The revolution of innovative architecture structures.

When design meets *efficiency.*

Capgemini

Index

Introduction

Additive manufacturing (AM) has proven its worth in prototyping, but scaling to industrialization remains complex. Challenges include speed of production, need to post-process the component, expertise in Design for Additive Manufacturing and fragmented workflows. Companies need a structured approach spanning strategy, design, and production. From an engineering perspective, four barriers stand out: materials, quality, scale, and integration.

Materials & Process Control: AM offers limited material options, and variability in powder flow or thermal behaviour impacts quality. AI-driven materials informatics can identify new combinations, while digital material passports ensure consistency and traceability.

Quality & Reliability: Repeatability is a bottleneck. Edge AI can monitor melt pool dynamics in real time for closed-loop corrections and early defect detection. Digital twins enable virtual validation, reducing qualification time for regulated sectors like aerospace.

Scale & Speed: Current AM machines lag behind casting or moulding in throughput. Innovations such as ETH Zurich's RAPTURE and AI-enabled process control show promise for automation that boosts speed without sacrificing precision.

Design & Standardization: AM demands a Design for Additive Manufacturing (DfAM) mindset – lightweighting, function integration, and manufacturability. Digital continuity across CAD, PLM, MES, and ERP is essential to preserve design intent and eliminate data fragmentation.

This paper focuses on the design phase, offering insights, methodologies, and tools to help companies scale AM effectively. At Capgemini, we support clients in automotive, aerospace, energy, and shipbuilding to move from pilots to integrated industrial systems. Our approach treats AM as an engineering challenge – spanning materials, design, process control, and digital execution. In short: we help companies "*Make it real*".

Ramon Antelo

Architectured metamaterials: From concept to capability.

Additive manufacturing defines how we make; architectured metamaterials redefine *what* we can make. These engineered materials leverage spatial architecture – lattices, trusses, and triply periodic minimal surfaces (TPMS) – to control properties such as stiffness, thermal expansion, damping, heat transfer, and wave propagation.

Advances in high-precision additive manufacturing now enable micrometer accuracy and multi-material integration, opening the path to programmable materials – objects whose function is tailored through geometry and process parameters.

At ETH Zurich, in collaboration with Capgemini, we explore the inverse design of architectured metamaterials, with a focus on multi-material systems. Our AI-driven algorithms map desired functional properties – mechanical strength, thermal expansion, thermal conductivity – back to the micro-architectures required to achieve them. By coupling physics-based simulation with generative machine learning, we automate structure synthesis, transforming an expert-driven, iterative task into an intelligent, data-guided process.

This research complements Capgemini's digital engineering and industrialization capabilities, integrating inverse design, simulation, and additive manufacturing into a seamless workflow. Together, we aim to build a closed-loop design-to-production ecosystem – from defining material behavior to validating and fabricating at scale.

Architectured metamaterials represent the next evolution of additive manufacturing, where AI solves high-dimensional inverse design problems. This publication explores how digital engineering and intelligent design are making that vision a reality.

Markus Bambach

01

Executive summary

01 Executive summary

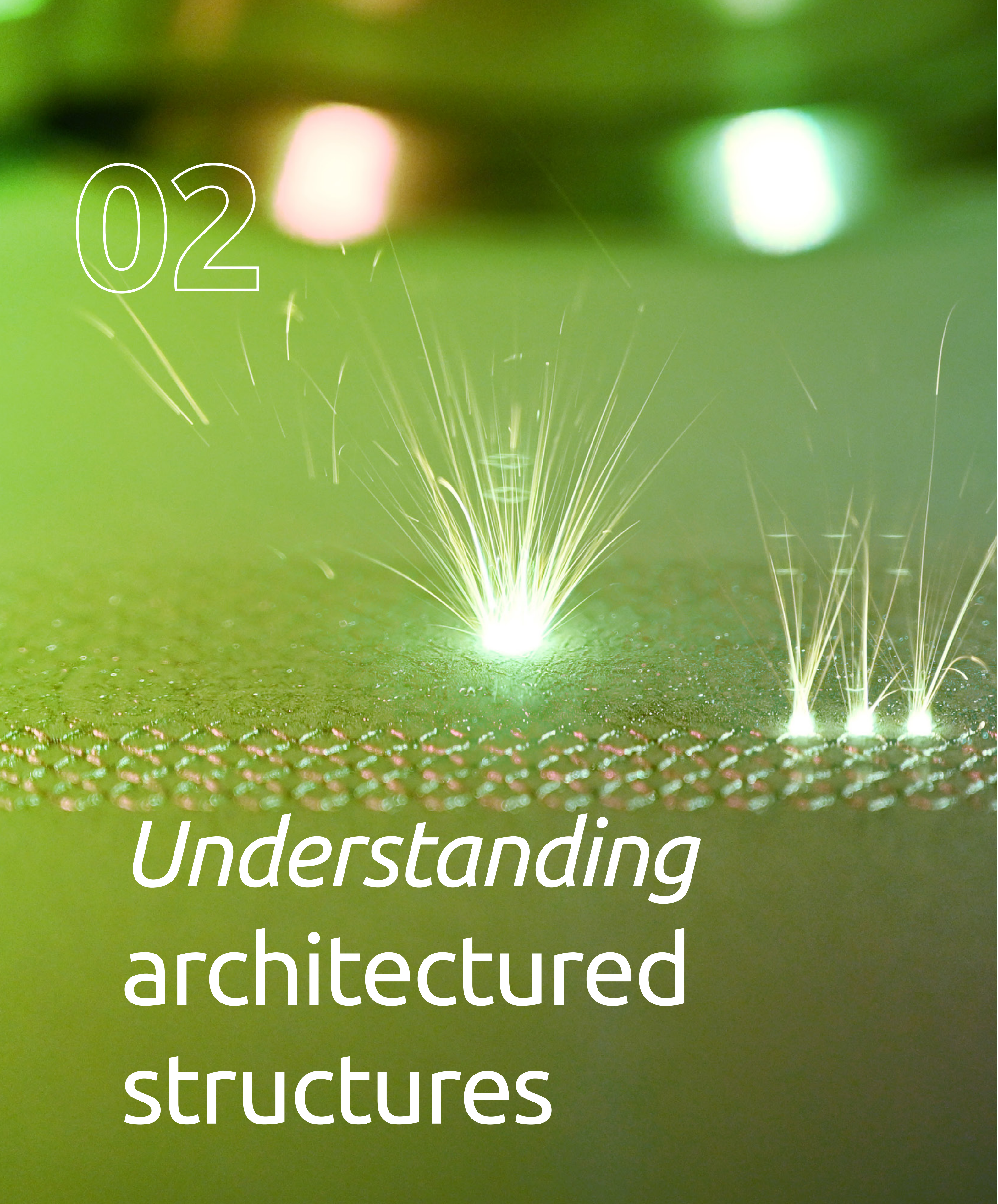
Modern industries increasingly demand materials that offer superior performance, greater efficiency, and enhanced customization. Traditional materials often fall short, due to limitations in weight, mechanical properties, and functional adaptability. Architectured lattice structures provide a revolutionary solution, using complex internal geometries to optimize material behavior and overcome these limitations.

These structures are engineered to enhance critical physical attributes like strength, stiffness, thermal conductivity, and acoustic insulation, all while significantly reducing material usage. Their versatile design makes them ideal for high-demand applications across a wide range of sectors, including aerospace, automotive, energy, and biomedical fields.

Thanks to advanced manufacturing techniques, particularly additive manufacturing (e.g. 3D printing), these lattice structures can be fabricated with unprecedented precision, enabling the production of lightweight yet robust components tailored to specific needs.

For example, Nissan has developed an acoustic metamaterial that is one-quarter the weight of traditional materials while offering the same level of sound isolation. This innovation not only reduces vehicle weight, but also improves energy efficiency without compromising passenger comfort[1]. In the biomedical field, lattice structures are increasingly used in orthopedic implants to promote better bone integration and extend the longevity of the implants, providing more personalized and effective medical solutions[2].

This white paper delves into the transformative potential of architectured lattice structures, focusing on their capabilities in mechanical, thermal, and acoustic domains. It introduces an intuitive graphical interface designed to simplify the design and customization process, even for non-experts. By merging cutting-edge computational design with advanced fabrication techniques, these materials are poised to define the future of sustainable, high-performance engineering. Through real-world examples and insights, the document highlights the practical benefits and adoption pathways for industries to leverage these advanced materials.



02

Understanding architectured structures

02 Understanding architectured structures

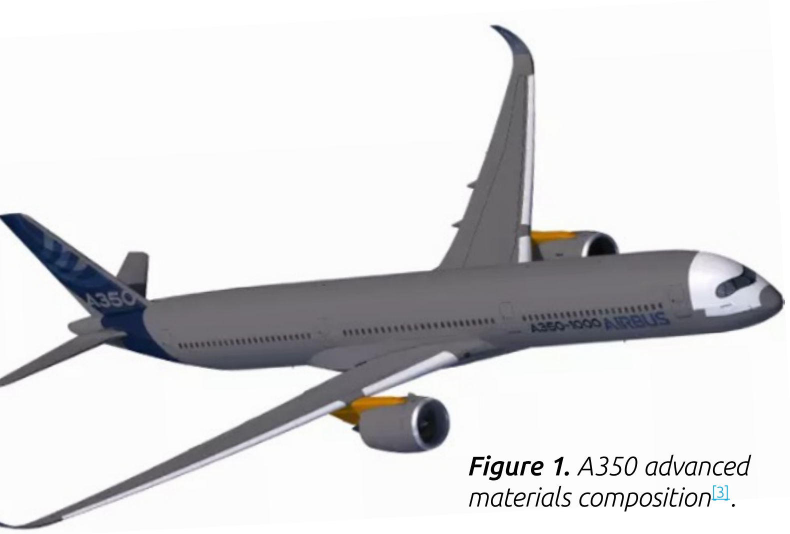
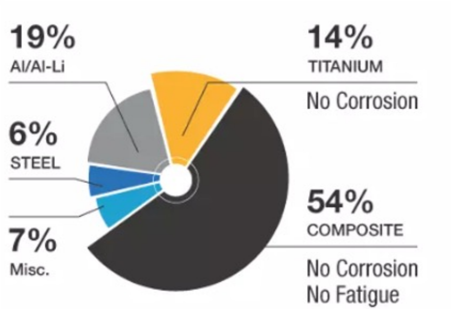


Figure 1. *A350 advanced materials composition*[3].

Figure 1

Structural mass



For decades, composite materials have played a foundational role in high-performance engineering, particularly in the aerospace industry, where reducing weight without compromising strength is critical.

In modern aircraft such as the Airbus A350, composites represent over 54% of the structural mass, see *Figure 1*, highlighting their profound impact on modern design strategies and operational efficiency. These materials have enabled significant weight reductions, resulting in improved fuel economy, extended flight range, and lower emissions.

Their combination of lightness, durability, and resistance to fatigue has redefined aerospace manufacturing standards and continues to drive innovation in aircraft design.

Building on this foundation, architectured materials represent a transformative evolution. Unlike traditional materials defined by their bulk composition, architectured materials are distinguished by their engineered internal geometries. This paradigm shift enables the creation of lightweight, multifunctional structures across industries including aerospace, automotive, medical, and consumer products.

A core advantage of architectured structures lies in their lightweighting capabilities. Through geometric optimization, these materials can reduce mass while maintaining, or even enhancing, mechanical performance. For example, cylindrical lattice structures in satellite applications have achieved up to 25% mass savings compared to conventional designs[4].

Industry leaders like Adidas and Nissan have applied lattice-based metamaterials in footwear and acoustic panels, respectively, advancing performance in energy efficiency, impact absorption, and noise control. Lattices with tailored porosity and topology enable precise vibration control and enhanced acoustic damping, offering superior sound absorption capabilities in compact systems.

The environmental and economic benefits of these structures are equally compelling: they optimize material usage, reduce manufacturing waste, and support sustainability through lower energy consumption and production efficiency.

Benefits

Architectured lattice structures provide several advantages over more conventional materials. There are also benefits derived from the additive manufacturing (AM) process by which they are produced. These benefits include:

- Lightweighting: lattice structures can reduce the weight of components and products, without compromising performance requirements.
- Energy absorption: the geometry of lattice structures enables products manufactured using AM techniques to distribute forces applied to them. This ability to reduce or dissipate the effects of force can be useful in many product areas, including bicycle helmets, body armor, and automotive safety components.
- Thermal management: that same geometry also changes the ratio of surface area to volume, dissipating heat more effectively than materials manufactured more conventionally. Product areas that benefit from this propensity include heat exchangers, electronics cooling, and aerospace thermal systems.
- Biomedical integration: the porous nature of architectured structures increases the propensity of their integration in medical implants.

Some benefits are connected:

Sustainability:
Lattice structures reduce the quantities of materials needed in production, which not only increases sustainability, but leads to…

Increased efficiency:
Components designed using architectured lattices are both more sustainable and more cost-efficient. They also provide…

Reduced production lead-times:
AM manufacturing can be both rapid and precise.

Applications

Composite materials produced via additive manufacturing techniques in lattice structures can be used in a wide variety of ways, including:

- Automotive manufacture: car components can be lighter and can absorb shock and sound, without compromising on strength or durability.
- Biomedical: orthopedic implants manufactured in lattice structures via AM techniques integrate more readily with bone, and also provide greater longevity.
- Aircraft design: the combination of strength and lightweighting is particularly useful in aircraft design, resulting in improvements to fuel economy, flight range, emissions, resistance to fatigue, and durability.
- Satellite design: cylindrical lattice structures can reduce mass while maintaining strength and performance.
- Consumer product design: footwear can be durable but lighter in weight, and can be produced using less material.
- Rocket science: AM techniques can produce highly complex, performance-optimized parts at scale.

See *Figure 4* for a graphic summary of real and potential application areas.

Relativity Space's Terran 1

A compelling example of the design freedom enabled by additive manufacturing is Relativity Space's Terran 1 rocket. Produced with a significant proportion of 3D-printed components, including fuel tanks and engines, it demonstrates the feasibility of fabricating highly complex, performance-optimized parts at scale. While architectured geometries have not been explicitly confirmed in this context, the achievement showcases the level of precision and integration possible through advanced fabrication.

Figure 2
Unparalleled precision

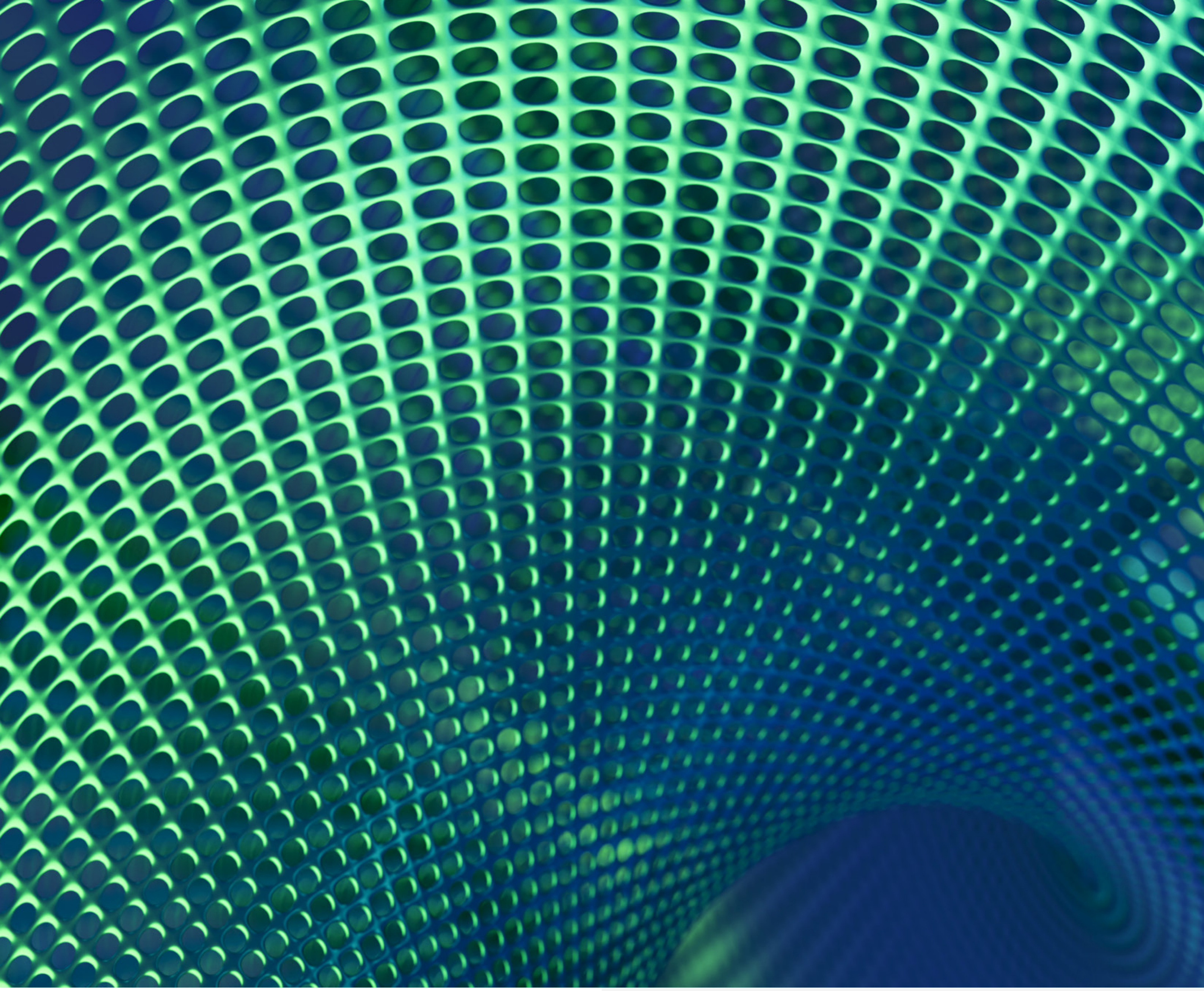
Figure 2. *3D printing technology enables the creation of rocket tanks with unparalleled precision*[5].

Relativity Space's advanced 3D printing technology enables the creation of rocket tanks with unparalleled precision and efficiency, see *Figure 2*. On the left, the image showcases a rocket tank being 3D printed, highlighting the intricate internal structures. On the right, the image features the Terran 1 rocket, fully 3D printed and ready for launch, demonstrating the culmination of this innovative technology.

Beyond lightweighting, architectured structures excel in energy absorption, thermal management, and biomedical integration. Their geometry allows efficient force distribution, making them ideal for impact mitigation in products like bicycle helmets, body armor, and automotive safety components.

The high surface-area-to-volume ratio of lattice networks enhances heat dissipation, supporting applications in heat exchangers, electronics cooling, and aerospace thermal systems. By maximizing surface area while minimizing material usage, architectured lattices serve as highly effective and compact thermal solutions.

In biomedicine, lattice structures are used to fabricate implants with porous architectures that promote osseointegration, the natural bonding of bone to implant surfaces. This leads to faster recovery, better mechanical compatibility, and customized patient-specific designs.



At the core of this versatility is the diversity of lattice geometries, each tailored to specific performance criteria:

- Surface-based lattices (e.g. TPMS – Triply Periodic Minimal Surfaces) are derived from mathematical equations, forming continuous structures like the gyroid, known for isotropic properties and excellent strength-to-weight ratios.
- Strut-based lattices consist of rod-like elements arranged in repeating patterns, commonly used for load bearing and energy-absorbing applications.

These geometries are further customized depending on the material class:

- Metals (e.g. titanium, aluminum): ideal for hexagonal and rhombic lattices for strength and durability.
- Polymers (e.g. nylon, polycarbonate): paired with honeycomb or Voronoi patterns for flexibility and lightweight performance.
- Ceramics (e.g. alumina, silicon nitride): often shaped into TPMS lattices for heat resistance and stiffness.
- Composites (e.g. carbon or glass fiber-reinforced polymers): compatible with truss and tetrahedral designs for optimized strength-to-weight efficiency.

Figure 3
Representative lattice structures

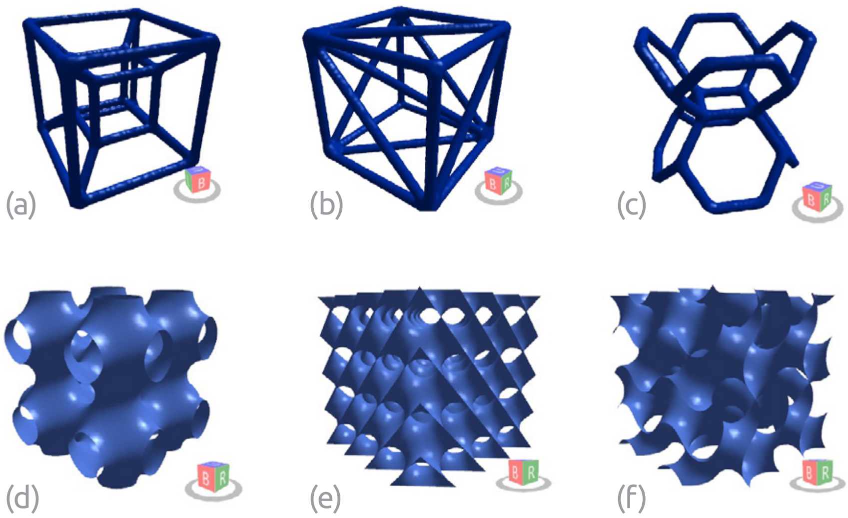
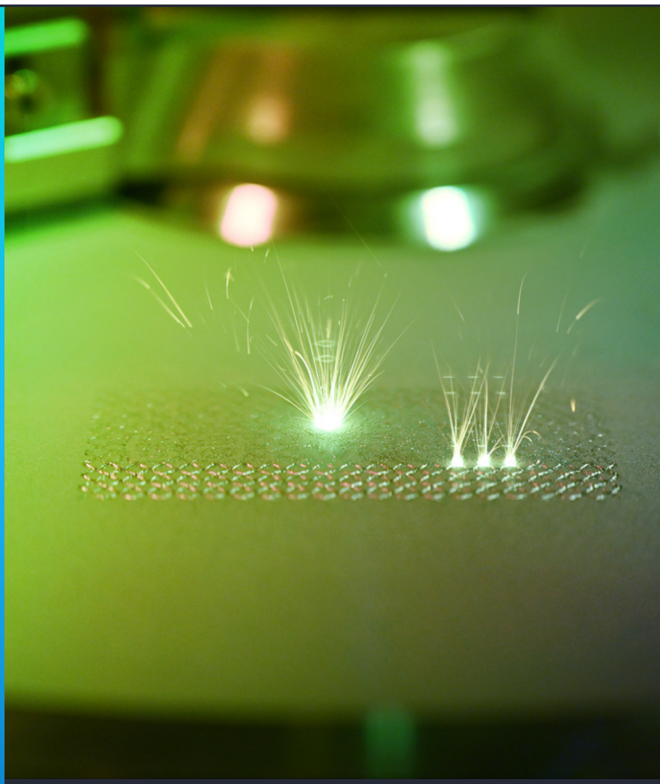


Figure 3. Representative architectured lattice structures. *(a) Tessaract, and (b) Tetrahedral structures – examples of strut-based lattices used for their mechanical efficiency; (c) Vintiles – showcasing a hybrid design approach; (d) Schwartz Primitive, (e) Schwartz Diamond, and (f) Gyroid – examples of triply periodic minimal surfaces known for their high surface area and isotropic mechanical behavior.*

This presents representative lattice structures, illustrating both strut-based and surface-based designs such as tetrahedral, tessaract, and gyroid structures, highlighting the geometric complexity and multifunctional potential of architectured materials. The compatibility of these designs with additive manufacturing further enhances their industrial relevance, enabling the precise realization of complex designs, unattainable through conventional methods.



By uniting geometry, material science, and advanced additive manufacturing, architectured lattice structures are redefining the boundaries of material performance. This means lighter, stronger, and more efficient solutions to meet the most demanding engineering challenges.

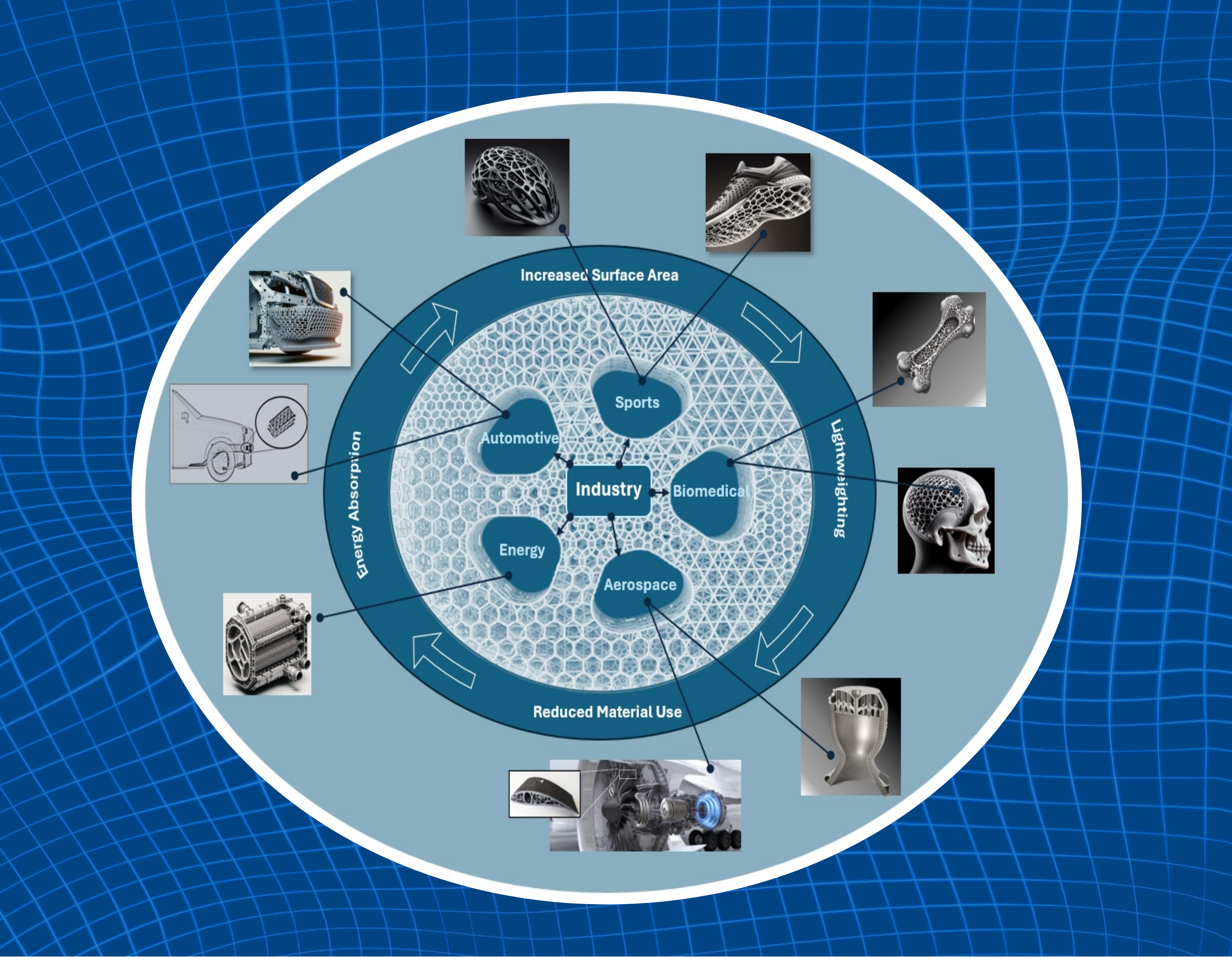


Figure 4. Examples of applications of architectured TPMS and lattice structures across Industries.

Figure 4

Applications across industries

This multifunctionality underscores their transformative potential across modern industries, as illustrated in *Figure 4*, which highlights applications of TPMS and lattice structures in automotive, aerospace, biomedical, and consumer sectors. Their optimized geometry facilitates a wide range of functions, such as energy absorption, lightweighting, protective capabilities, large void space creation, and biocompatibility – enabling them to meet the demanding requirements of advanced engineering applications.

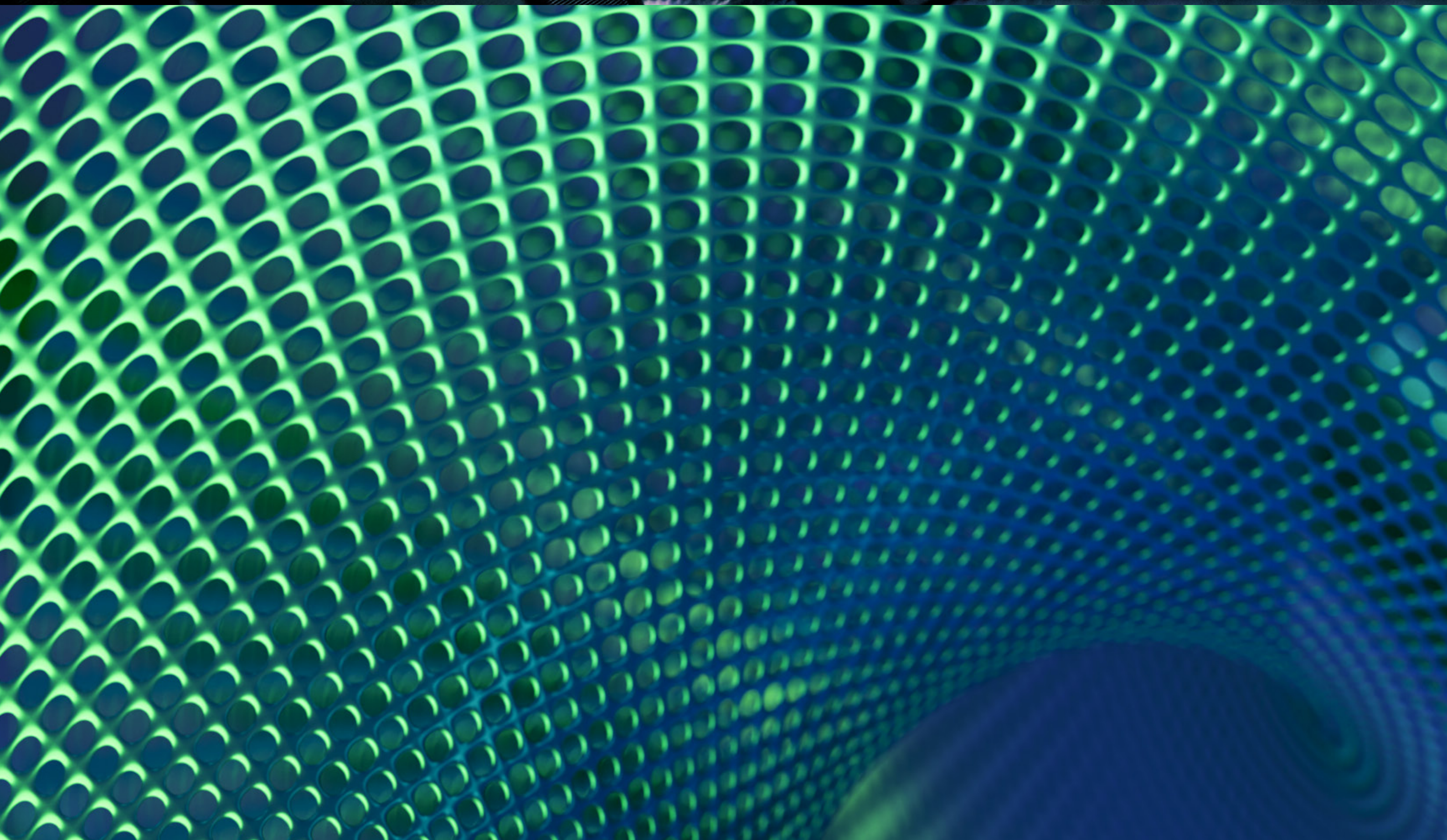
The commercial potential of architectured materials is undeniable, and their integration into key sectors like aerospace, automotive, healthcare, and consumer goods opens the door to numerous opportunities.

However, for these materials to become widespread and meet specific industrial needs, several technical challenges must be overcome. Companies aiming to leverage these materials at scale will need to develop tailored design tools, characterize their physical properties, and refine additive manufacturing processes.

These requirements highlight the need for innovations in engineering to ensure the competitiveness of architectured solutions, both in terms of cost and performance. It is within this framework that key challenges in design, production, and certification must be addressed.

03

Key engineering *challenges*



03 Key engineering challenges

Companies producing architectured materials will need to address several significant engineering challenges to successfully commercialize and scale these solutions across various industries. Some of the critical areas for development include:

a. **Design tools:** Advanced design software and simulation tools capable of handling complex geometries and material behaviors in architectured structures are essential for optimizing the performance and manufacturability of these components. This will ensure they meet the rigorous demands of industries such as aerospace, automotive, and healthcare.

b. **Characterization of physical properties:** Accurate physical property characterization, including mechanical strength, durability, and fatigue resistance, is crucial for validating the performance of architectured materials in real-world applications. A better understanding of these properties will help ensure that these materials can perform consistently under varied conditions.

c. **Development of additive manufacturing processes:** As these materials rely heavily on additive manufacturing, enhancing the capabilities and scalability of these processes is vital. This includes improving speed, precision, and material compatibility, while also reducing costs. Efforts in this area will make the large-scale production of architectured materials more viable and cost-effective.

d. **Sustainability in additive manufacturing technologies:** Some additive manufacturing approaches, like laser based technologies, are energy consumption intensive, compared to traditional manufacturing for high volume. It's difficult to recycle the contaminated powder waste of powder-based processes. Multi-material and complex additive manufacturing designs pose challenges for disassembly, repair, and remanufacturing, hindering sustainable practices.

e. **Quality and certifications:** Ensuring the quality and consistency of architectured components is critical, especially for industries such as aerospace and healthcare, where failure is not an option. Standardizing certification processes for these new materials will be essential for their widespread adoption. Reliable testing methods and clear industry standards are needed to ensure confidence in these components' performance.

While these challenges may seem daunting, they present opportunities for innovation and growth. Advanced design tools, such as those developed for optimizing complex lattice geometries and enhancing manufacturability, can play a crucial role in overcoming many of these obstacles.

By leveraging such technologies, companies can accelerate the development and commercialization of architectured materials, bringing them closer to widespread industrial adoption.

04

Addressing challenges through *digital engineering*

04 Addressing challenges through digital engineering

The integration of architectured materials into various industries presents a range of challenges that must be addressed to enable large-scale adoption and commercialization. Digital engineering tools, particularly advanced design and simulation technologies, play a crucial role in overcoming these obstacles. Below, we explore how digital engineering can help address each of the key engineering challenges identified in the previous section.

a. Design tool

A major barrier to the adoption of architectured materials lies in the lack of design tools that can efficiently handle complex geometries, adapt to specific constraints, and support advanced manufacturing processes. Traditional CAD software and academic tools often lack the flexibility, performance, or usability required for industrial applications, particularly in the early stages of concept generation and design optimization.

To address this gap, a custom parametric design tool was developed as part of the MODEST project. This tool provides a graphical interface for generating a wide variety of lattice structures, including TPMS and truss-based designs, with full control over key parameters such as cell size, thickness, and topology. It integrates real-time visualization, compatibility with simulation software (e.g. Abaqus), and direct export for 3D printing, streamlining the transition from design to manufacturing.

Two complementary solutions were implemented:

- **A *user-friendly GUI*, built in Grasshopper, allows intuitive design of single-material lattice structures and supports export in STL and INP formats, with embedded metrics such as relative density and connectivity checks.**
- **A *Python-Grasshopper* workflow enables automated generation of large, varied datasets of lattices for machine learning applications, and also supports multi-material integration.**

Figure 5

The GUI interface

Figure 5 represents the GUI interface used to create and parameterize a wide range of lattice structures. The interface is structured into four parts: (a) lattice type selection, (b) design parameters, (c) export options (STL, INP), and (d) live metrics, such as relative density and connectivity.

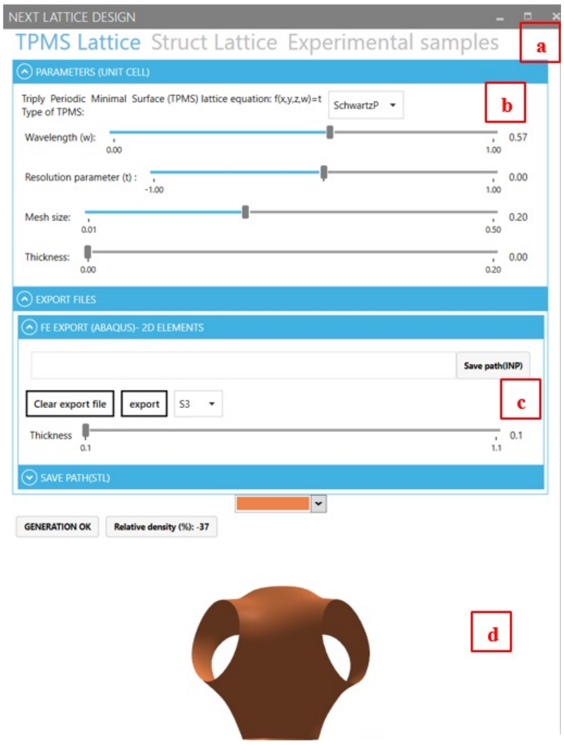


Figure 5. *GUI for the generation of lattice structures.*

Figure 6

Cylindrical samples

Figure 6 presents examples of cylindrical samples created with the tool, which have been used to characterize the acoustic absorption properties of gyroid-based porous structures.

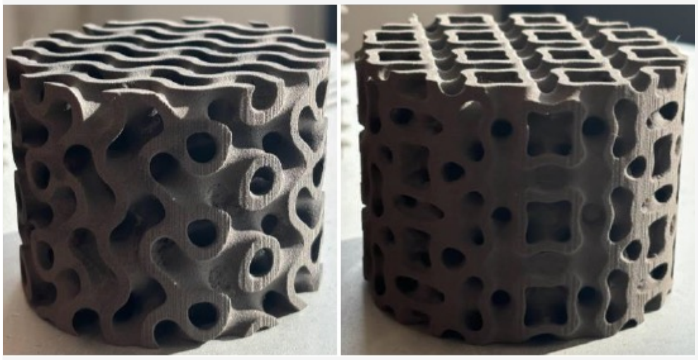


Figure 6. *Acoustic sample designs created with the GUI.*

Figure 7

Methodology used to generate multi-material lattice designs

To support advanced design exploration, a second solution was developed – a Python-Grasshopper workflow enabling the automatic generation of lattice databases with randomized parameters. This method not only facilitates large dataset creation for AI-based applications, but also allows for the exploration of multi-material lattices.

Figure 7 illustrates the methodology used to generate multi-material lattice designs through this automated workflow.

Together, these tools improve design flexibility, manufacturability, and data-driven optimization, crucial steps in making architectured materials viable at scale, even without relying on digital twins.

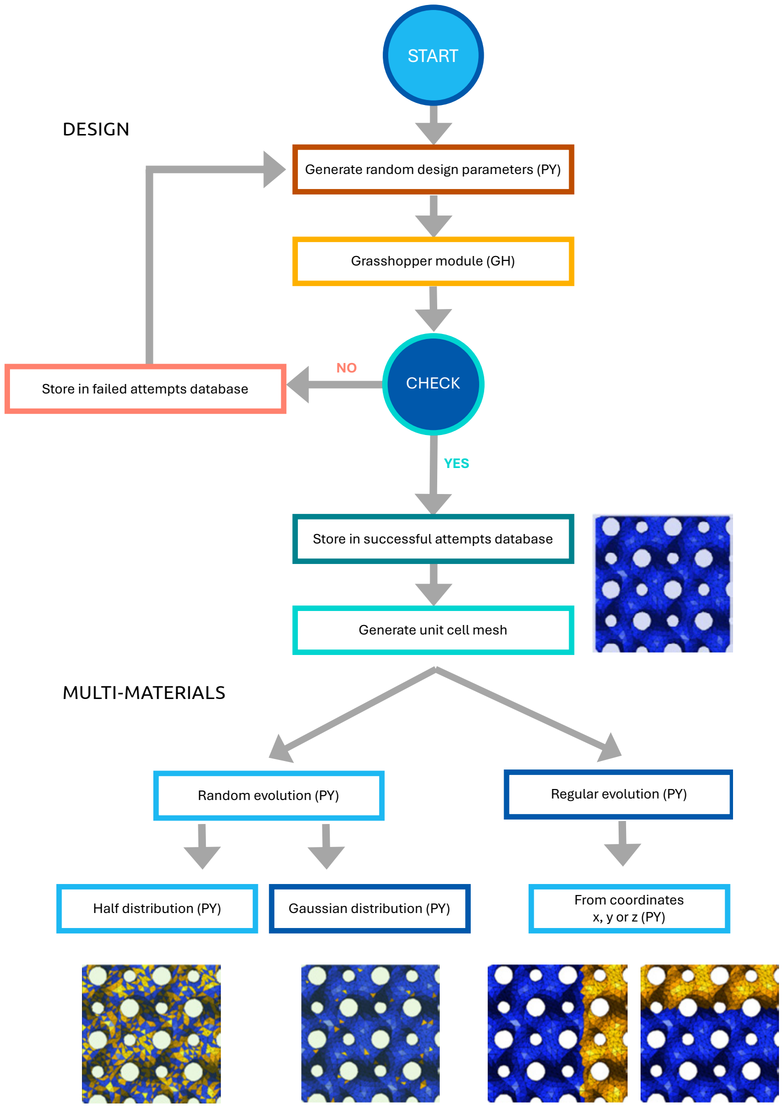


Figure 7. *Methodology for multi-material lattice design.*

04

b. Characterization of physical properties

Accurately characterizing the physical properties of architectured structures is essential to validate their mechanical performance and ensure reliability in real-world applications. Given the complexity of these materials, a combination of experimental and computational methods is often required to capture their behavior under different loading and boundary conditions.

On the experimental side, advanced techniques such as Digital Image Correlation (DIC) provide full-field, high-resolution measurements of strain, enabling precise tracking of deformation across intricate geometries. Optical caustics can be used to evaluate stress intensity factors, offering valuable insights into local stress fields, particularly around defects or cracks. In addition, sub-scaled model testing enables cost-efficient mechanical characterization, by replicating structural behavior on simplified or smaller specimens.

Figure 8 illustrates a typical compression test performed on a lattice structure, providing insights into failure modes and mechanical strength.

Complementing these approaches, computational methods play a critical role in simulating and predicting material responses. Finite Element Analysis (FEA) remains a key tool, allowing detailed study of stress and strain distributions in architectured components.

Figure 9 shows a stress distribution map within a CC beam-like lattice sample under compression, highlighting how simulations can inform the design of optimized structures. Emerging methods, such as k-space analysis, offer new avenues for understanding vibro-acoustic behavior and dispersion properties of periodic structures. Multidisciplinary Design Optimization (MDO) further enhances the ability to co-optimize structural, thermal, and acoustic performance across multiple constraints.

However, aligning numerical simulations with physical reality remains a major challenge. Variability in manufacturing, material anisotropy, and complex interactions at different scales can lead to discrepancies between predicted and observed behavior. Bridging this gap requires continuous progress in experimental techniques, model calibration, and data-driven validation strategies.

Figure 8

Compression test

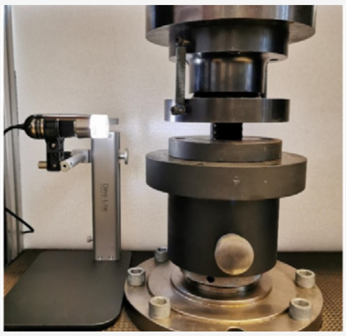


Figure 8. *Compression test on lattice structure*[6].

Figure 9

Stress distribution

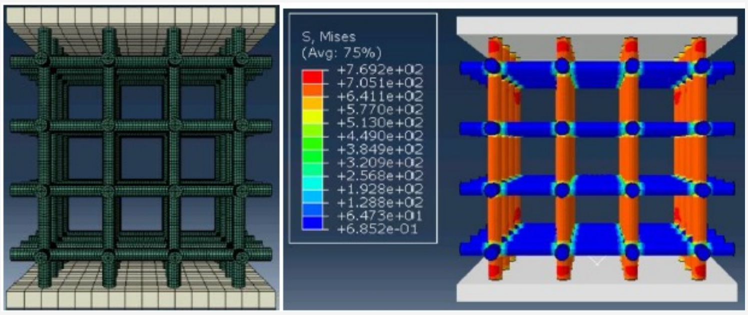


Figure 9*. Stress distribution within CC beam-like lattice sample under compression.*

c. Development of additive manufacturing processes

Additive manufacturing (AM) plays a central role in the production of architectured materials, enabling the fabrication of intricate lattice structures that traditional processes cannot achieve. Its layer-by-layer approach supports design freedom, material efficiency, and multifunctional integration. However, ensuring consistent quality, scalability, and mechanical reliability remains a major challenge. Digital engineering provides powerful solutions to address these constraints and elevate AM to industrial maturity.

Process simulation tools are among the most effective means of optimizing AM workflows. By simulating thermal gradients, residual stresses, and material flow, these tools support fine-tuning of parameters like laser power, scan speed, and cooling rates. This allows for predictive control over final part properties and geometric precision, particularly for complex lattice structures fabricated via selective laser melting (SLM) or wire arc additive manufacturing (WAAM). Hybrid techniques like SWAAM (Stud and Wire Arc Additive Manufacturing) have already demonstrated up to a 57.7% reduction in production time, without compromising structural performance[7].

Moreover, machine learning (ML) algorithms are increasingly used to improve print reliability and material compatibility. These models analyze historical print data to detect defect-prone settings and optimize process parameters in real time. When coupled with virtual prototyping and parametric design, ML facilitates rapid evaluation of numerous lattice configurations, streamlining development cycles and improving mechanical outcomes.

AI-driven design parametrization could enable the design of multifunctional components tailored for energy absorption, lightweighting, and thermal management[8]. For instance, TPMS-based structures can be customized for superior stiffness-to-weight ratios or damping properties[9],[10], while virtual material characterization ensures compatibility between design and AM process constraints.

Importantly, digital engineering bridges the gap between simulation and manufacturing, reducing the need for iterative physical prototyping. This accelerates the qualification of new geometries and materials, making AM a more viable option for high-performance applications in aerospace, automotive, and healthcare.

Despite these advances, further efforts are needed to improve reproducibility, especially when scaling up complex geometries or integrating multiple materials. Ongoing advanced AI algorithms, such as deep learning or ML, will be crucial to extend the reliability and versatility of AM for the next generation of architectured materials.

04

d. Sustainability in additive manufacturing technologies

Irrespective of engineering challenges, AM is transforming manufacturing through more sustainable practices. AM is a key driver of a sustainable and low-carbon future. Since manufacturing accounts for 20% of global carbon emissions, AM offers material efficiency while reducing waste by up to 90%, compared to conventional manufacturing methods. AM also participates in the circular economy while enabling new practices to use recycled materials and perform component repairability[11].

Meanwhile, energy saving challenges are addressed while producing precise structures that require minimum or zero machining. Enabling on-demand and localized production reduces the energy footprint associated with transportation and finally, minimizes transportation-related emissions by up to 40%[12].

The unique ability of AM to produce complex and lightweight structures while maintaining strength helps to reduce fuel consumption, especially in automotive and aerospace applications. AM could help us to create a cleaner, more sustainable, and greener planet[13]. A similar illustration of environmental sustainability driven by AM is shown in *Figure 10*.

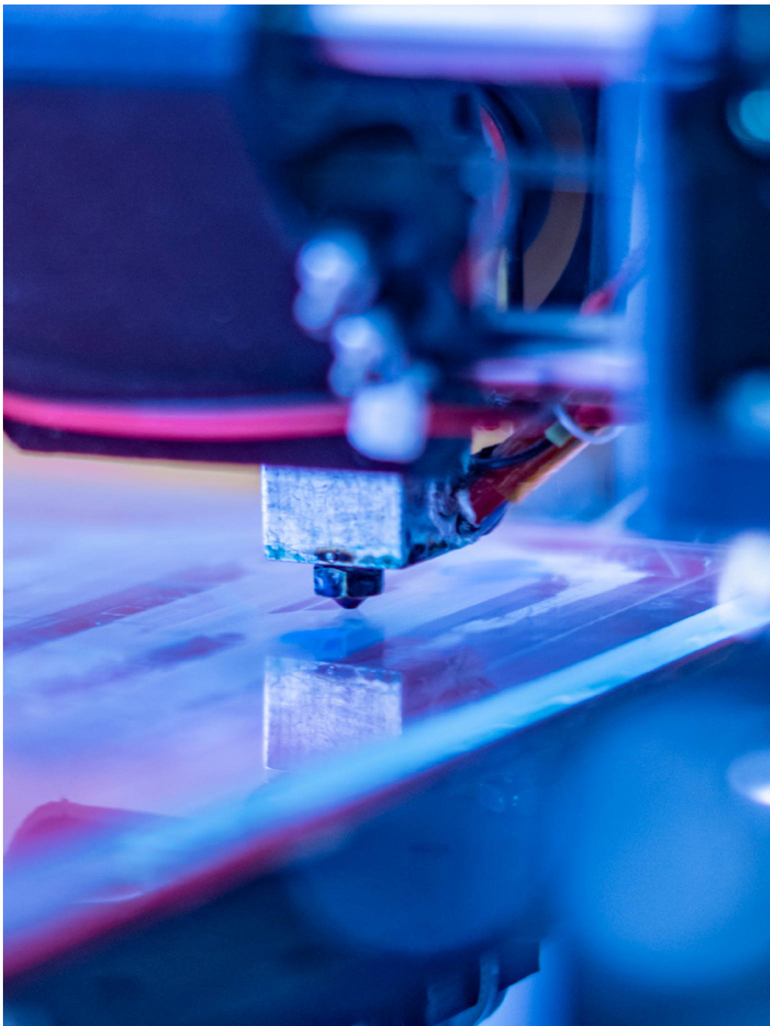
Recycling and remanufacturing challenges are handled, while enabling the direct use of waste materials as feedstock for polymer-based AM techniques[14].

In addition, life cycle assessment of material and product provides significant insights to enable a sustainable future[15].

Figure 10

Additive manufacturing

Figure 10. Role of additive manufacturing in a sustainable environment[16].



e. Quality and certifications

AM is the best candidate for manufacturing random architected materials; however, when these structures are needed with thin walls and struts, the manufacturer must first analyze their fabricability and the capacity to produce them from the relevant AM processes.

Once these architected materials are fabricated, different quality checks, like X-ray tomography, can help to investigate the structure quality – in particular, areas of higher porosity, lack of printing and excess of material manifests as trapped or partially fused powder[17]. The overview of AM principles to be considered for certification are shown in *Figure 11*. Various quality checks are important to qualify AM structures for real time applications, such as:

- **Dimensional accuracy through process control:** Ensuring the part's final dimensions match the design specifications[18].
- **Surface quality:** Assessing the smoothness and texture of the surface to meet required standards[18].
- **Material properties:** Evaluating the mechanical properties such as tensile strength, hardness, and elasticity.
- **Porosity and density:** Checking for internal voids and ensuring uniform density throughout the structure[19].
- **Microstructural study:** Inspecting the grain structure and phase distribution, using techniques such as X-ray computed tomography (CT) and light microscopy[17].
- **Non-Destructive Testing (NDT):** Using methods like ultrasonic testing, radiographic testing, and magnetic particle testing to detect internal defects, without damaging the part[19].
- **Control and qualification:** Using In-Situ Monitoring during the manufacturing process to detect and correct anomalies immediately[18].

Figure 11

Certification principles

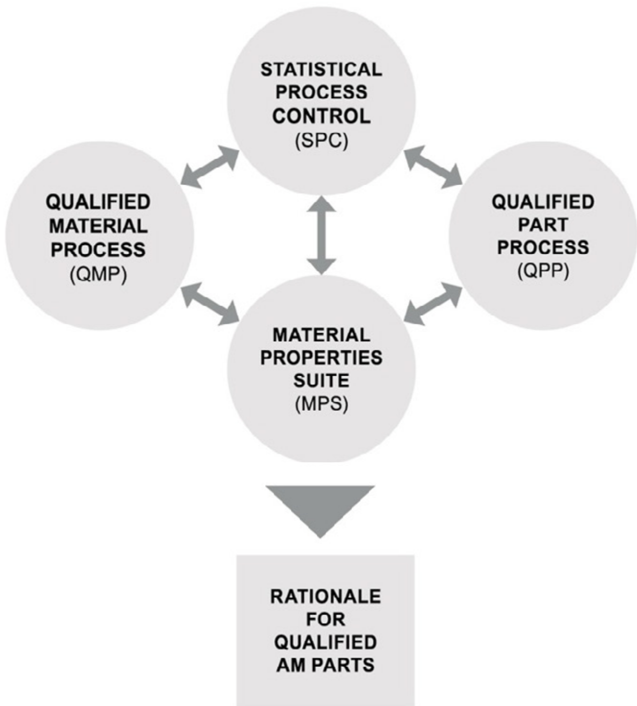
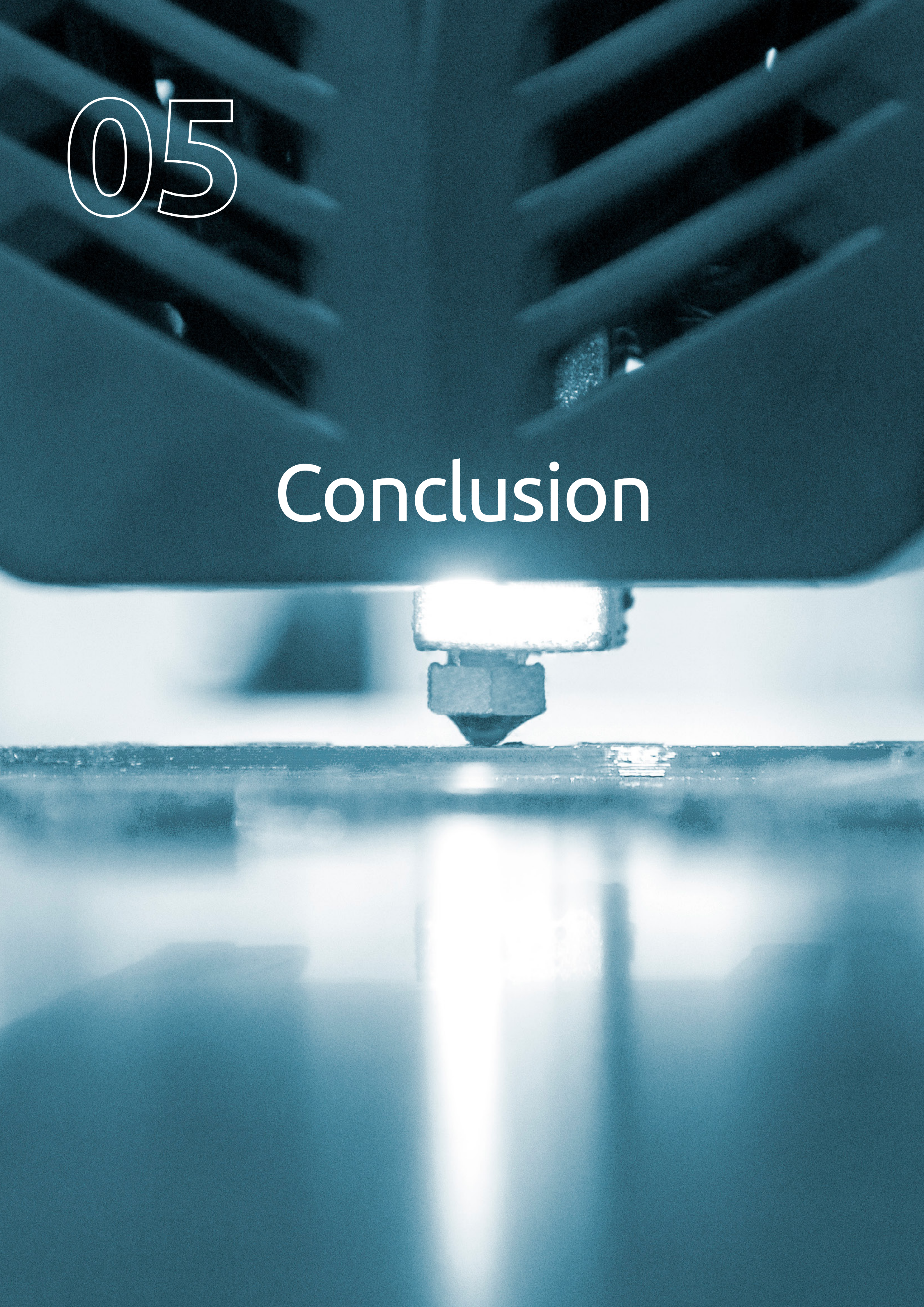


Figure 11. Certification principles to consider for additive manufacturing (AM) parts [20].



05

Conclusion

05 Conclusion

Architectured structures represent a paradigm shift in design and manufacturing, enabling unprecedented levels of customization, efficiency, and performance. With intuitive tools and versatile applications, these designs stand ready to revolutionize industries ranging from aerospace to acoustics.

As the demand for lightweight, multifunctional, and sustainable components grows, architectured materials offer a compelling solution by leveraging design freedom, material efficiency, and tunable physical properties. However, their successful deployment at scale depends on addressing key engineering challenges, including design complexity, characterization methods, manufacturing scalability, and life-cycle assessment analyses.

Digital engineering plays a pivotal role in overcoming these barriers. From advanced modeling environments and simulation frameworks to process optimization and predictive maintenance strategies, digital tools accelerate innovation and reduce development risks. Coupled with progress in additive manufacturing and integrated material design, they enable robust, efficient workflows for creating next-generation components.

To fully realize the potential of architectured structures, collaboration across disciplines, materials science, computational design, mechanical engineering, and digital manufacturing is essential. With continued investment and interdisciplinary innovation, architectured materials are set to become a cornerstone of high-performance engineering applications in the coming decades.

Additive manufacturing (AM) has transformed the landscape of design and manufacturing, paving the way for a more sustainable future. However, it necessitates a comprehensive approach to quality inspection. Non-Destructive Testing (NDT) technologies, including light microscopy and X-ray computed tomography, can ensure complete dimensional and tolerance quality control, which is essential for the final certification of components. Ultimately, the qualification of AM processes relies on standardization, which is linked to the precise definition of each AM process.

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