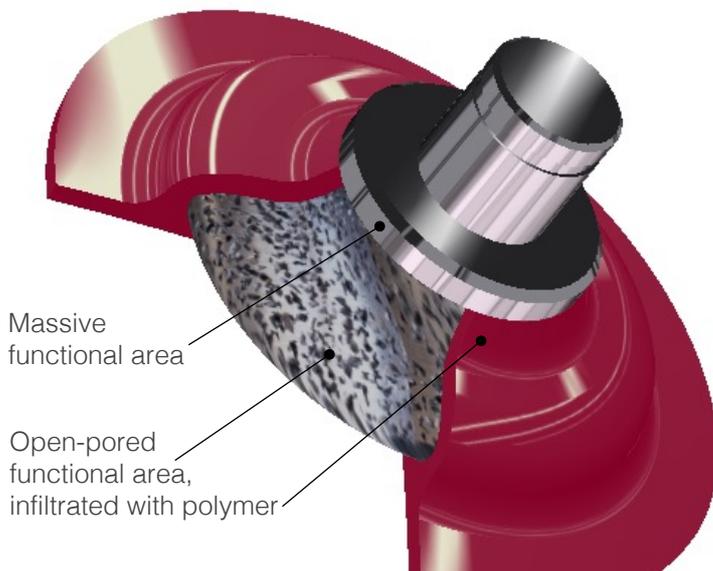


# BETTER HYBRID PARTS

Worldwide new FILLSSERT technology to produce future-oriented hybrid parts by injection molding, thermoforming, RTM blow molding, additive manufacturing and other processes.

**Light. Multifunctional. Ultra strong. Media tight.**



## New: infiltrating instead of overmolding

FILLSERTS are the macroscopically isotropic, selectively open-pored cast aluminum parts. Their properties differ in all aspects from conventional metal foams or sintered materials. In contrast to conventional metal inserts, plastics are not injected around them, but infiltrated.

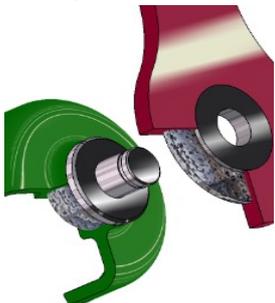
FILLSERTS can be flexibly adapted in terms of design and are available in different shapes, sizes and quantities. Optionally their mechanical, electrical, thermal, acoustic, optical, chemical, etc. material properties can be modified.

The hybrid parts with FILLSSERTS have previously unknown properties and potential for lightweight construction, functional integration, and energy and resource efficiency.

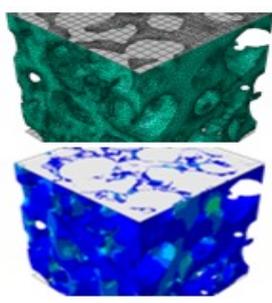
### OUR OFFER

Consulting | Product development | Prototyping | Production

#### Development



#### Simulation



#### Manufacturing



#### Functional surfaces



#### System solutions



## IMPORTANT INFORMATIONS

The new lightweight material class - open-cell cast aluminum - differs substantially from conventional aluminum foams, sintered metals and 3D-printed structures.

Depending on the application, hundreds of material variants with different material properties and multifunctionality can be set. The technical dependencies are not linear and are not universally valid. Application-specific feasibility, functionality and cost-effectiveness of individual solutions are influenced by a variety of parameters, including

- different aluminum alloys,
- different material structures (porous, solid, selectively porous, selectively solid),
- adjustable pore sizes,
- adjustable pore morphologies,
- component geometry,
- wall thicknesses of the components,
- component volume,
- spatial position of the components,
- possible functional integration (multifunctionality),
- application-specific process parameters such as temperature, pressure, pressure loss, mass flow, viscosity, sound frequencies and others,
- Combination with other technologies (multi-material systems).

This document only serves as basic information. Without specialist knowledge and application-specific advice, misunderstandings, misinterpretations and disappointments are inevitable. Please contact us if you have any questions.

## THE SPECIAL KNOWLEDGE OF HIGHLY SPECIALISED PARTNERS IS THE KEY TO SUCCESS

We have invested 12 years of our decades of experience in product development in the creation of a unique technological ecosystem METAHYBRID with 36 partners from research, product development, service and production into research new materials and the pre-development of numerous applications. We help you in different project phases to differentiate your products through unique optimized weight, function, energy, resource and cost efficiency.

### OUR SERVICES.

- Consulting
- Product development.
- Digital prototyping.
- Physical prototyping and MVP.
- Production at contract partners.

### OUR DEVELOPMENT PROCESS.

1. Initial consultation.
2. Definition of goals.
3. Development of concepts.
4. Feasibility study.
5. Industrialisation.

### OUR PRODUCTS.

- PORECOOL - lightweight cooling systems
- COOLSERTS - cooling of plastic parts
- FILLSERTS - functions for plastic parts
- OPENPORE - parts for different applications
- PORETOOL - lightweight tooling systems

### SOME CUSTOMERS OF METAHYBRID TECHNOLOGY ECOSYSTEM



**We develop and produce individual solutions for you too!**

### CONTACT

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**NEW ALUMINUM STRUCTURES AND FUNCTIONS AT THE MICRO AND MACRO LEVEL**



**Cohesively connected functional areas**

One or more massive and open-pored functional areas. Material connection in the casting process. Any pore sizes from 10 µm can be set. Component sizes from 1.5 to 2,000 mm. The material density in the open-pored area is 0.8-1.3 g/cm<sup>3</sup>.



**Infiltration with materials**

Complete or selective infiltration of open-pored functional areas with one or different materials in various primary molding processes (injection molding, thermoforming, resin transfer molding, etc.). Gas-tight, strong composite material without the use of chemicals.



**Selective porosity**

Separate open-pored functional areas for infiltration with different materials and / or integration of further functions such as heat exchangers, filters, crash elements, energy storage, etc.



**Fasteners**

Integration of conventional connecting elements in porous and solid functional areas: screwing, riveting, pressing, hooking, ultrasonic welding, soldering, welding, gluing, etc.



**Inserts made from other materials**

Integration into the open-pored and solid functional areas of inserts made of aluminum, steel, copper, glass etc. Subsequent infiltration of polymers for reinforcement, compression and functional expansion.

**MATERIAL PROPERTIES**

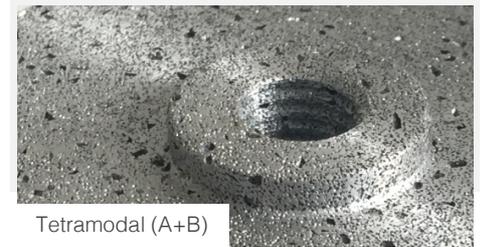
Standard aluminum casting alloys. The pore sizes can be freely adjusted using a combination of NaCl placeholders (salt fractions). A total of 40 salt fractions with a size between 0,2 mm and 20 mm are available. Larger dimensions are possible on request. The structure is macroscopically isotropic. Many other adjustable material properties.



Bimodal A



Bimodal B



Tetramodal (A+B)

**New class of materials: open-pore aluminum chill casting**



1. Mold filling with salt granulate.



2. Mold filling with Al melt.



3. Conventional processing.



4. Rinse out the salt, done.

**Comparison of microstructures**



Open-pored Al cast



Open-pored Al foam



Open-pored sintered material

Series production for over 25 years as filters, silencers, sensor protection, lightweight constructions, decorative parts. Cast structure with isotropic, adjustable, reproducible properties. Different microstructure than with foamed or sintered materials with better mechanical, fluid mechanical, thermal, acoustic and other properties.

## ADJUSTABLE MATERIAL PROPERTIES

Different physical processes such as filtration, sound absorption, shock absorption or heat transfer require specific pore morphology settings.

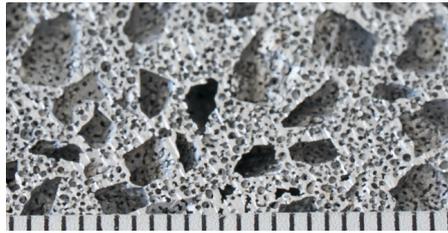
The pore morphology can be set bimodal (2 sizes of NaCl placeholders) or tetramodal (4 sizes of NaCl placeholders).

The sizes of NaCl placeholders can be selected as required between 0,2 mm and 20 mm.

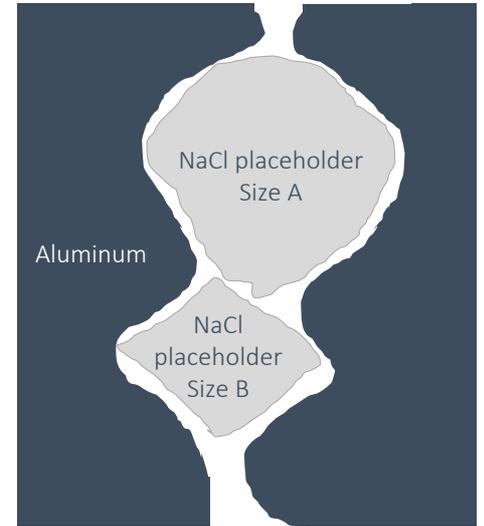
This means that hundreds different materials can be set for all possible applications.



*Bimodal 3,0-5,0 mm*



*Tetramodal 3,0-5,0-0,40-0,63 mm*



*Pore morphology of bimodal material*



*Bimodal 0,2-0,4 mm*



*Bimodal 0,35-0,63 mm*



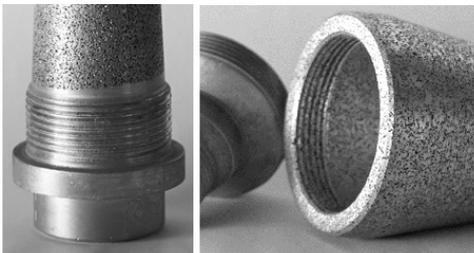
*Bimodal 1,6-3,0 mm*



*Bimodal 5,0-20 mm*

## PROCESSING AND JOINING TECHNOLOGIES

The material can be processed very well. The machining of open-cell aluminium castings can be carried out with any type of CNC milling or turning machine. For larger constructions, open-pore components can be assembled in the conventional way: press fits, tongue-and-groove joints, screws, rivets, welding, ultrasonic welding, soldering, gluing, etc.



*Thread*



*Riveting and pressing*



*Glue*



*Infiltration with polymers*



*Ultrasonic welding*



*3D printing*

## MULTIMATERIAL SYSTEMS AND FUNCTIONAL SURFACES.

### INFILTRATION WITH POLYMERS AND MATERIAL BONDING.

#### Adjustable and strong.

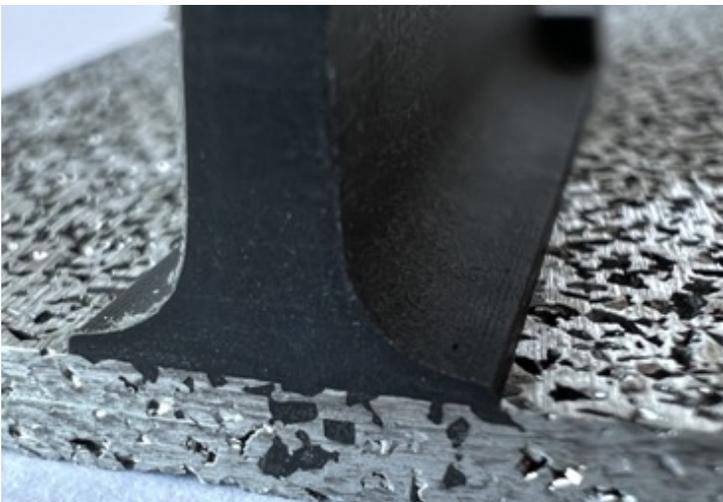
The PORECOL components can be infiltrated extremely well and media-tight with any polymers in any manufacturing process with a maximum process temperature of 400°C.



*Testing the bond strength of the composite with infiltrated PA6GF30 polymer into large and small pores (injection moulding process).*

The properties of the bond between aluminium and polymer can be adapted for many functional integrations using different parameters:

- Air and water ducts,
- Seals,
- Vibration dampers,
- Thermal insulation,
- Fastenings.



*Local functionalization with PA6GF30 polymer in the injection moulding process.*

### FUNCTIONAL SURFACES.

#### Advanced performance and multifunctionality.

The surfaces of open-pored aluminium parts can be functionalised in different processes. Not only the outer but also the inner pores in the entire volume of the component are functionalised. As the open-pored components have an extremely large specific surface area in a small volume, different surface technologies reach their limits under different boundary conditions.

#### Anodic oxidation (anodising)

This process is suitable for components with larger pores that enable the safe removal of electrolytes. The surface properties correspond to conventional surface properties of anodised aluminium.

#### METAKER® Surface

METAKER® Surface is a new technology for powerful, multifunctional, micro-structured, chemically activated, graded micro-composite surfaces. The process is suitable for smaller components with pores of any size.

#### PEEK / PEKK coating systems

Coatings with high-performance polymers PEEK or PEKK are particularly suitable for applications where a combination of high corrosion resistance, scratch resistance, temperature resistance and diffusion resistance is required. The process is suitable for small and large components with small and large pores.

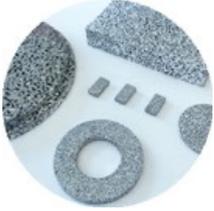
#### Other coating systems

Feasibility studies for other coating systems can be carried out on request.



*Bushing made of open-cell AISi7 cast aluminum (top) with METAKER® Composites surface (left) and PVD coating (right).*

## FILLSERTS TYPES



### INTEGRATION FILLSERTS

100% open-pored components for complete infiltration with polymers and other materials.

Applications: reinforcement, crash, acoustics, vibration, joining technology (self-tapping screws, gluing), energy and heat storage, etc. Production by machining standard semi-finished products (round material, block, tube).



### FUNCTIONAL FILLSERTS

Selectively open-pore components with solid and open-pore functional areas.

Applications: Multifunctional hybrid parts with mechanical, thermal, acoustic, decorative and other functions. Production by machining standard semi-finished products (round material, block, tube). Limited design of solid and porous functional areas.



### INNOVATION FILLSERTS

Application-specific components for the development of patentable products.

Production by machining application-specific semi-finished products. Extended design of solid and porous functional areas (e. g. graded). Extended multifunctionality and material combinations.



### FASTENING FILLSERTS

Hybrid fastening systems for multifunctional multi-material systems.

Integration of conventional fastening elements by screwing, riveting, flanging, pressing on and pressing, soldering, gluing or ultrasonic welding.

Integration of additional functions for vibration damping, filtration, ventilation, heat transfer, sound absorption, sensor protection, flame arrester, homogenization and distribution of media, among others.

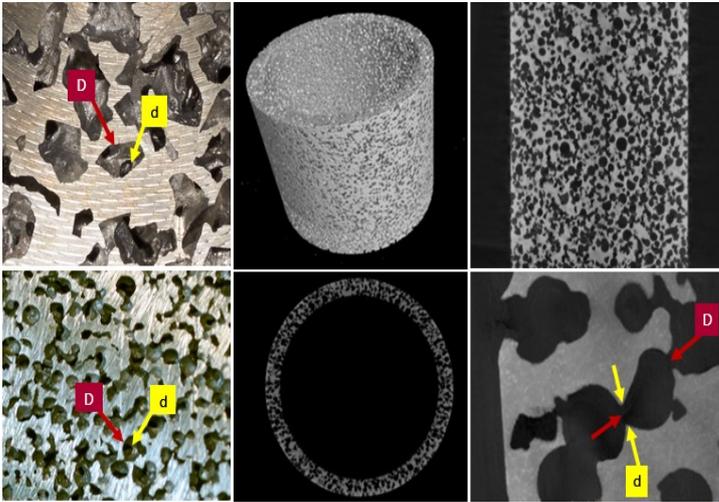


### COATED FILLSERTS

FILLSERTS with modified surfaces.

Modification of massive and / or open-pored functional structures also inside the pore labyrinth. Different surface technologies.

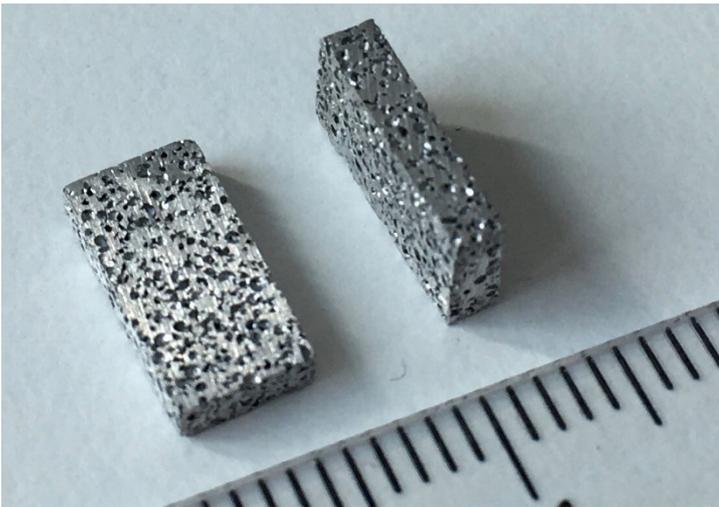
**OPENPORE CAST ALUMINUM. NEW LIGHTWEIGHT MATERIAL CLASS FOR VARIOUS APPLICATIONS.**



The cast structure is macroscopically isotropic. The pores can be adjusted in a wide range of sizes. Selectively porous components can be produced.



Resilient threaded connection between a completely open-pore cast part and a solid material socket.



The world's smallest, completely open-pore cast parts for use in electronics.



The geometry of the cast parts can be as complex as desired. The maximum possible component size depends on the application and geometry.



Series application: Silencers made of open-pore cast aluminum (below) are lighter, smaller, better and cheaper than conventional silencers.



Series application: sensor protection caps made of open-pore cast aluminum are lighter, better and cheaper than conventional parts made of sintered metals.

**Worldwide new FILLSSERT technology to produce future-oriented hybrid parts by injection molding, thermoforming, RTM and other molding processes.**

FILLSERTS are the selectively open-pore aluminum inserts to produce light, powerful, multifunctional, media-tight hybrid parts for mechanical, fluidic, thermal, electrical, mechatronic, optical, chemical and many other applications.

In contrast to conventional metal inserts, the FILLSSERTS have previously unknown multifunctional and multi-structural properties and are infiltrated with plastics rather than being overmolded.

**Insert and outsert technology.**

The manufacture of hybrid components in the combination of plastics with metals has long been established in plastics processing. There are essentially two procedures for this:

- In insert injection molding, the functional properties of metallic materials are integrated into the plastic matrix in the form of inserts. The metal inserts are inserted into the primary molding tool during the manufacturing process and are almost completely encapsulated by the primary molded plastic with a positive and positive fit.
- In outsert injection molding, the functional properties of polymer materials are integrated through the selective coating of a metal insert. In this case, the metal inserts are only overmolded by the molded plastic in selected areas.

However, both hybrid technologies have well-known disadvantages, especially for modern, function-integrated lightweight construction:

- use of heavy metals such as steel or brass,
- small contact area with limited force and form fit,
- warpage, cracking and leakage due to different thermal expansion,
- increased risk of crevice corrosion, contact corrosion and electrochemical corrosion at the interfaces between different materials,
- limited quality and functionality when transmitting higher forces and torques, especially when there are vibrations or changes in climate,
- partial need to use chemicals for better adhesion.

**FILLSERT technology. Light. Multifunctional. Strong. Tight.**

The worldwide new FILLSSERT technology improves the hybrid parts in terms of weight, performance,

multifunctionality and quality and enables previously unimaginable constructions and applications.



*The FILLSSERTS (exemplary forms) combine solid and open-pored functional structures. The open-pore structures, like the solid ones, can be adjusted to suit the application and can be infiltrated with other materials.*

FILLSERTS are produced as selective or completely open-pore cast parts made of aluminum using the permanent mold casting process. They have massive and/or open-pored functional areas that are materially connected to one another. The possible geometric combinations of open-pored and solid functional areas allow many new constructive solutions.

The open-pore chill cast parts differ in all aspects from the conventional foamed or sintered metals. They have adjustable pores, macroscopically isotropic properties, a resilient cast structure, better mechanical, thermal, acoustic, fluid mechanical, etc. properties and can be manufactured with an accuracy of one hundredth of a millimeter in different shapes and sizes. The density of the open-pored aluminum is approx. 0.8-1.3 g/cm<sup>3</sup>.

Both in the solid as well as in the open-pore functional areas of the FILLSSERTS, all functions known from solid metals, such as threads, bores, hinges, eyelets, press-in bolts, rivet nuts and much more can be implemented.

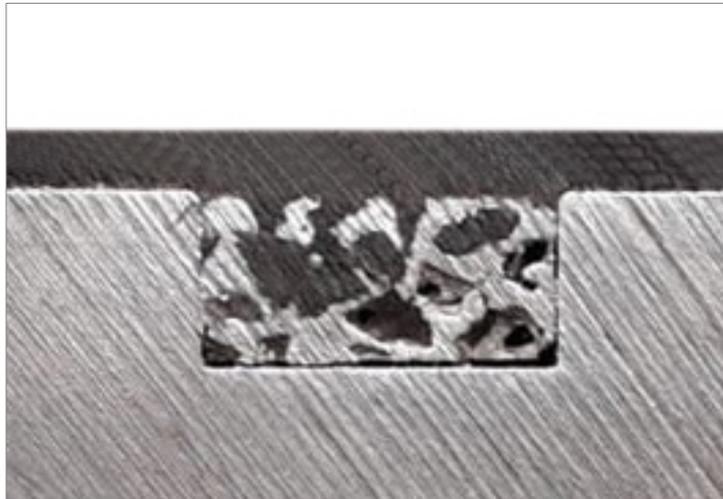
The pore size in the open-pored functional areas can be set application-specifically from a few micrometers to several millimeters, with even graded settings being possible. They can be infiltrated with polymers in various primary molding processes such as injection molding, thermoforming, blow molding, foaming or RTM in order to produce an extremely strong, gas-tight composite material without the use of chemicals.

If they are specifically not infiltrated, they can integrate other functions specific to open-pore metals such as filtration, sound absorption, heat transfer, crash energy absorption, ventilation and much more.

The completely open-pored FILLSSERTS without a massive functional area can be fully integrated into a plastic matrix. In this way, a plastic component can deliberately be equipped with a functionality from the composite material at selected points.



*FUNCTIONAL FILLSSERT with several porous functional areas (not in the picture), infiltrated with polymer (injection molding).*



*INTEGRATION FILLSSERT welded to an aluminum component and infiltrated with polymer (thermoforming).*

The massive FILLSSERTS with selective open-pored functional area can be infiltrated locally with polymers. An aluminum component can be deliberately equipped with a functionality from the composite material at selected points or provide a defined interface for a plastic component.

The selectively open-pored FILLSSERTS can be equipped with one or more solid and / or open-pored functional areas to enable many other

combinations of solid, open-pored, infiltrated and non-infiltrated functional areas.

**FASTENING FILLSSERTS.**

**Hybrid fastening systems for material hybrids.**

The FASTENING FILLSSERTS are hybrid fastening systems for multifunctional multi-material use.



*FASTENING FILLSSERTS as a hybrid fastening system in combination with the ecosyn® blind rivet nut technology.*



*FUNCTIONAL FILLSSERT integrated in CFRP, the application was optimized with structural adhesive (Patent University Stuttgart, IFB)*

They are based on the excellent compatibility of the open-pore cast parts with conventional joining processes such as screwing, riveting, flanging, pressing on and pressing, soldering, gluing, ultrasonic welding, etc. This means that very flexible options are available to develop an optimal fastening system for every application. In addition, such interfaces can also be used with other functions such as vibration damping, filtration, heat transfer and others. equip.