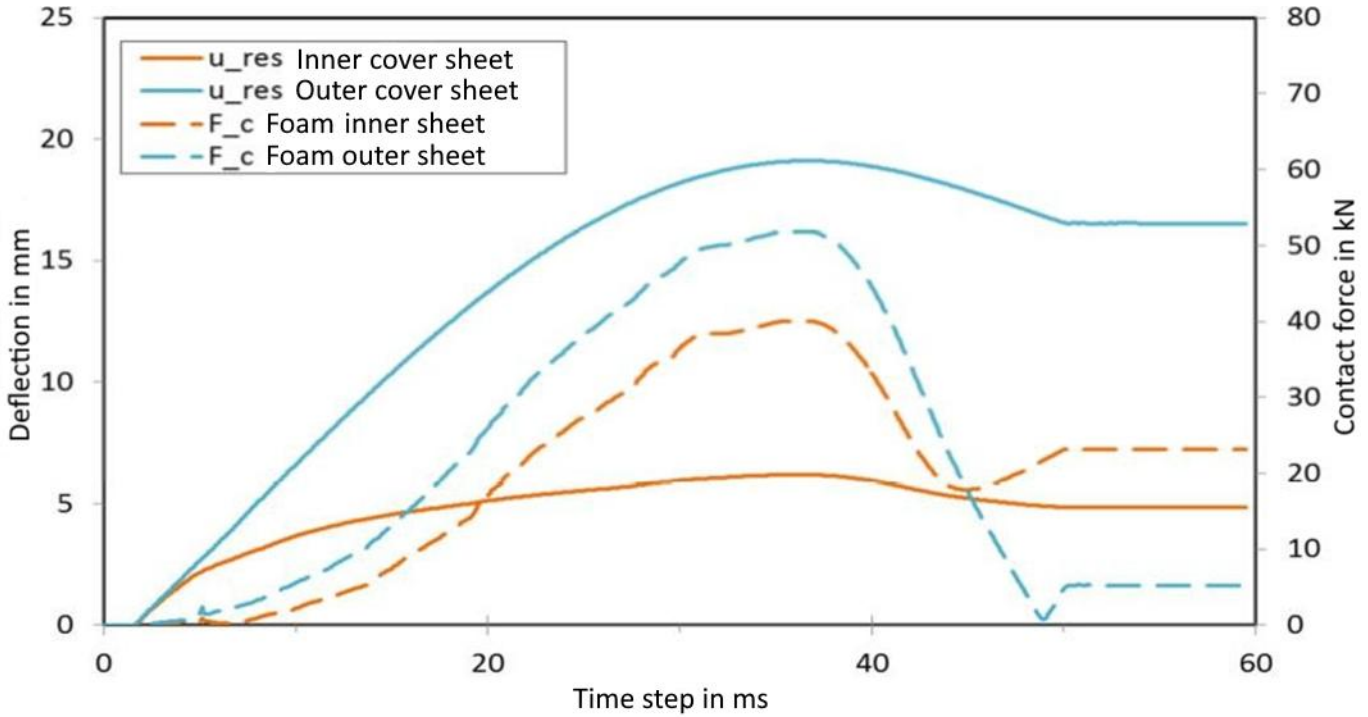
Carring out a bollard test

Impact between two cross stiffeners

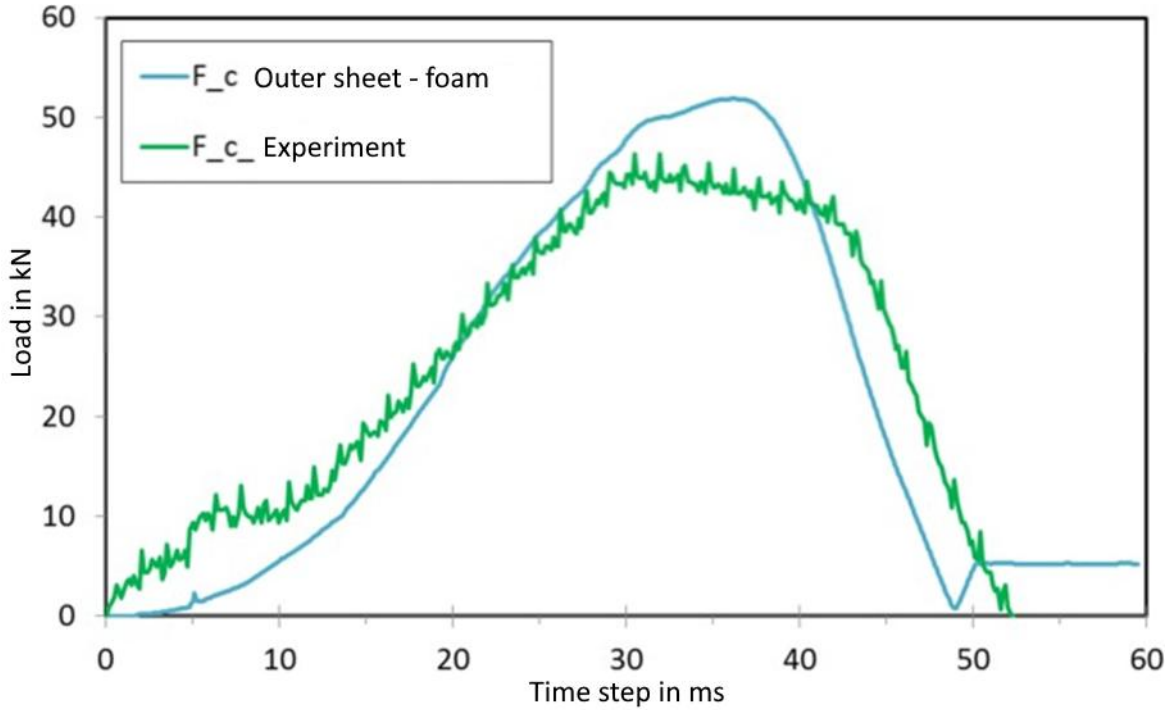
- DIN 6603-2:2000
- Mass drop weight: 10 kg
- High of fall: 1 m
- Energy: 981 J


7500 fps
frame : -3217
Date : 2018/4/27
896 x 864
-428.933 ms
Time : 12:03

Simulation results
Max. deflection and contact forces



Comparsion of the FEM calculations with the tests carried out

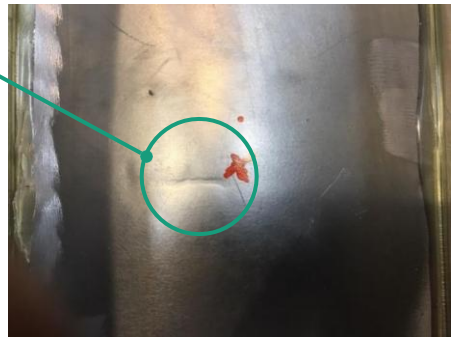


Results 22 mm AAS

Remaining deflection inside: 16,4 mm

Deformation of the sandwich inside between transverse stiffeners
- ➢ Reinforcements make an impact

Thinning of the top layer
- ➢ Recommendation: Increase security through thicjer top layers



(Annotation: high viscosity adhesive widely used when curing)

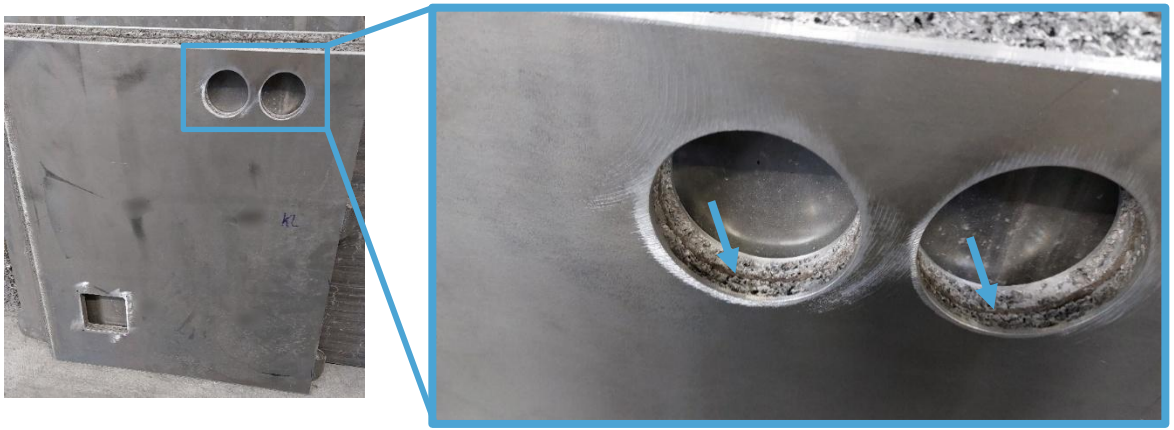
The interior of the battery housing is sealed!

Thermal insulation solutions with aluminum foam

- Integration of a (thermal) insulation layer in the foam
- over the entire surface or only in specific areas
- Various insulation materials and layer thicknesses possible
- Advantage over glued insulation:

→ Both sides remain easy to work with, complete freedom when attaching additional components to the cover plates.

20mm aluminum foam with 6mm rock wool insulation

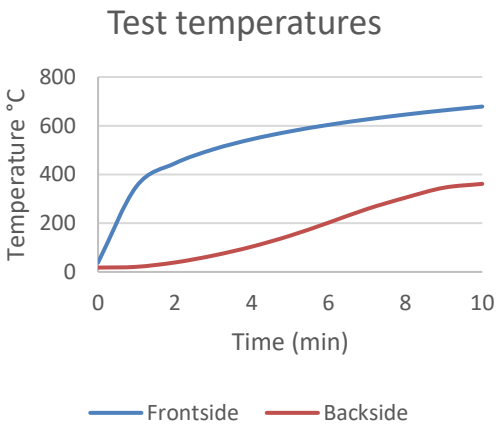


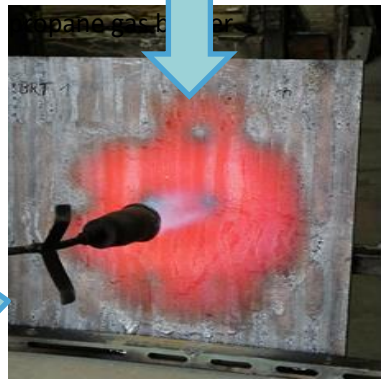
Aluminum foam sandwich (AAS 20-2-2) with an 1mm aluminum-/silicon oxide fiber sheet, customized manufacturing

Thermal insulation solutions with aluminum foam

- Test procedure with a propane gas burner
- Front side begins to melt after approx. 10 minutes

  → Backside still unharmed
- Further developments ongoing





propane gas burner, front side

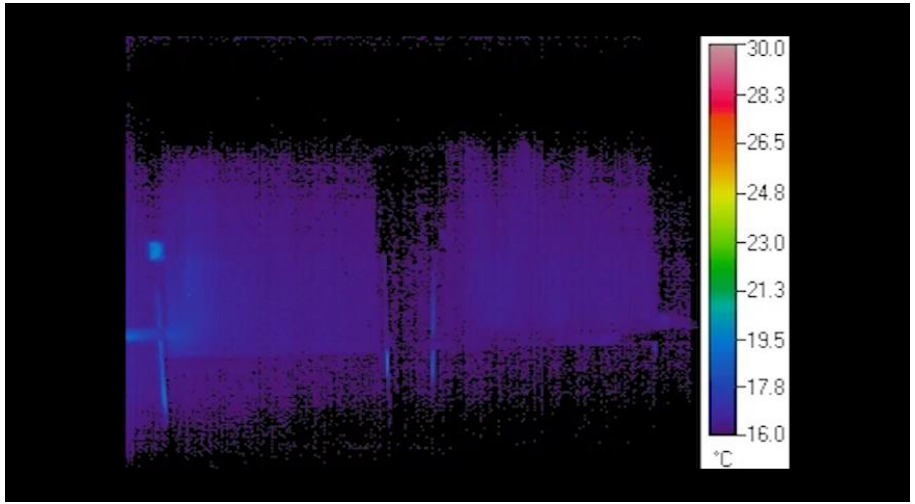
Cross section of second plate

Front side after test

back side after test

Active thermal management with aluminum foam

- Integration of canels/pipes for cooling/heating directly into the foam
- Flat and complex geometries possible



Heat-up comparison of an aluminum foam and a plaster plate with the same meander configuration, test for room heating/cooling elements

Pure aluminum foam with integrated pipes

Customized battery box with integrates cooling pipes

Active thermal management with aluminum foam

- Integration of canels/pipes for cooling/heating directly into the foam
- Flat and complex geometries possible

Example: cooling plate for EV batteries

Aluminum foam sandwich cooling plates

Battery pack of an EV with cooling plates between modules

Vibration damping on foam filled steel profiles

Samples

- Square tubes out of S235JR+AR
- Different cross sections
- Tubes tested with/without foam

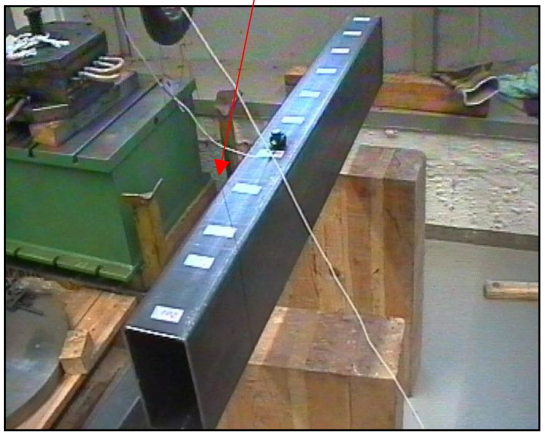
Examination

- Log of the vibration curve
- Determination of logarithmic decrement
- Damping calculation

$$D = \frac{\ln \frac{\hat{X}_1}{\hat{X}_z}}{2\pi(z-1)}$$

Set-up

- Beam holded with two wires, excitation du to impact hammer



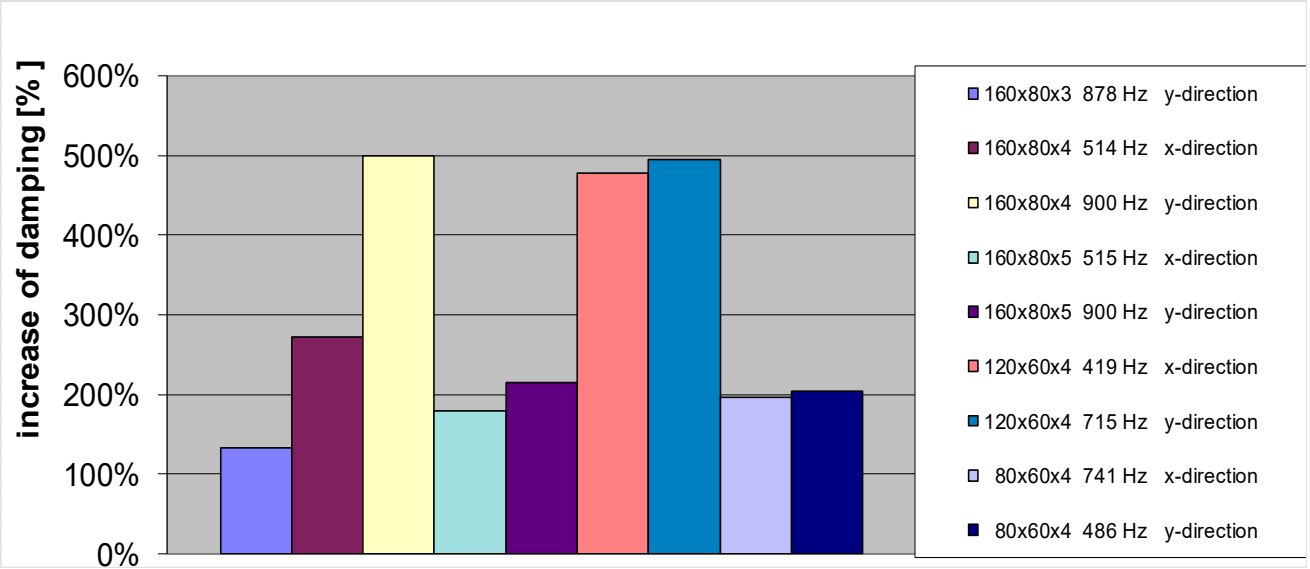
Test setup of steel profiles with/without aluminum foam

The study and analysis were conducted by Fraunhofer IWU in Germany

Conclusion

- Significant increase of damping due to metal foam integration
- No dependence on frequency range and form, no dependence of the tube form

Increase of vibration damping compared to the same profile without aluminum foam



Development

FEM calculations

Product solutions

Series production

Processing

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