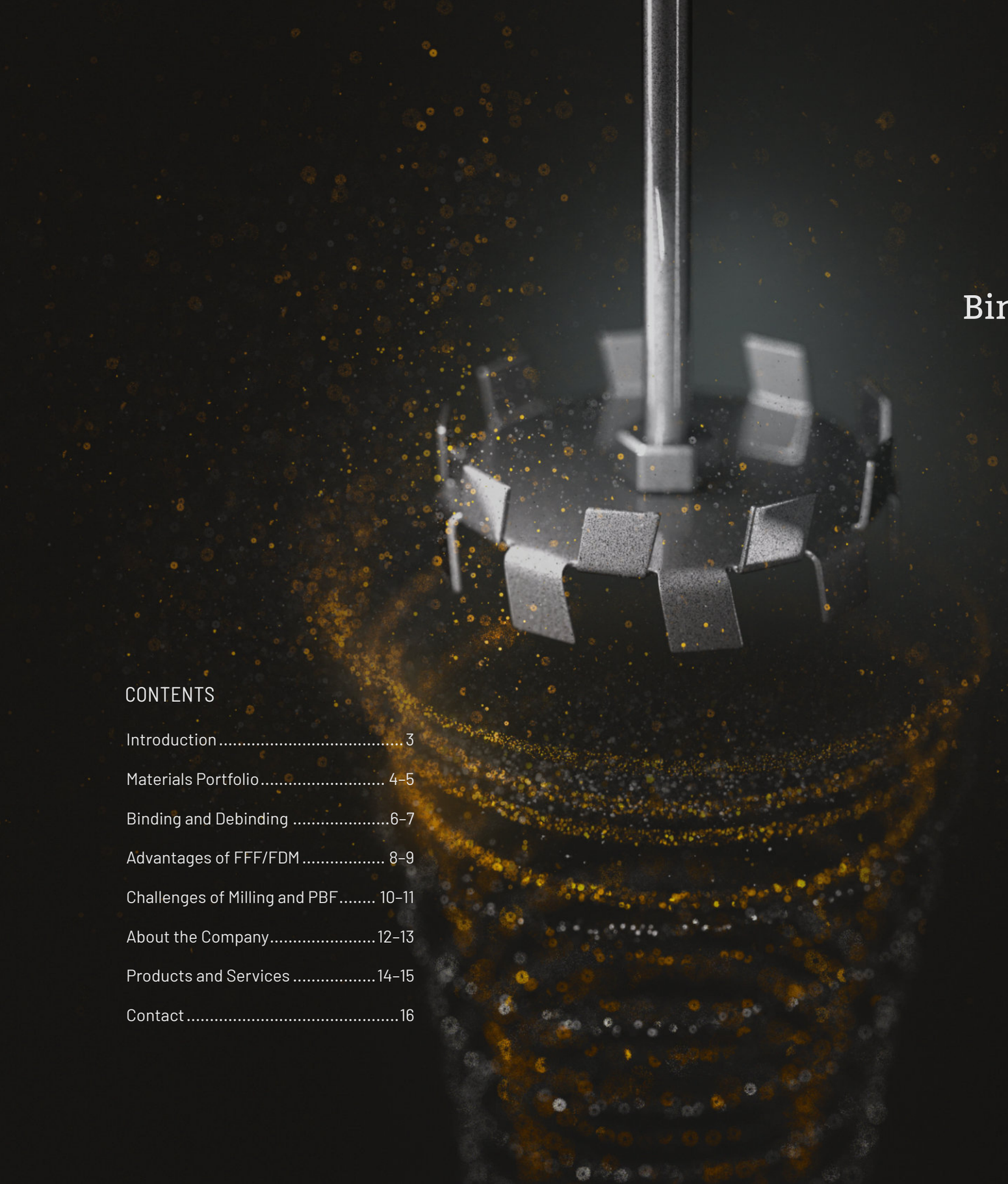
AM EXTRUSION

Binder Solution

Starting with Experience



AM EXTRUSION

Binder, Filaments, Technology and Services Out of **Innovation**

Binding industrial powders is the crucial step in additive manufacturing methods. With groundbreaking research results as our 'seed capital', AM Extrusion has set out to bring innovative products to the market, e. g. for Fused Filament Fabrication or Fused Decomposition Modeling.

Our range of products starts at the previously weak point of the FFF-technology, material availability, and further offers solutions throughout the entire manufacturing process for the successful application of the material – up to our custom services for special requirements.

The simplicity and safety of the most economical AM method of all enables industry and research to 3D print ceramic and metal components quickly and effortlessly, combined with entirely new design freedoms.

Whether as individual pieces or in small batches, in principle any available MIM or CIM powder can now be printed in point-of-demand production. By applying the material-containing filament layer by layer, only as much material is used as the component contains. Thereby, cavity constructions and infill-patterns are possible, which are difficult or impossible to achieve with other methods. The final sintering process densifies the components and enables chemical and mechanical properties whose values match or exceed those of classic MIM and CIM products.

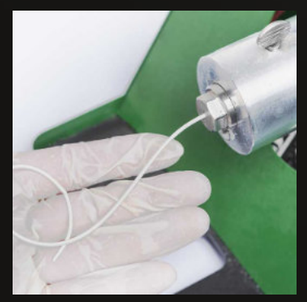
Tool or specialty manufacturers, industrial designers, researchers, medical, electrical or other technicians and engineers who rely on FFF today will also benefit from the near future of the method. This future promises the processing of metal-matrix-composites, nanoparticle-enhanced materials or the simultaneous printing of different materials at the same time.

CONTENTS

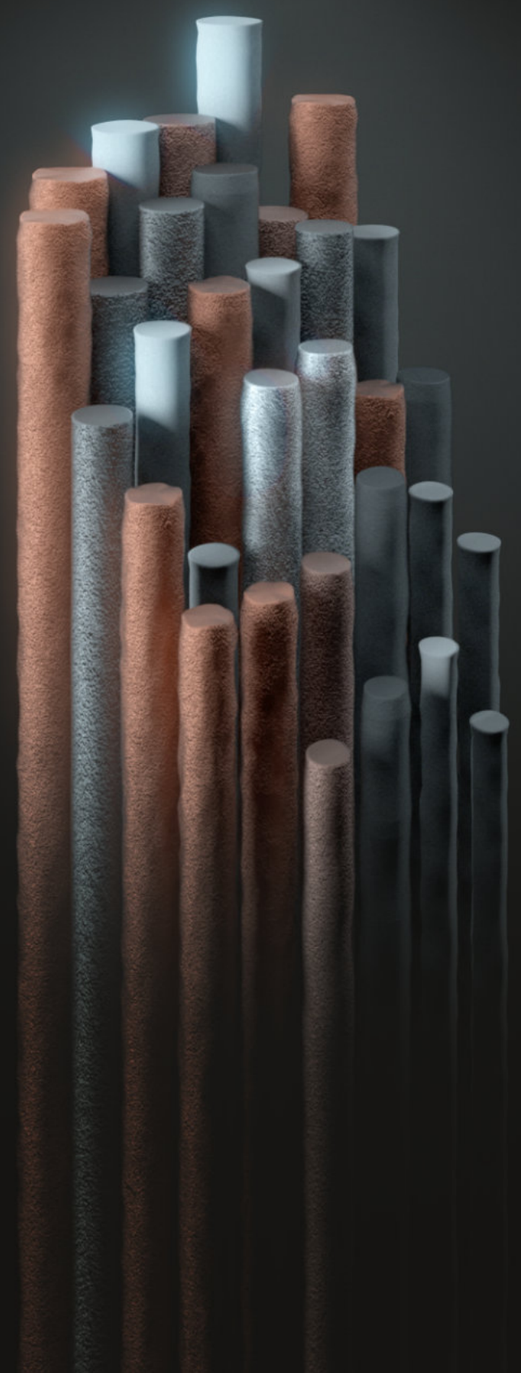
Enabled by Our Binder Concept

Due to the high compatibility of AM-Xcomp, we can extrude almost all alloy and ceramic materials on the market into filaments, achieving unsurpassed enrichment rates of over 65 % by volume metal powder or over 50 % ceramic powder. Our highly filled filaments do not exhibit any agglomeration or inhomogeneity and enable relatively low shrinkage of the metal components of under 15 % during sintering. This allows the prediction of the final contour of the part in the range of ±50 microns. Such values correspond to classical metal injection molding.

Thanks to AM-Xcomp, we produce filaments with an optimal melt-viscosity, sufficient to enable printing layers with a thickness of under 100 microns. Quick consolidation after leaving the printing nozzle ensures a high stability of the printed shape. Due to the tight adjustment of the binder, aging processes like crystallization, water absorption, and brittleness hardly show up on our filaments.



Extruded ceramic filament



AM EXTRUSION

WE ARE PROVIDING A HUGE RANGE OF FFF-MATERIALS

BASIC

Stainless Steel
Tool Steel

Our standard portfolio consists of 'classic' printing materials such as various steels. With FFF, manufacturers can produce small and wear parts, such as milling cutters or drills, independently of suppliers and right on the site of their application. Tool manufactures will benefit from printing hot-working, cold-working or high-speed tool steels, but also from our advanced portfolio which allows to print technical ceramic.

ADVANCED

Technical Ceramic
Electronics
Lightweight

Aerospace structures have to be lightweight and strong. Therefore, sophisticated hollow constructions are required. But medical engineers also benefit from the possibility of printing the light and strong titanium because it is highly biocompatible, and each implant is unique.

Similarly, zirconium and aluminum oxide is interesting not only for dental technicians, but also for aerospace, energy, and electronics etc. Especially the latter industry will, besides the ability to process electro-ceramics, also be glad to see the possibility of printing copper, which is useful for power electronics and two and three-dimensional circuit construction.

Thus, our advanced portfolio opens up new roads in so far only modest developed areas of application for FFF or AM in general.

EXPERT

Carbon
Multi Material

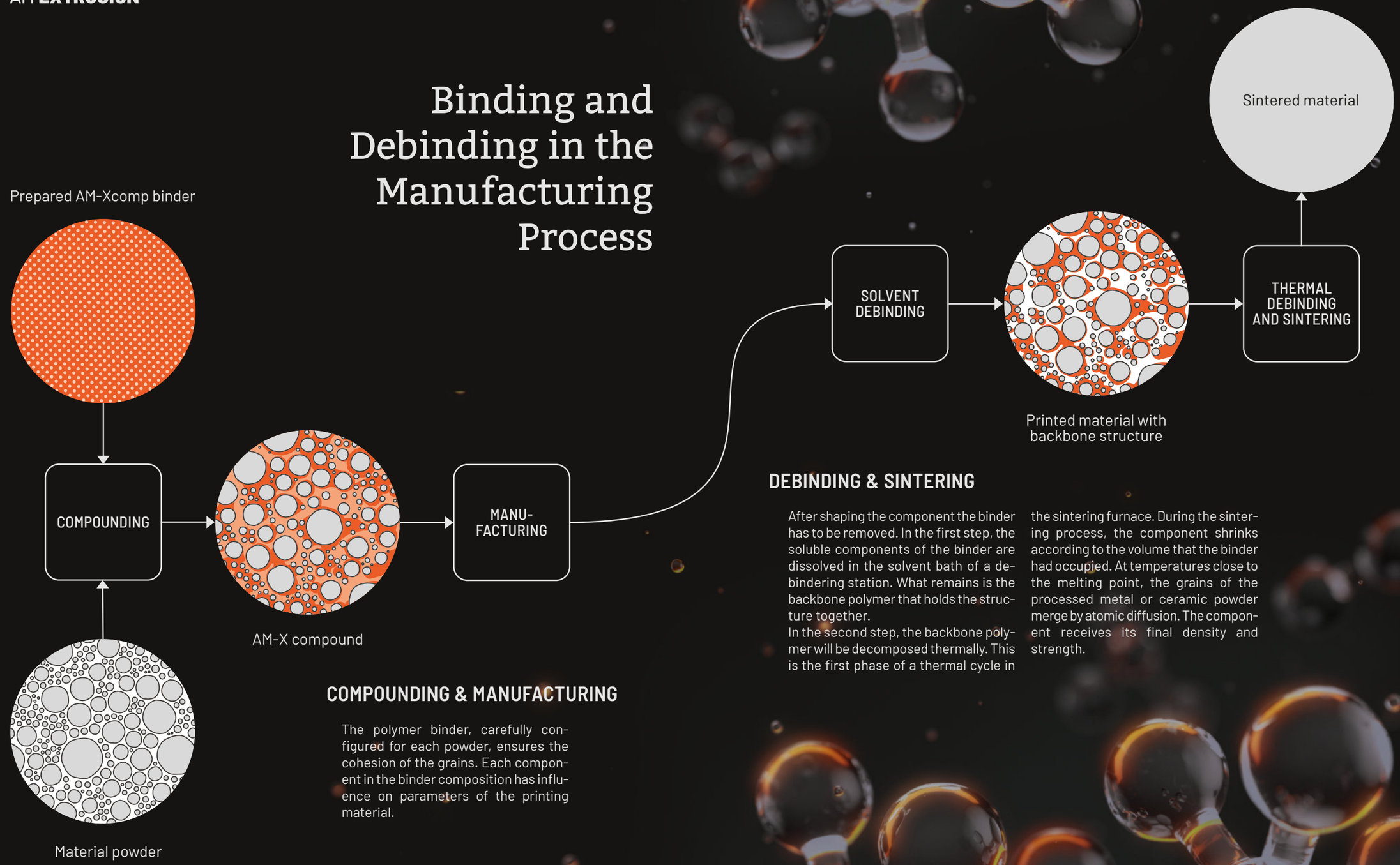
Combining the advantages of two different materials in one component is the benefit of multi-material printing, a process that can only be realized with FFF. However, only those materials can be processed together that have approximately a similar coefficient of thermal expansion. And it is necessary to adjust the fill levels of the filaments in each case so that the shrinkage of the processed materials is the same during sintering. Our R&D can simultaneously print ZrO2 and 17-4PH in experimental state, for example. We expect market maturity of the technology soon.

Our prospects even get visionary when it comes to the binding of carbon. The ability to process the versatile carbon will lead to an explosion of entirely new applications in lightweight, highly conductive, and ultra-strong components.

To get full information about our current portfolio of ready-made or on-demand materials, just visit www.am-extrusion.com!

AM EXTRUSION

Binding and Debinding in the Manufacturing Process

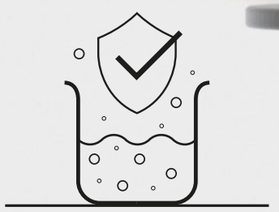


COMPOUNDING & MANUFACTURING

The polymer binder, carefully configured for each powder, ensures the cohesion of the grains. Each component in the binder composition has influence on parameters of the printing material.

DEBINDING & SINTERING

After shaping the component the binder has to be removed. In the first step, the soluble components of the binder are dissolved in the solvent bath of a debindering station. What remains is the backbone polymer that holds the structure together.
In the second step, the backbone polymer will be decomposed thermally. This is the first phase of a thermal cycle in the sintering furnace. During the sintering process, the component shrinks according to the volume that the binder had occupied. At temperatures close to the melting point, the grains of the processed metal or ceramic powder merge by atomic diffusion. The component receives its final density and strength.



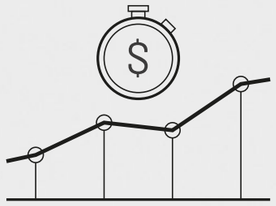
SAFETY

low requirements for safety engineering and measures, because of:

no health hazards during application

no explosion and ignition risks during printing

low environmental impact



EFFICIENCY

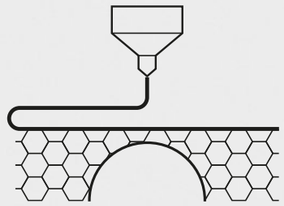
low investment costs for printing technology

sustainable use due to 100 % material utilization

little post-processing required

almost independent of skilled workers

decentralized and independent of supply chains



WORKABILITY

any materials in various powder sizes and forms

design freedom, e.g. for complex hollow bodies and infill patterns like honeycombs

material properties of components reach or exceed MIM values

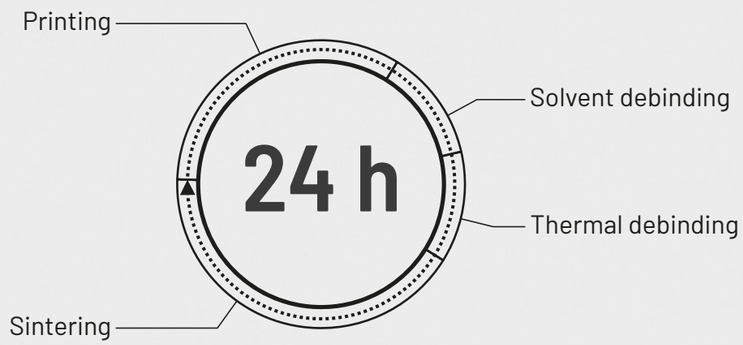
simultaneous processing of different materials possible

Advantages of Fused Filament Fabrication with AM Materials and Technology

We consider the idea of using filaments as the printing material to be a turning point in additive manufacturing. Melting a constant 'thread' of physically bonded powder in the print head to produce components layer by layer, this method has obvious advantages: all processes take place under room conditions, there are no airborne powders, and all used powder ends up in the workpiece. For these reasons, the application is simple and reliable and requires no special occupational health and safety measures.

FFF comes with a design plus that even eclipses the possibilities of PBF: Since no excess powder ends up in the components, infill pattern and complex closed hollow structures can be created.

On the horizon of the possibilities of the FFF method is also the prospect of simultaneous multi-material printing.



Our Story: Technological **Challenges**

CHALLENGES OF CLASSICAL MILL CUTTING PROCESSES

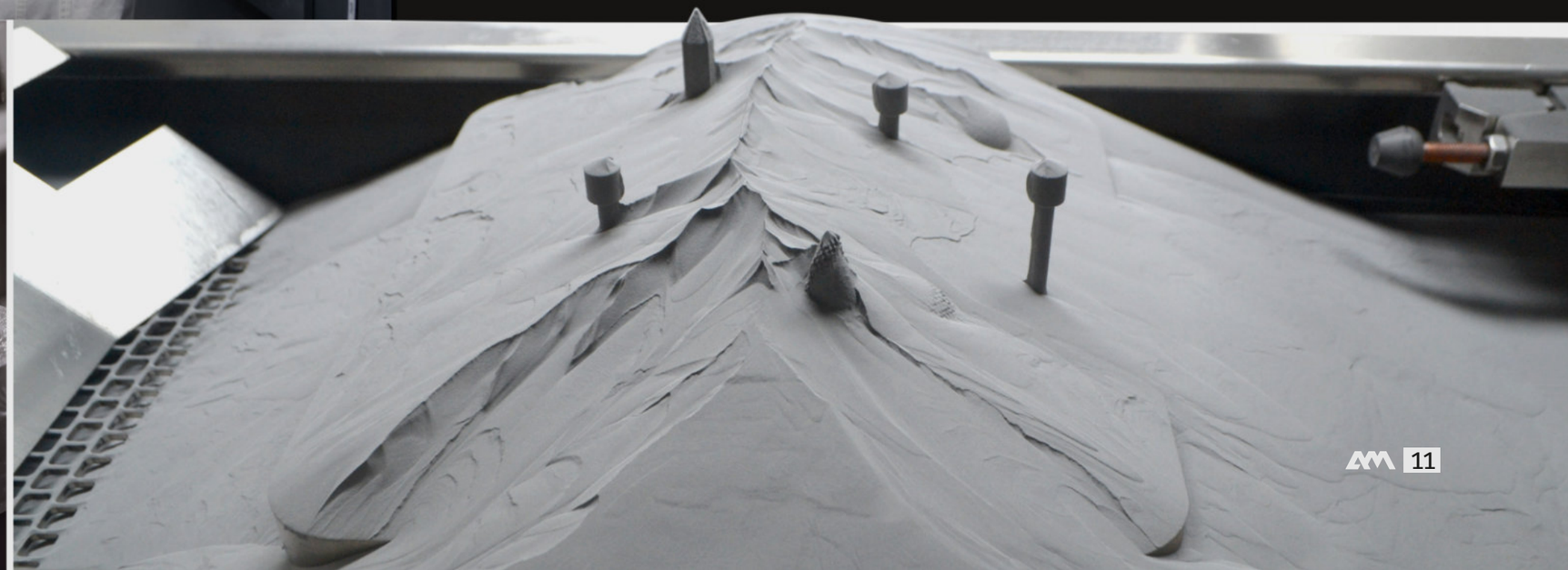
Subtractive manufacturing processes have to date been the most commonly used processes for machining special parts with precise tolerances. But the principle of material removal by advancing a milling cutter is accompanied by high material costs. And although modern automated CNC machining centers can combine milling and turning operations in different directions on multiple axes, the production of workpieces with an internal structure is not possible without assembling individual parts. Overall, manufacturers face the following disadvantages:

- material waste partially over 90%
- high tool costs
- limitation of design options
- need for trained specialists
- high dependence on supply chains

CHALLENGES OF POWDER BED 3D PRINTING METHODS

Powder Bed Fusion (PBF), also known as selective laser melting (SLM) or selective laser sintering (SLS), allows the additive manufacturing of strong, durable parts, using a laser to melt and fuse metallic powders together. Since this is a layer-by-layer process, it is possible to design internal features and challenging passages that could not be cast or otherwise machined. But the layered powder finally fills the entire space in and around the finished part, and the harmful unfused residue must be removed carefully. The building chamber has to be heated and to maintain a tightly controlled atmosphere of inert gas. The nature and the complexity of the process limits the range of available materials. Thus, compared to FFF technology, PBF has significant shortcomings:

- very high safety requirements due to the exposure of the powder
- limitations of material availability
- high system costs
- necessity of post-processing
- fabrication of multi-material components almost impossible



Vision and Mission

Helping your additive manufacturing process succeed, for us, that means being ambitious in our joint work and meeting the highest standards with our products and services. We are open to new industrial collaborations and are looking forward to new contacts.

Due to its competitive advantages, fused filament fabrication will be the primary 3D printing technology in the industrial realm. That's the vision in front of our mission: to build up fruitful partnerships.

EXPERIENCE TO WORK WITH

Working in academia and industry, Co-Founder and CTO Dr.-Ing. Aljoscha Roch and our team members accumulate decades of experience in the fields of polymer chemistry, powder metallurgy, material processing and heat treatment. In collaboration with our clients, we challenge the disadvantages of powder-bed-based AM-technologies and remove a crucial limitation in the success of fused filament fabrication: material availability.

Headquarter Radebeul, Germany

Turning **Results** into Innovations

Our company is based in Radebeul, Germany, just a stone's throw from the place where the founders met for the first time. They were both studying in Dresden when they got to know each other as members of the same tennis club. Since then, they have had a close friendship, which gave rise to the initial ideas and plans for founding the company in 2019.

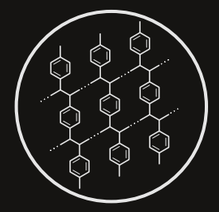
A founding team formed, and after many meetings and countless hours of preparation, the plans became reality with the founding of AM Extrusion in early 2021. From now on, it was possible to turn years of research and laboratory work into market-ready next-generation AM technology.

AM EXTRUSION

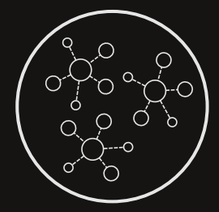
SYSTEMIC OR CUSTOMIZED

Our Line of **Products** and **Services**

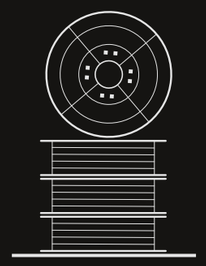
The basis of industrial FFF/FDM is the bonding of MIM and CIM powders by a polymeric binder. Our binder system AM-Xcomp is highly adjustable to almost all available metal and ceramic powders with all their varying behaviors.



Xcomp
BINDER SYSTEM

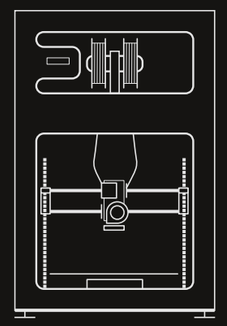


Xsolve
DEBINDING SOLVENT



AM-X
FILAMENTS

The bonded material is extruded into a filament roll, the printing material. Thanks to AM-Xcomp, our range of AM-X metal and ceramic filaments is outstanding not only for its great variety, but also for its excellent processing properties.

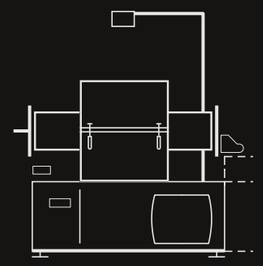


Xfuse
PRINTERS

During printing, the filament is melted in the print head, which extrudes the material layer by layer onto a build platform. In conjunction with AM-Xact, AM-Xfuse printers are the perfect devices for optimal utilization of our AM-X filaments.

Xclude
DEBINDING STATION

The soluble components of the binder will be dissolved in a debinding station. The exceptional solubility parameters of AM-Xcomp enable ultrafast solvent debinding under 3 hours and thermal debinding under 3 hours. The utilized debinder AM-Xsolve is completely harmless to workers and the environment.



Xheat
FURNACE

The printed workpiece reaches its final strength through the sintering process. Optimum temperature profile and ideal atmosphere are guaranteed by the German engineered AM-Xheat sintering furnace. Due to the high solids loading of AM-X filaments, shrinkage of under 15% is possible.

CUSTOMER-SPECIFIC SERVICES

MATERIALS

For special applications (such as for medical purposes, or in space printing), we develop customized filaments from any materials. We are also supply printing material in the form of pellets or rods if your AM system requires this.

BINDERS

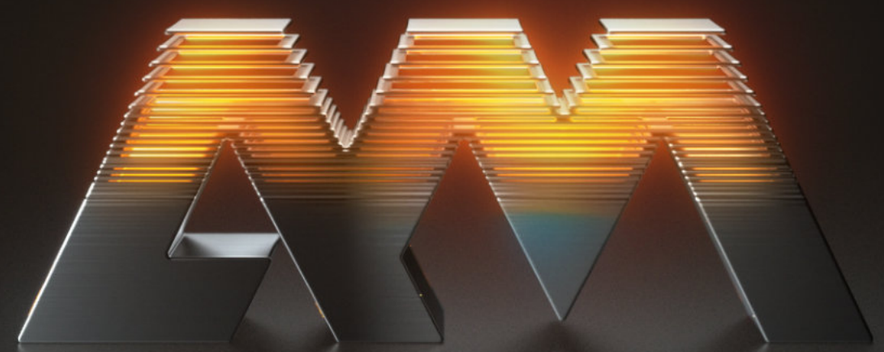
We create binders for a wide range of materials and according to customer-specific requirements. The binder can be used for filaments, pellets, and pastes as well as an adhesion agent for the binder jetting technology.

PRINTING

According to customer-specific designs and specifications, we print prototypes and small series. The precise and effective work of our specialists and the advantages of our technology will perfect the pieces.

SINTERING

With our debinding and sintering service, green parts will be processed into full metal or full ceramic components. This allows customers to benefit from our proven process and our experience in the "densification" of high-quality components.



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