Subtractive
Joins Additive

AMAREA TECHNOLOGY

Hybridization for Perfection

MMJ ProX Series

Multi-Material Additive Manufacturing of High-Performance Materials

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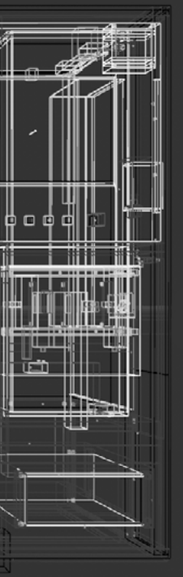

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At a Glance

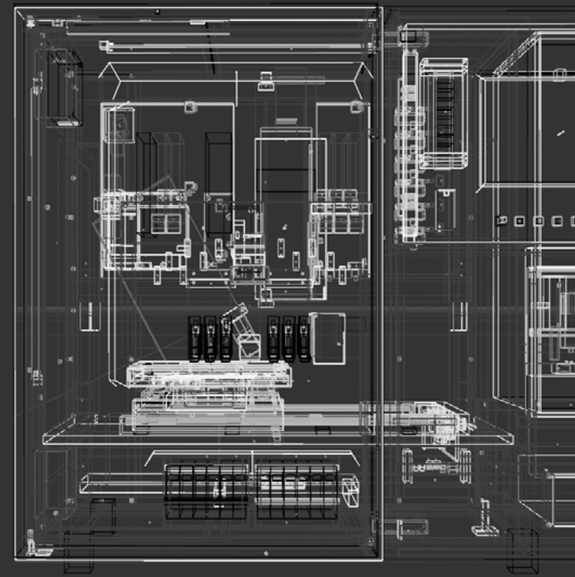
AMAREA Technology presents the MMJ ProX Series, an **advanced multi-material 3D printer** for hybrid manufacturing of highly functional parts from multiple high-performance materials in a single build.

Powered by Multi Material Jetting **» MMJ «**, the system integrates multi-material additive and subtractive processes. A high-precision fiber laser module enables in-line surface refinement, delivering exceptional accuracy and surface quality.

This **hybrid approach** offers outstanding flexibility for producing complex, miniaturized components with integrated functionalities from materials such as ceramics, high-alloy steels, and even precious metals.

It accelerates development, simplifies production, and reduces costs **across industries** including semiconductors, aerospace, defense, energy, packaging, automotive, medical, dental, and luxury goods.

The **modular design** supports easy configuration and scalable upgrades for evolving production needs.



MMJ ProX Series

System Overview

1 **Stand-Alone Machine**
Self-sufficient, measurements 2550 mm x 1150 mm x 1930 mm, no additional cleaning machinery necessary.

2 **Laser Safety Housing**
Safe operation when ablating, smoothing, structuring with the optional laser module.

3 **NEW High-Precision Pulsed Fiber Laser**
Powerful upgrade for optimized MMJ-inline surface processing

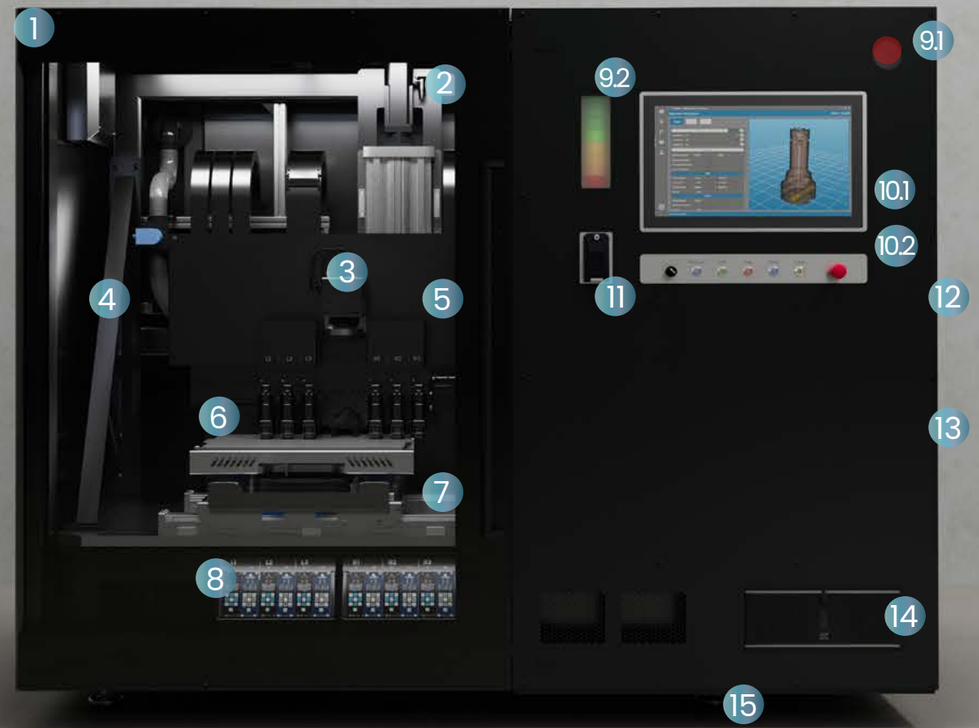
4 **Rigid Steel Frame**
Maximum stability for additivley manufacturing high-precision parts.

5 **Large Front Door**
Safe and easy access to the build area supporting fast print bed swapping. Equipped with additional safety panels when optional laser module (3) installed.

6 **Building Envelope**
Features a removable, heated print bed supporting build sizes up to 530 × 300 × 200 mm³, up to six print heads, and a laser profile sensor.

7 **High-quality Motion System**
Rapid and precise movement in all three axes with a 20 µm accuracy level per axis.

8 **Additional Print Head Control**
Positioned below the build area, head control remains easily visible and accessible during developer mode or maintenance.



Flush Signal Lights 9
9.1 Dedicated signaling of optional laser operation.
9.2 Real-time operation and status monitoring.

User-Friendly Control Panel 10
10.1 Large 24" touch display for effortless software control of all machine functions, from parametrization to slicing, 3D printing, analysis, and more.
10.2 Illuminated stainless steel buttons and emergency stop switch for quick actions.

Secured Access Interfaces 11
Future proof due to design compliance with the latest EU Machinery Regulation 2023/1230, effective January 2027.

Air-Conditioned Control Cabinet 12
Conveniently side-mounted ensuring reliable operation in various environments.

Extendable Air Maintenance Unit 13
Optimal Accessibility for Compressed Air Systems.

Integrated High-Performance Workstation 14
First-class performance through an efficient Multi Material Jetting workflow that enables seamless build job execution.

Adjustable Stainless Steel Feet 15
High load capacity for solid stand and optimal machine leveling.

MMJ ProX Series

System Overview | Build Area with Advanced Functional Modules.

1 Print Heads

Innovative jetting heads operate at up to 220°C and under air pressure. The system supports a flexible configuration of up to six print heads with a quick-release setup for fast and easy changes of heads, nozzle sizes, and materials.

2 Print Bed

2.1 Heatable print bed for (green) part build sizes of up to 530 x 300 x 200 mm³. **2.2** Rapid release mechanism for quick and easy print bed swapping for effortless part removal and maximized uptime. **2.3** Analysis Area for precise and automated drop deposition.

3 Service Station

Integrated automated service stations maintain print head performance through controlled purging and cleaning cycles.

4 Laser Profile Sensor

High-precision laser-based sensor, as a standard feature, used to capture 3D surface profiles of deposited materials, enabling inference on droplet and layer characteristics, as well as build process documentation and optimization.

5 High-Precision Pulsed Fiber Laser

5.1 Available as a powerful upgrade, the high-precision pulsed fiber laser enables optimized MMJ inline processing from surface ablation and smoothing to fine structuring at very high resolution. **5.2** The integrated extraction system ensures safe and efficient removal and filtration of material particles and vapors during laser processing.

MMJ ProX Series

System Overview | Control Unit and Software.

The MMJ ProX Series is a complete additive manufacturing platform, integrating high-performance hardware with tailored control software for Multi-Material part production.

The system's large 24" multi-touchscreen enables direct loading of .3MF files from USB or network sources. The 3D manufacturing format **.3MF**, standardized under **ISO/IEC 25422:2025**, ensures reliable data exchange for additive manufacturing workflows.

Design your Multi-Material parts in your preferred CAD software, export them as a .3MF file, and upload to the MMJ ProX. The **integrated slicer** automatically converts the model into a high-resolution point cloud, where each point defines the exact position of a deposited droplet. It intelligently assigns materials from the print heads to the corresponding colored volumes defined in the .3MF file.

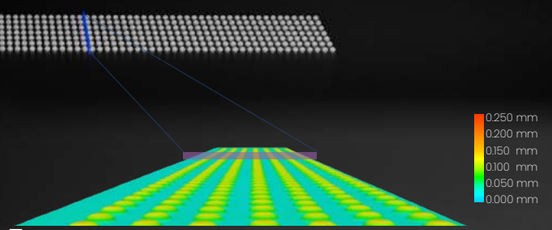
Your workflow, unchanged. Your possibilities, expanded.

To support the production of your unique parts and development of custom materials, **the system is fully open**, allowing complete parameter customization. even when working with your own, self-developed printing materials.

To manage the system's high degree of flexibility with ease, the **integrated high-precision profile sensor** continuously captures detailed topological data of each printed layer, from individual droplet characteristics to full 3D surface profiles. This enables reliable, data-driven quality assurance and process monitoring in real time.

Regular software updates keep your MMJ ProX system ahead of the curve, while **optional upgrades** can extend its functionality, ensuring long-term performance and future readiness.

Looking ahead, advanced smart features will increasingly assist and even automate optimization processes. As part of these developments, the optional pulsed fiber laser module, available pre-installed or as an upgrade, enables true hybrid manufacturing, combining additive and subtractive techniques. Upcoming software releases will unlock laser smoothing, ablation, and structuring, further expanding your system's manufacturing capabilities.



MMJ ProX - Series

Configure to Your Needs

The MMJ ProX is designed as a **modular system** to adapt to your specific needs and future requirements.

Configurations can include **multiple print heads**, allowing for 3D printing with different materials in a single build job. This enables the integration of functional details with **voxel-level precision**, paving the way for unprecedented miniaturization and functional grading.

Prioritizing both safety and flexibility, all configurations come standard with a **laser safety housing** featuring a large transparent pane door. This MMJ ProX Series design ensures uncompromised visibility for process monitoring with the human in the loop and allows for future expansion with the **optional laser module**.

Upgrade Anytime

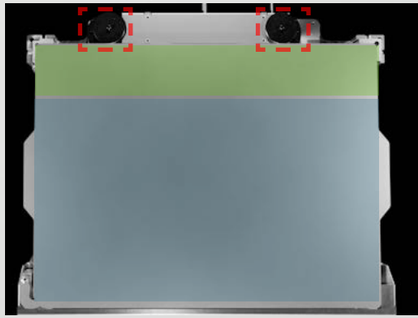
MMJ ProX3

The MMJ ProX3 configuration features three print heads, enabling the combination of up to three materials in a single manufacturing process. This allows the production of fully functionalized assemblies in one step by eliminating the need for multiple technologies and process stages, and significantly reducing costs through streamlined production.

MMJ ProX6

The MMJ ProX6 offers maximum flexibility and capability with its six-print-head configuration. It increases the number of usable materials within a single build, enables complex material gradients between different substances, and multiplies productivity by significantly reducing costs in series or large-format production.

Print Bed Zones
(Top down view)



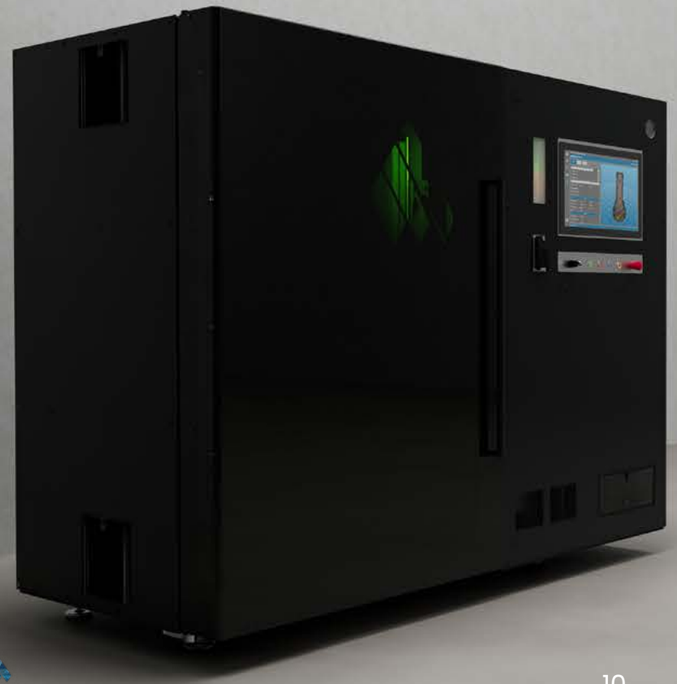
Manufacturing Zone
Maximum build envelope
530 x 300 x 200 mm³.

Analysis Zone
Dedicated area to ensure consistent droplet & layer quality.

Service Zones
With four or more print heads, a 2nd service zone is included.

Note: Configuration examples showcasing setups that include multiple print heads for manufacturing of Multi-Material components in a single build.

MMJ ProX - L Series



Subtractive
Joins Additive

Boost Your AM Power

To enhance the advanced manufacturing capabilities of the MMJ ProX, a **laser module** can be installed.

When the module is added, the laser safety housing is equipped with a **laser-safe door** insert. This insert features laser safety glazing, allowing direct operator monitoring while the laser module is active. Additionally, an **extraction system** ensures the safe and efficient removal, and filtration of material particles and vapors during laser processing.

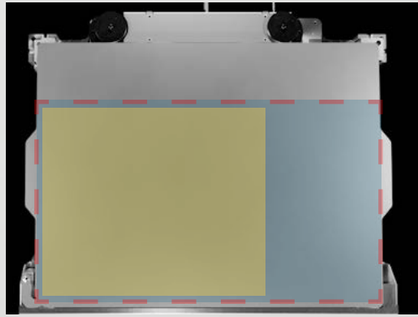
The **L-Package** can come pre-installed or be added later, conveniently transforming your MMJ ProX configuration into the even **more powerful** MMJ ProXL.

Upgrade with the Laser Processing Module

MMJ ProX3L

MMJ ProX6L

Print Bed Space
(Top down view)



The displayed configuration examples combine multiple print heads with a powerful laser module for advanced in-line surface processing, including ablation, smoothing, and structuring. This upgrade enables hybrid manufacturing — alternating between 3D printing and laser processing of each layer — for precise adjustment of both inner and outer surfaces of the part.

Since machining sintered components made from hard materials often accounts for most of the total cost due to expensive tooling, MMJ in-line laser processing of the green part can reduce or even eliminate post-sintering machining, resulting in substantial time and cost savings. Additionally, the laser upgrade improves accessibility, enabling the fabrication of high-quality internal structures that are unreachable by conventional CNC machining.

Print Heads R1, R2, R3
Maximum build envelope of
530 x 300 x 200 mm³ available.

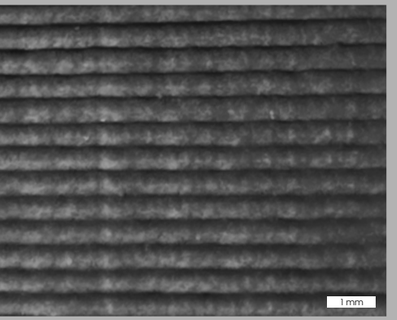
Print Heads L1, L2, L3
Maximum build envelope of
365 x 300 x 200 mm³ available.

Laser Zone
The laser covers the entire
print bed of 530 x 300 mm².

Hybridization

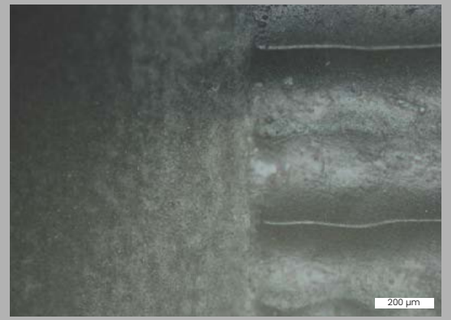
In-line Laser Surface Processing.

From Raw Surface to Perfection



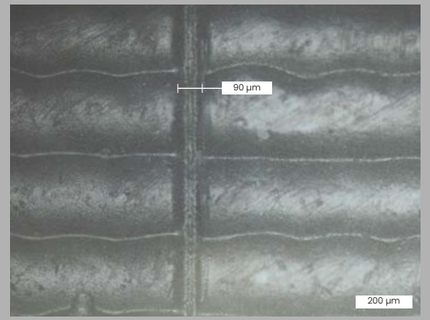
Initial surface roughness
Typical printing surface roughness is R_a 5–7 µm. In the case of the test sample (see image), a higher roughness of R_a 15 µm was deliberately generated by increasing the droplet spacing during deposition, resulting in a distinctly visible line structure.
Material: Silicon nitride molybdenum disilicide
Sample size: 50.00 x 50.00 mm

Re-Melting/Ablation



Inline Laser Processing
Enables selective re-melting and smoothing of the MMJ-printed surface. Layer by layer, the integrated fiber laser refines the microstructure, reducing surface roughness already in the green state. This ensures high surface quality, precision, and consistency before sintering.
Aim: Saving costs and time when manufacturing with the hardest of materials
Post-smoothing roughness: R_a < 0.5 µm

Structuring



Surface Structuring
Precisely controlled ablation selectively forms functional patterns and textures directly during printing, even on the hardest materials. This achieves high structural accuracy and enables the design of application-specific surface functions.
Aim: Enhancing component functionality and enabling advanced hybrid manufacturing. with the hardest of materials
Result: Channel width ≈ 90 µm

Subtractive joins Additive

Technology

Drop by Drop Material Deposition.

Multi **M**aterial **J**etting **» MMJ «** creates parts by overlapping droplets, building from single droplets to lines and then to entire layers. Each MMJ printing material combines fine powder, the actual material that forms the part, with thermoplastic binders and additives. When heated, it flows like a liquid, carrying the powder within.

As droplets of printing material are **selectively deposited** only where needed, they fuse together and **solidify instantly upon cooling**.

Such green parts are subsequently **debinded** and **sintered** to achieve their final properties, using the same proven industrial process applied to ceramic or metal injection molded parts.

Print Bed Top Down View

Lateral Resolution (xy), Layer Height (z), and Wall Thickness

Designed fully parameterizable, the MMJ print heads allow droplet volume and other characteristics to be adapted to the specifics of each Multi-Material part.


Lateral Resolution
200 µm to > 1000 µm

The lateral resolution (xy-plane), defined by the droplet diameter, ranges from 200 µm to over 1000 µm.*

** depending on the material used.*

The layer height » z-axis «, roughly equivalent to the droplet height, varies from 70 µm to 300 µm – approximately from the thickness of a human hair to roughly the diameter of a needle.

Correlated to droplet diameter, the droplet volume spans from 0.5 nl » as small as a bacterial cell or even smaller than a speck of dust « up to more than 25.0 nl » approximately the volume needed to cover the cross-section of a human hair «.

Wall thicknesses can range from a single droplet's diameter up to 20 mm.

Benefits

Multiply value creation.

- Material-agnostic AM technology with a growing portfolio of **high-performance materials**.
- Complex geometries with contrasting material properties in one build. **High design freedom**.
- Integration of multiple functions, structural and functional, in one process without complex or time-consuming assembly steps. **Simplified, efficient** manufacturing.
- Miniaturization and weight reduction.
- **Functional Graded Components** (FGC). Seamless transitions between materials and properties.
- Digital workflow accelerates development, prototyping, and testing while **saving resources**.
- **Flexible** material combinations nable better-performing, application-specific designs.
- In-line laser-based green processing **minimizes** or eliminates **costly finishing steps**, saving time and expense with hard-to-machine materials.

Materials

Oxide, Nitride & Carbide Ceramics

Alumina
(High purity, electrical conductive)
Zirconia
(3YTZ (white), 8YTZ, black, blue, luminecent, electrical conductive)
Alumina Toughened Zirconia
Zirconia Toughened Alumina
Aluminum Nitride
Silicon Nitride
Silicon Nitride Molybdenum Disilicide
(electrical conductive, insulating)
Silicon Carbide
(RSiC, SSiC)
Silicon Carbide - Glass
Titanium Oxide
(Electrical conductive, electrical insulating)
Nickeloxid
(NiOYSZ, NiOGDC)

Sinteres Glasses

Borosilicate glass
(Electrical conductive, electrical insulating, luminecent, coloured)
Lead glass

Silicate Ceramics

Porcelain

Glass-Ceramics

Low Temperature Co-fired Ceramics (LTCC)

Cemented Carbides & Cermets

Tungsten Carbide Cobalt (WC-6Co, WC-8Co, WC-10Co, WC-12Co, WC-16Co)
Tungsten Carbide Nickel
Titanium Carbonitride (Cermet)

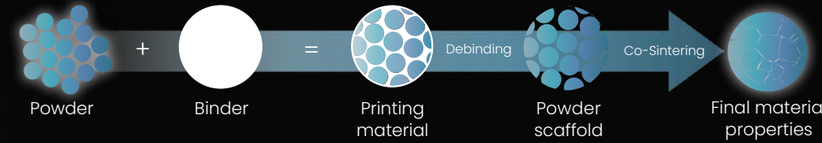
Metals

316L
17-4PH
Silver
Copper
GRCop-42
IN718

Thermoplastic Polymers T_m<220°C

Particle-filled Polymers

Proven Process. Reliable Results.



The powder-based process route in MMJ follows an established industrial method, comparable to injection molding. Each **MMJ material** combines fine powder with thermoplastic binders and high-performance additives, enabling a broad range of multifunctional applications. MMJ seamlessly merges multiple materials within a single part, all in one print.

Leverage MMJ
Use customized printing materials tailored to your needs and select from a broad range of material powders.

Particle size flexibility
Supports powders from 40 nm to 25 µm, with even larger particles possible via adjusted nozzles.

Morphological adaptability
Compatible with powders of various shapes, from spherical to irregular.

Optical-agnostic
Overcome the inherent limits of light-based processes such as SLA & VPP for broader material freedom.

BYOP

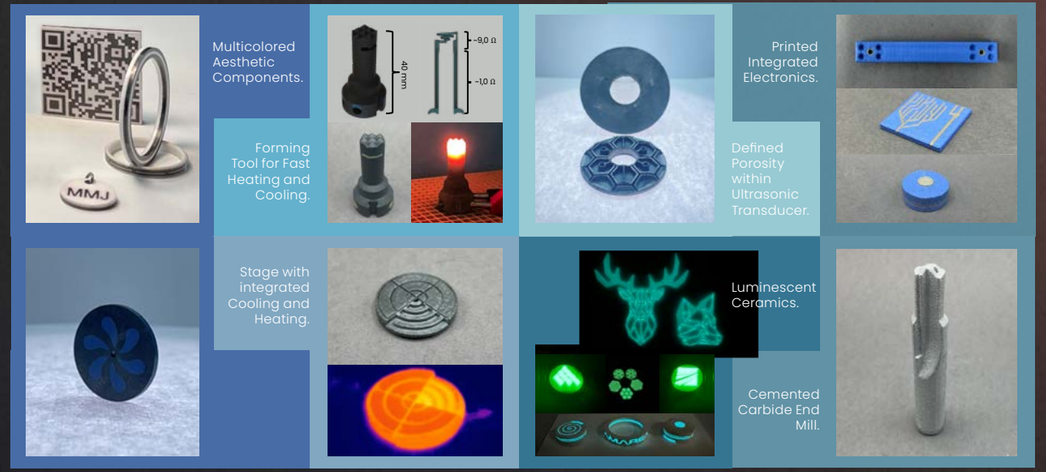
You bring it. We convert it. You use it.

AMAREA Technology offers its unique »**B**ring **Y**our **O**wn **P**owder« (BYOP) service, transforming almost **any powdered material into** an **MMJ printing material** through advanced thermoplastic binder systems. Recognizing that every application has specific requirements, we provide unmatched flexibility in 3D printing materials.

While our portfolio already includes a wide range of high-performance printable materials, BYOP extends this spectrum by enabling clients to use their own specialized powders. Through close collaboration, we develop exclusive materials tailored to each client's needs, seamlessly integrating proprietary powders into the MMJ process and **pushing the boundaries** of next-generation multi-material parts.

From Lab to Fab

Selection of Industry Use Cases



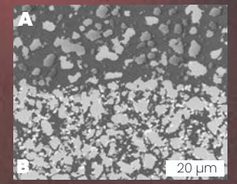
Where others see limits, we see combinations. We engineer answers, not assumptions.

Printed Electronics

Fast-Heating Tool Design. Using MMJ to print Multi-Material parts with embedded conductors and cooling channels. Maximizing design freedom for targeted heating and thermal control.

Multi-Material CAD-Design

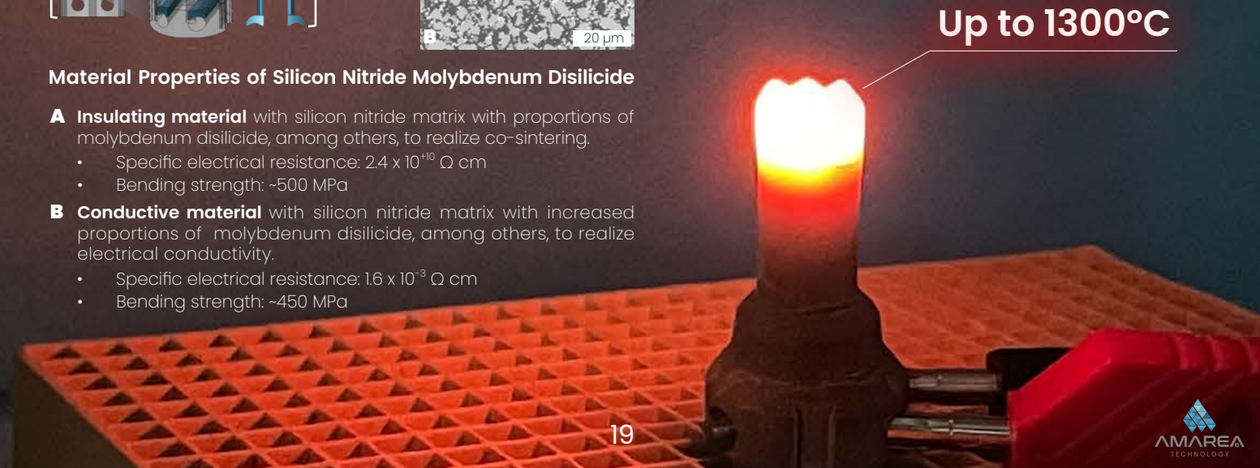
Interface Electrical Conductive and Insulation Material



Material Properties of Silicon Nitride Molybdenum Disilicide

A **Insulating material** with silicon nitride matrix with proportions of molybdenum disilicide, among others, to realize co-sintering.
- Specific electrical resistance: 2.4 x 10^{+10} Ω cm
- Bending strength: ~500 MPa

B **Conductive material** with silicon nitride matrix with increased proportions of molybdenum disilicide, among others, to realize electrical conductivity.
- Specific electrical resistance: 1.6 x 10^{-3} Ω cm
- Bending strength: ~450 MPa



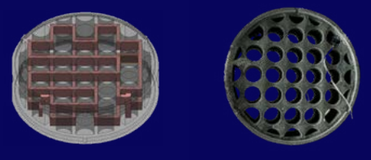
Printed Electronics

Sustainable heat for a cleaner future.

Combining conductive and insulating grades of Si_3N_4–$MoSi_2$, this Multi-Material 3D-printed component demonstrates how functional ceramics unite electrical performance with sustainability.

The structure delivers uniform heating, oxidation resistance, and high thermal efficiency, ideal for cyclic CO_2 capture applications.

Material
Si_3N_4–$MoSi_2$



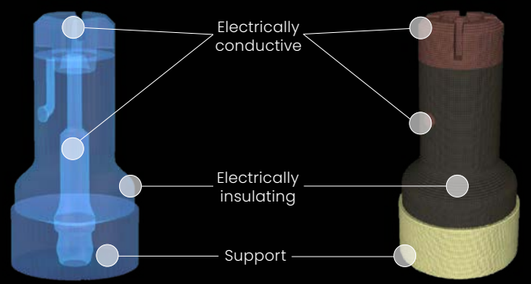
By tailoring material compositions and electrical properties, the component achieves:

- Electrode resistance: ~65 Ω
- Insulation resistance: > 1×10^9 Ω
- Breakdown voltage: 40 V
- Generated current flow: 4 A

Spark Plasma Igniter for Aerospace Engines.

Developed in collaboration with the Institute of Aerospace Engineering at TU Dresden, this multi-material igniter redefines ignition systems for rocket engines. Unlike conventional single-use spark plugs, it withstands repeated plasma ignition cycles and extreme environmental conditions.

Engineered from a combination of conductive and insulating Si_3N_4–$MoSi_2$ ceramics, the component endures temperatures up to 1300°C while maintaining electrical integrity and mechanical stability.

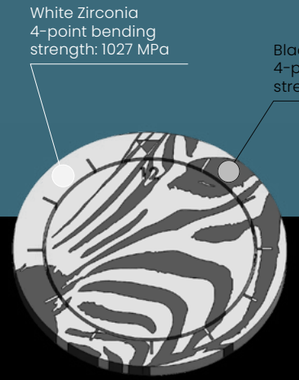


Multi-Material design with integrated electrical traces

Sintered & finished

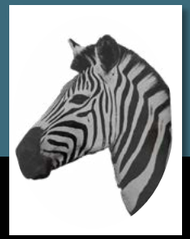
Multicolored Aesthetic

Components with aesthetic features such as selectively colored voxels.

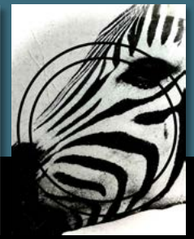


Rendering

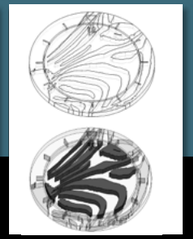
Motive zebra



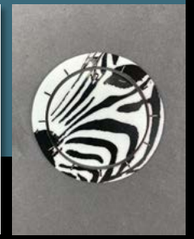
Digital transfer I



Digital transfer II



Finished dial&bezel



Spatially discrete color (material) combinations were manufactured in a single build job without any separate assembly or joining.

Colorful accents can be realized by using material powders colored by synthetic pigments.

In addition to spatially discrete color combinations, color gradients can also be realized in a component.

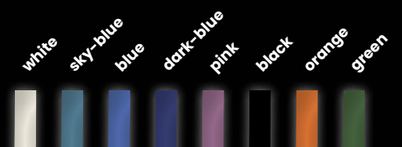
Color up your Ideas

Shape your ideas not only by function, but by color and expression.

Colored zirconia and ATZ ceramics combine outstanding mechanical performance with refined aesthetics. A wide color palette from pure white to deep black, green, orange, light and dark blue, and many more is available on the market. These materials offer high strength, excellent wear resistance, and flawless surface finishes ranging from matte to mirror-polished.

At AMAREA Technology, we have extensive experience, whether you aim for a single elegant color or want to combine multiple hues in one part. We take it a step further: our MMJ ProX Series can print with multiple colored zirconia materials in a single build, enabling unique design freedom and aesthetic precision. Colors shown are examples and may vary after sintering and processing. No liability for deviations.

» *What will you enhance next:*
color, function, or both? «



Services

Innovations Require the Right Approach.

Getting to Know You
We can arrange on-site or online meetings to understand your needs and goals.

NDA for Sensitive Topics
We ensure full confidentiality with a Non-Disclosure Agreement.

Part Feasibility Consultation
Our experts assess part feasibility and recommend suitable materials and designs.

Prototypes and Demo Parts
We create and manufacture prototypes and demonstration parts to validate designs and material performance ahead of your MMJ ProX installation.

Production Support
We support your transition from prototyping to production, providing guidance on process upscaling and on equipmen for debinding and sintering that we know works reliably in practice.

Inspection, MRO, and Upgrades & Updates
Comprehensive services for inspection, maintenance, repair, and upgrades to ensure peak performance.

BYOP
Customized printing materials for your specific needs.

Acknowledgements.

AMAREA Technology emerged from the CerAM MMJ project and received funding from the German Federal Ministry for Economic Affairs and Climate Action (BMWK) and the European Social Fund (ESF) under the EXIST program.

In addition, AMAREA Technology receives financial support from the Sächsische Aufbaubank (SAB) within programs co-financed by the European Union.

These initiatives contribute to the further development of AMAREA's Multi-Material Jetting (MMJ) technology, combining Multi-Material capability, precision, and innovation to shape the future of hybrid additive manufacturing.

Funded by the European Regional Development Fund. Our contribution to a sustainable development. This project is co-financed with tax funds on the basis of the budget approved by the Saxon State Parliament.

Combine Material Properties

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