Issue 4 | 2022/Q2

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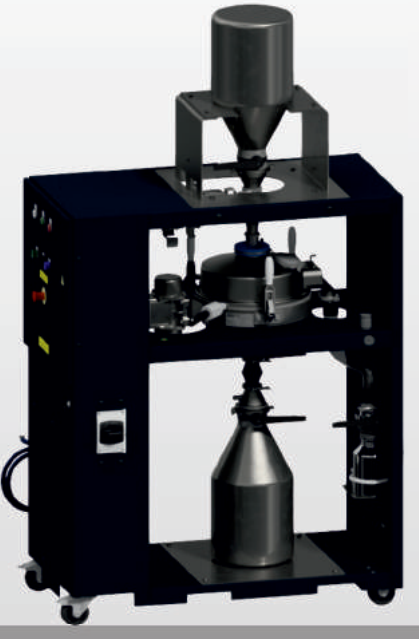

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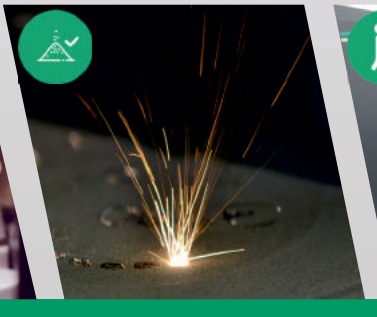

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SUBSCRIPTION

The AM Chronicle Journal is a quarterly publication in the digital format (and in print format upon request). No charges are levied for subscription. However, this is subject to change at our discretion, without prior notice.

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EDITORIAL

AM Chronicle continues its growth journey

Showcasing Additive Manufacturing success stories has always been at the heart of what we do at AM Chronicle and ensuring building the right awareness about the technology to accelerate adoption of Additive Manufacturing.

We are happy to share that we are now reaching over 30000 professionals from across various relevant industries on a weekly basis with our engaging content

Our feature article in this edition details the Advantages of Additive
manufacturing in Maritime Applications. The issue also covers topics ranging from Ceramic Additive Manufacturing, use of 3d printing in mould making, Post processing, Standard and Certification and Importance of 3D Printing education and more.

We are also excited to be hosting two of the industry leading event for Additive Manufacturing in India - Metal Additive Manufacturing Symposium (MAMS) 2022 and the 6 th edition of AMTech. MAMS 2022 an user focused Metal Additive Manufacturing conference will be held on 27-28 th July and will bring the entire Metal AM ecosystem on one platform including Users, Software Providers, Hardware and Material Manufacturers, Research and Standards to advance the utilization of this technology. AMTech to be held on 2-3 December 2022 in Hyderabad in India's leading AM tradeshow and in addition to the exhibition, will feature a technical conference, ASTM workshop, startup pitch session and a Healthcare zone.

We look forward to serving the Additive Manufacturing Industry better and further catalyzing the adoption of this technology in 2022. Stay tuned for more existing stuff coming up

Aditya Chandavarkar
Co-Founder - AM Chronicle

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AM Chronicle is the Leading 3D Printing Voice of the Region focused on India, APAC, Middleeast and Africa working with the industry to advance adoption of Additive Manufacturing.

Our service offering consists of an online knowledge sharing portal, Quarterly Magazine, weekly newsletter and social media activation.

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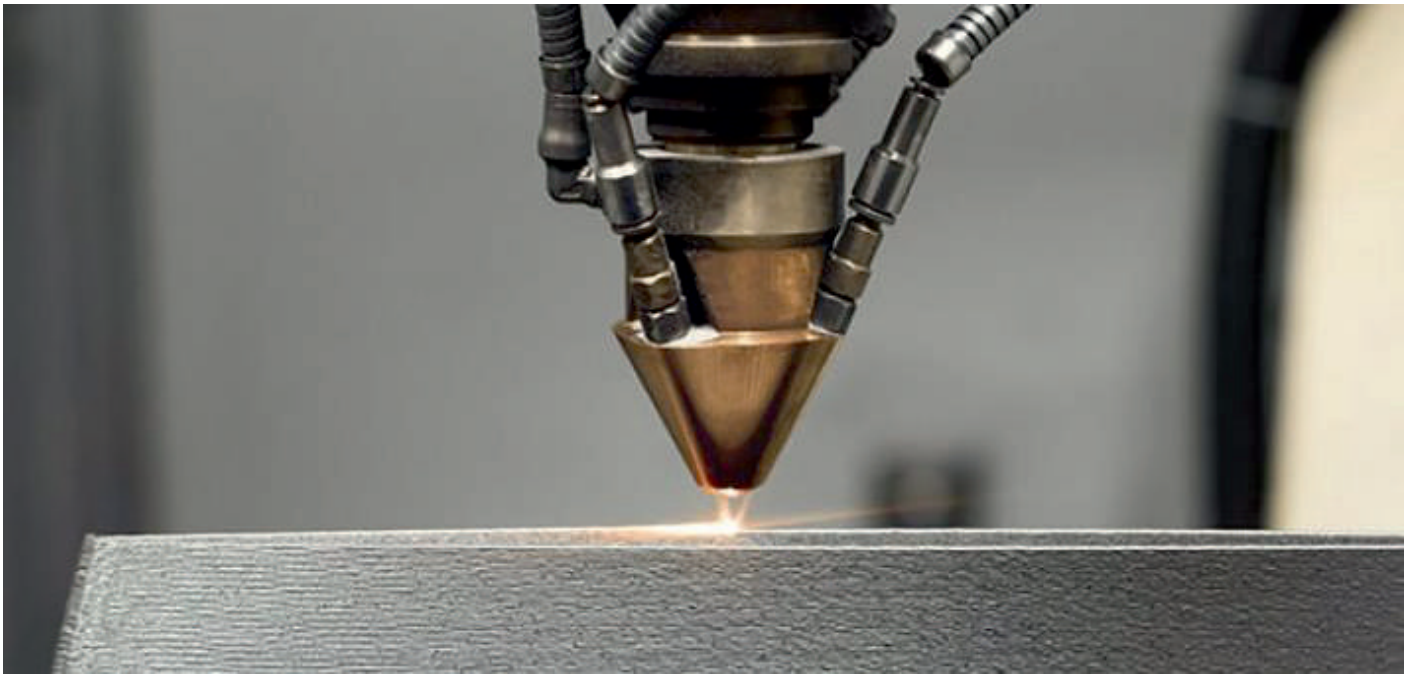


Advantages of Additive manufacturing in Maritime Applications

Dr. Eva Junghans and Ramesh Babu Govindaraj

As the shipbuilding industry increasingly discovers the advantages of Additive Manufacturing (AM), DNV is working closely with industry partners to further expand the range of 3D printed products and prove their safety and functionality.

This article has been republished with permission from DNV from the original article Additive Manufacturing enters the maritime mainstream under Industry Insights on dnv.com

Additive Manufacturing technology is making steady advances. While the automotive and aerospace industries, where weight reduction is key to maximizing fuel efficiency and minimizing carbon emissions, have benefitted from AM for a number of years, the maritime sector has only recently begun to explore the opportunities offered by layer-by-layer 3D printing. There are two main fields of interest: establishing a local supply infrastructure for 3D-printed spare parts in major ports to accelerate delivery and exploiting the unique capabilities of AM technology to make parts no other manufacturing process can produce.

Scrutinizing materials and processes for class approval

Several factors set the maritime industry apart from the aerospace and automotive sectors: Many

components are much larger and heavier; and the safety of life and property at sea depends on a different set of criteria. As a classification society, DNV must ensure that the processes, materials and equipment used to manufacture critical ship components meet the applicable class requirements. This means that when a new manufacturing technology comes into play, appropriate standards and rules must be defined against which to test.

New DNV rules pave the road for AM

Since DNV began exploring the potential of AM for the shipping industry in 2016, a number of joint industry projects have been formed to build know-how and engage in a constant dialogue with industry stakeholders to learn about the needs of the shipping industry and its suppliers. This has resulted in a framework of new rules and guidelines, which form the basis for DNV's qualification, certification, verification and class approval activities. "Contrary to most other classification societies, which just have Recommended Practices," says Ramesh Babu Govindaraj, Principal Material Specialist at DNV Maritime, "DNV actually has class rules for Additive Manufacturing so AM materials, processes and components can be included in the classification regime. This benefits both the designer and the OEM because the AM-manufactured parts will be accepted for the classification regime. This means that class accepts the AM process the same way it has been accepting rolling, forging and casting."

Added benefits for the OEM and the ship owner include the availability of the stored digital design file for the part as well as the option to have the part printed when a spare is needed.

Approvals of Manufacture, qualification of parts

So far the work of the DNV experts in this field has been focused on metallic parts but will include non-metallic materials from 2022, says Dr Eva Junghans, Senior Principal Engineer and Lead of Practice – Materials & Welding and Additive Manufacturing at DNV Hamburg. "In 2018, DNV issued the first Additive Manufacturing Approval of Manufacturer certificate to thyssenkrupp Marine Systems, giving thyssenkrupp TechCenter Additive Manufacturing the status of a DNV-approved supplier for maritime and general industrial applications. Further approvals of different manufacturers as well as qualifications of parts supplied to the maritime industry, and approval processes are underway." Manufacturer qualifications are required for classed components, the expert adds – without these approvals, ships are not allowed to install safety-critical AM components or replacement parts. "These parts are highly significant for the safety and/or functionality of a ship and a maritime or offshore structure."

Lighthouse projects demonstrate the power of AM

As the industry discovers the benefits of Additive Manufacturing compared to casting and forging – such as better control of quality, a more consistent internal structure, innovative shapes and shorter delivery times – a number of unique projects have emerged, says Govindaraj. For example, DNV has issued a verification statement for a ship propeller with a two-metre diameter, made in a Wire Arc Additive Manufacturing (WAAM) process by SY Metal in South Korea. The WAAM process is twice as fast as conventional casting and provides a solution to avoid supply chain bottlenecks; what is more, WAAM-printed parts are generally characterized by higher strength due to a more regular microstructure when compared to castings whose microstructure varies from the surface towards the core. While the fatigue test of the prototype has yet to be carried out, this is a first step towards resolving an issue that is not uncommon, says Dr Junghans: replacing a ship propeller at short notice after it has been lost at sea.

Wire Arc Additive Manufacturing (WAAM)

The WAAM technique can be used to make a wide

variety of parts. DNV has issued a feedstock type approval for a solid carbon steel wire made by voestalpine Böhler Welding. A crank disc for Kongsberg Maritime has been made of that wire, using ADDILAN equipment in a Joint Innovation Project (JIP) with partners representing all sections of the AM value chain. A DNV Qualification in Principle and Approval will be issued after successful testing.

WAAM-produced Panama chock, a special type of hawse hole with 20% higher load capabilities and a yield strength twice that of the traditional casting (Credit: DNV).

Furthermore, DNV issued a verification statement for a WAAM-produced non-class Panama chock, a special type of hawse hole. The load test showed that the part was able to handle loads 20% higher than the design specification and had a yield strength twice that of the traditional casting. Andrew Sales, Managing Director at AML3D is very happy about the good collaboration with the project partners Keppel Technology & Innovation (KTI) and DNV: "The solution we found has proven to be successful. The component is intended for non-class maritime applications and is the world's largest additively manufactured shipboard fitting. The verification by DNV shows that AML3D's patented Wire Additive Manufacturing (WAM®) process meets maritime industry requirements and provides a framework and pathway for further component production and verification. AML3D will continue to partner with customers to find unique solutions for its diverse customer base by exploring additional opportunities with 3D printing."

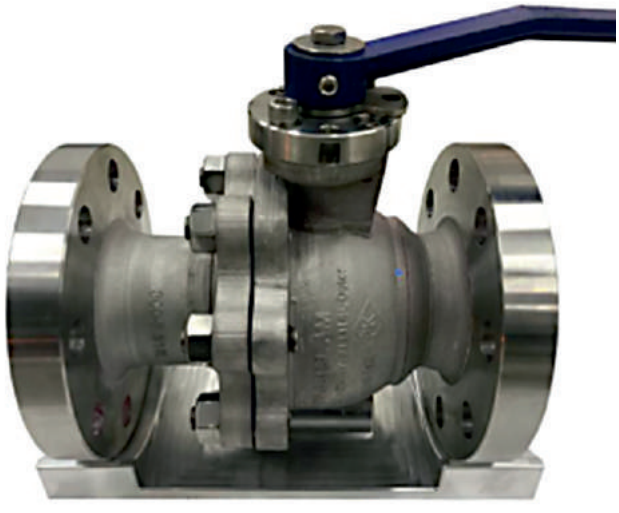
Powder Bed Fusion (PBF)

Powder Bed Fusion (PBF), or Selective Laser Melting (SLM), is an AM technology that holds enormous potential for producing complex geometries. In this process, the part is created in a basin filled with metal powder. A high power-density laser beam is directed to specific locations of the powder surface to melt the powder forming a solid structure layer by layer. The excess powder is then recycled. PBF ensures highly specific density and consistent mechanical properties of the finished part and has been applied successfully to make components as complex as a heat exchanger. In an ongoing joint project with Kongsberg Maritime and AM specialist SLM Solutions, PBF has been used to create an innovative hollow thruster blade with a titanium internal honeycomb structure. The part is currently undergoing fatigue testing. Based on this project DNV is preparing a concept study to amend DNV standard B203 for Additive Manufacturing.

Blown Powder Technology (BPT)

A process similar to PBF, Blown Powder Technology (BPT) is a "directed energy deposition" process whereby a nozzle directs a laser beam surrounded by an annular metal powder and inert gas flow to the depositing location while the laser beam melts the powder. A unique joint project involving SHI, InssTek, KOS GLOBAL, PK Valve, KIMS, KAERI and DNV succeeded in manufacturing a bi-metal cryogenic valve, an industry first. The body of the valve consists of SUS316L stainless steel, whereas the inside, which will be exposed to the cryogenic media, is lined with a 3 mm layer of corrosion-resistant Inconel 625. The Korean specialist InssTek produced the part using simultaneous 5-axis motion. "There is no alternative process for combining two materials in such a complex geometry," stresses Govindaraj. "The two materials are applied by two separate nozzles operating

alternatingly. The method makes the product less expensive because the costly Inconel is only needed on the inside while the lower-grade stainless steel is entirely sufficient for the valve body." The valve has passed the pressure tests. DNV issued a type approval for feedstock to the powder manufacturer, KOS GLOBAL, as well as an OEM approval to InssTek. "The success of this valve will be the first use case of multimaterial parts manufactured with metal 3D printing technology that will revolutionize not only the ship industry but will also shape the way we see today's manufacturing practices across diverse industries," states Se-ho Park, Vice president, InssTek.



This bi-metal cryogenic valve made using BPT has a stainless-steel body and an Inconel inner lining (Credit: DNV)

JIPs drive the development of rules

DNV's work on Additive Manufacturing continues. In several JIP consortiums, the Maritime and Energy Systems business areas of DNV are jointly developing new standards. The Singapore Maritime and Port Authority (MPA), which has shown strong interest in promoting AM in the maritime sector, has been involved in a number of AM initiatives. The Global Additive Manufacturing Technology Centre of DNV's Energy Systems in Singapore is supported by the Singapore Economic Development Board (EDB) and focuses on AM research as well as advisory services and industrial certification. DNV Maritime provides class approval services and verifications for ships and offshore structures, which involve a wider scope of requirements, tests and on-board trials.

Dr Luis Alejandro Orellano, Chief Operating Officer at thyssenkrupp Marine Systems, emphasizes the importance of certification for a manufacturer: "We are delighted that with thyssenkrupp TechCenter Additive Manufacturing we now have a certified partner who can supply thyssenkrupp Marine Systems with additive manufactured parts that meet both our own and our customers' high expectations. Together we are putting innovative solutions into our submarines and ships, setting new standards for the navy of the future."

"The DNV pathway for Additive Manufacturing has made great strides towards making AM a key technology for safety-critical, classed as well as non-class ship parts and components," says Dr Junghans. "As more AM materials, processes, manufacturers and individual part designs receive class approval, ship owners and yards will be able to rely on a growing list of components whose design has been optimized for the intended application, and which feature better, i.e. more regular, material properties and can be made available faster and at a lower cost."

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Dr. Eva Junghans

Senior Principal Engineer, Material, Welding & Additive Manufacturing

Materials (metallics/non-metallics), welding and corrosion issues, additive manufacturing; Failure analysis, damages, fracture mechanics, manufacturer qualification, trainer; Maritime, navy and energy sector; IACS, IMO, marine authorities, rules & regulations, and development thereof; ISO 9001, CPR, EN 1090, PED 97/23/EC, AD2000.

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3D Printing Revolutionizes Mould Making for the Manufacturing Industry

Nitin Chaudhari

Using 3D printed moulds and patterns allows businesses to reduce workflow complexity, expand flexibility and design opportunities, and reduce costs and lead time. This article explores the various opportunities for mould making with 3D Printing

In today's world, maximum products are manufactured using injection molding. However, fabricating moulds can be expensive and time-consuming. Thanks to desktop 3D printing, moulds that were traditionally known to be machined out of metal can now be 3D printed.

So, let's see what is mould making.

Molding or mould making is the act of creating the cavity/form that carries a negative or reverse impression of an original model.

The printed three-part mould with the caps injected in polyethylene

Various industries benefit from the common products manufactured using mould making techniques namely, automotive, bottle components, electronic components, toys, entertainment, medical, agriculture, kitchen and food service, even smartphone production.

Traditionally, the mould manufacturing process usually consists of several steps. Throughout the process, various testing for form, fit and function are required to discover any part flaws. It requires more manual labor than automated production and is expensive as well as time-consuming. Another approach to mould manufacturing involves the digitization of as many steps as possible. This approach is referred to as rapid or digital manufacturing and offers various benefits over the former such as reduced time to market, labor overhead and asset use with better quality, mass production and cost-effectivity.

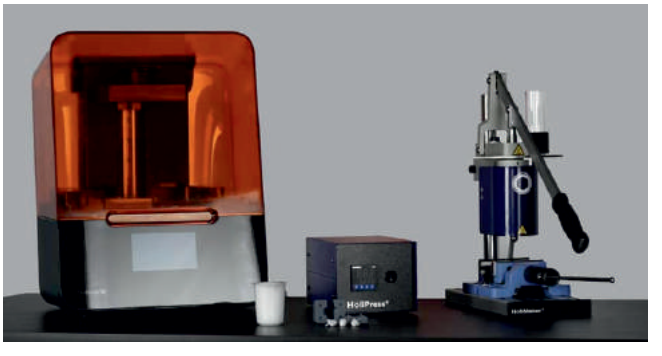
Although digital manufacturing is not just about mouldmaking but also about 3D printing in general, we today are going to talk about how digital manufacturing has transformed the mould making industry.

Mould making with 3D printing has the ability to supplement and enhance traditional manufacturing techniques to create new and exciting possibilities, which ultimately creates better end products for consumers. It allows engineers and designers to increase the functionality from their 3D printer beyond rapid prototyping and directly 3D printing parts.

3D Printers these days come in various shapes and sizes but the most common entry level, high accuracy 3D Printers are offered by Formlabs. Given the size of the Formlabs 3D Printers and the latest Low Force Stereolithography, the desktop 3D Printers have changed the way moulds are manufactured today.

With their small size, desktop 3D printers are ideal for otherwise small workspaces. They offer a space-saving solution to manufacturing companies with confined spaces. They can fit on the surface of a desk, making them an attractive choice for small workspaces.

The desktop 3D printers Form 3+ with a build size of 145mm x 145mm x 185mm and Form 3L with outer height of 28.9" (73.5 cm), width of 30.5" (77.5 cm), and depth of 20.5" (52 cm) by Formlabs make them an ideal choice for manufacturing units with compact spaces. These desktop 3D printers make use of the Stereolithography (SLA) technology providing a cost-effective alternative to machining aluminum moulds. Combining traditional techniques like injection molding, thermoforming, or silicone molding with SLA 3D printed parts allows you to bring products to market faster with a more time and cost-efficient manufacturing process. mouldmaking with Formlabs 3D printers opens up a world of production materials, and provides the ability to produce short run batches and test mould designs prior to committing to expensive tooling.



The Holipress next to the Form 3 printer

This combination of Formlabs 3D printers with traditional manufacturing techniques-called rapid tooling has grown in popularity as the affordable 3D

printers have become versatile, industrial quality workhorses.

A chunk of this growth belongs to the proliferation of high-performance SLA printing materials by Formlabs, which gives engineers access to a wide range of plastic materials. For example, Rigid 10K Resin, a highly glass-filled resin created for precise industrial parts that will be dimensionally stable under load and can withstand the clamping and injection pressures without breaking. Another material, Tough 1500 Resin, balances elongation and modulus, Parts printed in this material can bend significantly and quickly spring back to their original shape, which facilitates the demoulding of the part. Materials such as Tough 1500 Resin and Rigid 10K Resin have enabled a range of demanding rapid tooling applications from injection molding to composite molding.

The combination of powerful SLA materials and high-resolution 3D printers by Formlabs means rapid tooling leading to savings in both time and money compared to traditional manufacturing methods such as CNC machines.

Today, we will shed some light on these rapid tooling workflows:

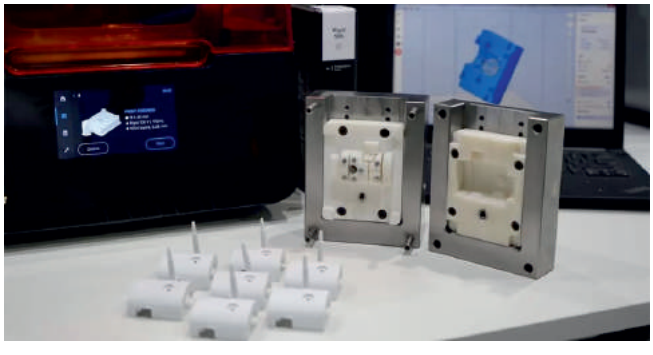
1. Injection Molding:

Being the leading process for manufacturing plastics, injection molding is widely used for mass-producing identical parts with tight tolerances. It is a cost-effective and extremely repeatable technology that yields high-quality parts for large series.

Desktop 3D printing is a powerful solution to fabricate injection moulds rapidly and at low cost. It requires very limited equipment, saving CNC time and skilled operators for other high-value tasks in the meantime. Manufacturers can benefit from the speed and flexibility of in-house 3D printing to create the mould and couple it with the production force of injection molding to deliver a series of units from common thermoplastics in a matter of days, even for complicated mould shapes. Injection moulds need to withstand clamping pressures, injection pressures, injection temperatures, and any coolants or mould release agents that may be used. Doing so ensures the mould can be repeatedly used overtime and consistently produce parts true to the original design.

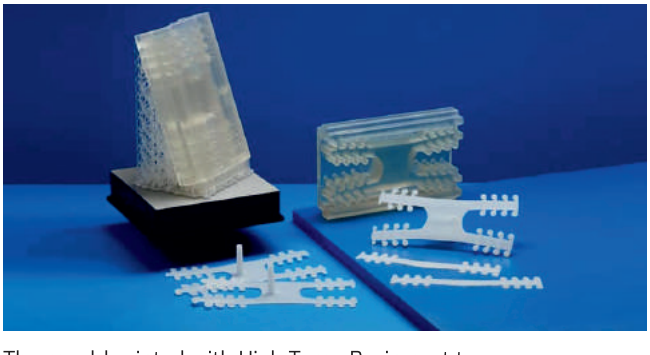
Formlabs offers a range of materials that meet these requirements and are capable of replacing aluminum moulds for low-volume manufacturing.

· To support short-run injection molding, Formlabs developed Rigid 10K Resin. The combination of strength, stiffness, and thermal resistance makes Rigid 10K Resin an ideal material for injection moulds. Rigid 10K Resin has an HDT of 218°C @ 0.45 MPa and a tensile modulus of 10,000 MPa, making it a strong, extremely stiff, and thermally stable molding material that will maintain its shape under pressure and temperature to produce accurate parts.



A mould 3D printed in Rigid 10K Resin

High Temp Resin is an alternative material that can be considered when clamping and injection pressures are not too high.



The mould printed with High Temp Resin next to the two-straps injected in polypropylene

Grey Pro Resin should be chosen when pressures and temperatures are low and the dimensional accuracy of your molded part is less critical. moulds made from Grey Pro Resin will bend before breaking, potentially increasing longevity, but potentially worsening accuracy over time as the mould is used.

POM football cleats injected in the Holipress from moulds printed with Grey Pro Resin.

2. Overmolding:

Overmolding for Customer Beta Prototypes for Dame Products

Overmolding is a multi-step injection molding process where two or more components are moulded over top of one another. Overmolding uses fewer work-hours (and thus, costs less) compared to other manufacturing methods.

Overmolding is often the best manufacturing method for large production runs and/or products with colorful and multi-layered designs. Similar to injection molding, overmolding has excessive upfront costs. It is time-consuming and expensive to manufacture and modify tooling out of metal, and two-shot injection molding machines are complex to dial in.

Prototyping is a crucial part of the product development process. However, prototyping overmolded parts can get very expensive, very fast. Also, it can be time-consuming at times if you are outsourcing. Some are overcoming these prototyping challenges by combining manufacturing processes like overmolding and insert molding with 3D printing.

3. Vacuum Forming:

A vacuum forming mould printed in Formlabs High Temp Resin accompanied by the final vacuum formed part.

Vacuum forming is a manufacturing method used to shape plastic materials and is used for creating the packaging of various goods.

During the vacuum forming process, a sheet of plastic is heated and then pulled around a single mould using suction. From grocery store salad mixes, the lid of your to-go cup of coffee, and high-end consumer electronics, vacuum forming is useful for producing lightweight, cost-effective packaging.

Creating vacuum forming moulds with traditional manufacturing processes like machining or casting is time consuming and costly, especially for complex geometries, textured surfaces or fine features.

Formlabs SLA 3D printers deliver high resolution, smooth prints which are perfect for vacuum forming moulds. SLA printing offers almost total design freedom and the ability to print intricate and detailed moulds. Plus, in-house SLA 3D printing offers a fast turnaround time and low price point, especially for

shorter runs, custom parts, and prototype designs.

4. Silicone molding:

One-piece silicone moulds are ideal for designs that have a flat side and no deep undercuts.

Creating silicone moulds has seen increased adoption across multiple industries, most noticeable consumer goods and jewelry.

Silicone is a strong choice for mould-making because it offers such a diverse array of benefits. You can easily create durable custom designs using silicone moulding and can use them repeatedly without fear of breakage. Silicone is highly resilient to heat and cold, chemical exposure, and even fungus.

Desktop 3D printers by Formlabs offer many benefits, including design flexibility within CAD software, high accuracy, ease of prototype modification, and quick turnaround times.

Many users turn to Clear Resin when creating silicone moulds. Clear Resin is most commonly used, because it provides a visual queue for mould filling. However, depending on your clamping pressure, other resins in our Tough and Durable Resin Family may be more appropriate.

5. Composite Molding

Composites are highly versatile and efficient materials, driving innovation in various markets from aerospace to healthcare. They enable the fabrication of high-performance lightweight products by outperforming traditional materials such as steel, aluminum, wood, or plastic.

The 3D printed mould and the demoulded carbon fiber part for the steering wheel front housing.

Fiber-reinforced polymers (FRP) dominate the market and have fueled the growth of new applications in various industries. The most popular composite materials include carbon fiber, fiberglass, and kevlar.

Using 3D printed moulds and patterns allows businesses to reduce workflow complexity, expand flexibility and design opportunities, and reduce costs and lead time.

For small-scale production, engineers can directly print the mould in a few hours at low costs and can achieve complicated mould shapes with fine details.

Formlabs' SLA 3D printing technology creates parts with a very smooth surface finish, which is essential for a layup mould. It allows for complex geometries with high precision. Additionally, the Formlabs Resin Library has engineering materials with mechanical and thermal properties that pair well with mould and pattern manufacture.

In-house desktop SLA 3D printing requires limited equipment and reduces workflow complexity. Professional desktop printers from Formlabs are affordable, easy to implement, and can be quickly scaled with the demand.

With the recent release of the Form 3L, Formlabs's

large format SLA 3D printer, this process can now be easily scaled to large moulds to better enable innovations in markets such as automotive and aerospace.

Mould making with Formlabs SLA 3D printers is a powerful strategy for producing parts in small batch quantities, and in commonly used plastic and elastomeric materials. For different types of mould making, the growing Formlabs material library offers a wide range of options, from High Temp Resin to Rigid 10K Resin, all of which enable engineers and designers to create the moulds they need for any application.

There are two types of Formlabs SLA 3D printers that are best suited for the applications you are planning to produce:

The Form 3+:

Our go-to compact, workhorse SLA printer. Scale prototyping and production as your business grows with the Form 3+, an affordable, industrial-quality 3D printer that consistently delivers.

The Form 3L:

A large format 3D printer compacts enough for the office and robust enough for the factory floor. Bring your biggest ideas to life with the Form 3L, a cost-effective large format 3D printer that doesn't compromise on the details.

SRT's partnership with Formlabs aims at building the 3D Printing industry in India and expanding the adoption of 3D Printers across industries, by combining the technological expertise of Formlabs with the sales and marketing presence of SRT. Formlabs' affordable range of 3D Printers and the sales and marketing reach of SRT will improve every manufacturer's accessibility to 3D Printing, irrespective of the investment capability or industry.

Think Big Think Form 3L now expand your fleet with $1000 Off for a Limited Time. Bring home a Form 3L Today. For more details reach out to us on marketing@shreerapid.com

ABOUT THE AUTHOR

Nitin Chaudhari

Partner, Shree Rapid Technologies

Nitin Chaudhari is one of the pioneers of Additive Manufacturing in India and brings with him decades of experience of working in this area

Taking the leap with additive manufacturing Part 1: Uncertainties

Samkitt Shah

Additive Manufacturing is expected to show significant growth in the coming years. It's important for industries and individuals to accept the uncertainty around it and work together for its development

Uncertainty; a situation most of us want to avoid, foresee and mitigate, and amongst many outcomes it has also been one of the most important reasons when people or organizations turn to introspection.

The world has been privy to this situation for the last 2 years. I completed a decade in Additive Manufacturing (AM) / Digital Manufacturing (DM) and decided to move on from my prior role without hopping on to the next one. The intent behind this was to take a step back to energize myself for the next leap, I wanted to utilize this time to introspect, have a third person view of everything around, connect to a wider set of colleagues/adversaries, unlearn, contribute and derive a vision for the next decade.

I have always been a believer of the importance of creating a larger marketplace. In case of AM/DM, primary objective being whatever it takes to educate, advise, spread and encourage new users, new use cases, new entrepreneurs to get excited about Digital Manufacturing (DM) / Additive Manufacturing (AM). Objective being, higher education, leads to higher awareness, leads to new developments and application,

effectively converging to a larger market place. If the pie is bigger, then positioning yourself well and building a strong go-to-market strategy in order to seize the opportunity rather than "sell". I have never really connected with how sales is depicted or perceived. If it were for me, I would designate every "sales" oriented workforce as "promoters" not to represent the ownership side but I strongly believe that sales is about promoting. A clearly defined role within an organisation can bring a very high sense of understanding of goals, purpose and responsibility for the person in question. This also empowers, the individual to think about a cause & effect decision making and create a win-win situation with prospective customers which can yield benefits for both the customer and the provider with long-term profitable and sustainable outcomes.

Last 50+ days have been absolutely engaging. Yes, there were feelings of uncertainty around what next, when will I start my next chapter, will I be employed, how will it be and some more intense thoughts. However, I can say life had a surprise planned for me; it presented me with an opportunity to connect to the lengths and breadths of industry not just in India but also globally. Being in a no man's land (not representing any organization) and having built a great relationship, camaraderie and trust with global industry peers resulted in insightful and candid discussions around collective vision, unit economics, scale, profitability, problem areas and the next frontier. A rather more interesting take away has been the transparency with which this transpired and it has been a humbling experience.

This article is not about me, but its about why I chose to use this medium. It is when my discussions with Aditya Chandavarkar (Managing Editor, AM Chronicle), lead us to see, if we can do something to pump up the sentiment, highlight how synchronized many in the industry are, highlight some key notions/myths and give our most sincere attempt to try and raise the bar. It is our attempt to emphasize how it is important to go all-in on this new industrial revolution and seize this global multi-trillion dollar opportunity.

I realized, that there is a lot of common synchronized vision, objectives, issues and many more interesting themes but despite all of this there is a lacuna. Despite all optimism there was a single most concerning element which was common and a reason for the lacuna: "CONFIDENCE". Despite all the ideas, experience, finance, qualifications and validation, it seems everyone is wanting to take the leap but everyone is waiting for someone to start. With this thought provoking article series on AM Chronicle, I want to take this opportunity to bring up some themes which I am supremely confident will lead to more conversations, planning, execution, assertiveness and much more. Why? Like I said before:

1. First and the most important mission is for larger awareness and confidence which are the pillars for larger interest and adoption. Making the pie bigger.

2. Hustle up! The rush has started

Everyone's waiting for someone, but without fully realising that someone has already started the first steps and its time to introspect, set out an ambitious vision and lay down the path for 10x growth. Anyone in AM/DM already present for more than 1 year at least should consider any growth of less than 10x in the coming decade to be a below-par performance.

This article is part of the series – taking the leap with additive manufacturing. This article series is not sponsored, not paid for, not supported by, not intended for promoting any particular brand/company/ individual but for bringing in a collective conviction for the AM/DM community to seize this once is a life-time industrial revolution.

Stay tuned to the next one !

ABOUT THE AUTHOR

Samkitt Shah

Business head - Solutions, Imaginarium

A firm believer in creating a larger marketplace for Additive Manufacturing. Samkitt with his 10+ years stint in 3D Printing sales and strategy brings a sound understanding of the technology and its potential. His passion leads him to educate, advise and encourage new users, new applications and new entrepreneurs to drive the adoption of Additive Manufacturing.

Popular Post Processing Methods for Fused Deposition Modelling

Karan Khatke

Post-processing methods improve the mechanical and aesthetic properties of the finished products. Some popular post-processing methods for fused deposition modeling include acetone treatment, sandblasting, and cleaning.

Additive Manufacturing is one of the fastest expanding manufacturing sectors, with applications in a wide variety of industries. Additive manufacturing is described as the technique of layer-by-layer production of products. The fundamental benefit of the additive manufacturing technique is that it can generate complex structures at a low cost and without the use of expensive machines. Many additive manufacturing technologies have been developed that can print a wide range of materials. However, one of the highly utilized methods is fused deposition modeling (FDM). The FDM approach has been widely studied in the literature and is currently used in areas of medicine, engineering, and art.

Post-processing is the process of treating FDM-produced items to get the required technical attributes. The article explains several post-processing processes used in the FDM process. The qualities that are enhanced by the FDM process are also elaborated.

Cleaning and Preparation

The cleaning and preparation process is mainly followed on all the FDM-produced items. The cleaning and preparation procedure is linked with the removal of superfluous materials and support structures complete the product. In some cases, tools may be used, and in some situations, industrial instruments are also used.

Painting

Painting is a popular method for improving the surface roughness and coloration of FDM-produced objects. Painting can be done using a brush or a spray and is mainly used to improve the part life and color the part. The method is very popular to develop 3D printed lifestyle products such as toys and crafts.

Treatment with Acetone

Acetone Treatment is the technique of dipping items in an acetone solution to improve surface roughness. When compared to abrasive finishing, CNC machining, manual cleaning, peeling, and spray painting, the acetone treatment procedure gives the greatest results in terms of surface roughness improvement.

Image Source: Sink Hacks

Use of Lasers

There is a lot of debate over using lasers as a post-processing tool in the FDM process. The primary focus is to increase the part's dimension accuracy and surface polish. A process is usually performed utilizing a low-power CO_2 laser to increase dimensional accuracy and surface finish of the part.

Vibratory Finishing

A vibrating bowl is used in the vibratory finishing process to improve the mechanical qualities of the FDM printed part. Mechanical qualities improve as a result of the abrasive action that takes place in the vibrating bowl.

Image Source: Soli Forum

Ball Burnishing

Ball burnishing is a post-processing technique that involves using a burnishing tool on a lathe machine to enhance the mechanical qualities of FDM-produced components. According to the research, the method enhances the hardness and surface roughness of ABS components.

Sand Blasting

Sandblasting is a technique that involves using a sandblasting cannon on printed items to eliminate burrs and enhance surface polish. The method is widely used if large number of burrs occur on the FDM printed part.

Sanding by Hand

Manual sanding is a post-processing technique in which sandpapers are used to increase dimensional accuracy and surface finish. It is recommended to start with low grit sandpaper and work your way up to fine-grit sandpaper. The method is used by hobbyist 3D printers and is also used in low-scale manufacturing.

Machining using CNC

CNC machining is utilized to increase the surface roughness and dimensional accuracy of FDM-produced objects. Due to the strong reliance of the FDM process on deposition angle, the study on the use of CNC machining for improving surface roughness of FDM printed parts suggests that interpreting the optimal cutting parameters for the FDM printed components is quite difficult.

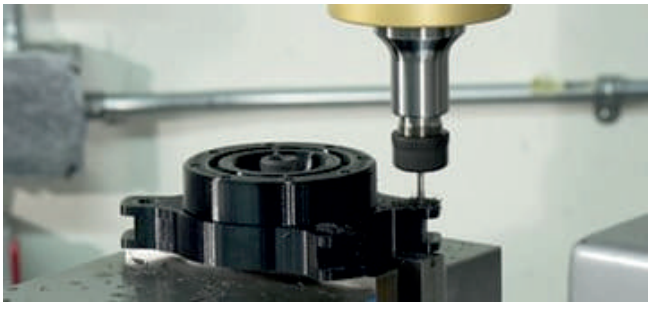


Image Source: Stratasys Direct

Inserts made of metal

Metal inserts are utilized in threaded regions of an FDM-produced item. As the metal inserts operate as reinforcement in that location, the method lowers stress concentration in the areas of the hole. The procedure begins with heating the metal insert and pressing it into the hole; after cooling, the metal insert is snugly fitted within the hole.

Welding

One of the limitations of FDM printers is that the print size is restricted. As a result, large size items have been manufactured in pieces. This large-size product is joined together with the help of welding. The common welding methods include adhesion with industrial glue.

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Karan Khatke is working as Assistant Professor at Prestige Institute of Engineering Management and Research, Indore. He has completed his masters in thermal engineering and Specialist in CAD CAM CAE, Product Development, Design Ergonomics, Sustainability Analysis, Additive Manufacturing and Design Thinking.

Synergies in Additive Manufacturing and Drone Technology

Chinmay Saraf

The use of additive manufacturing has significant scope to improve the performance of drones. Additionally, new additive manufacturing technologies such as 4D printing, soft materials, and multi-material printing are likely to transform drone tech.

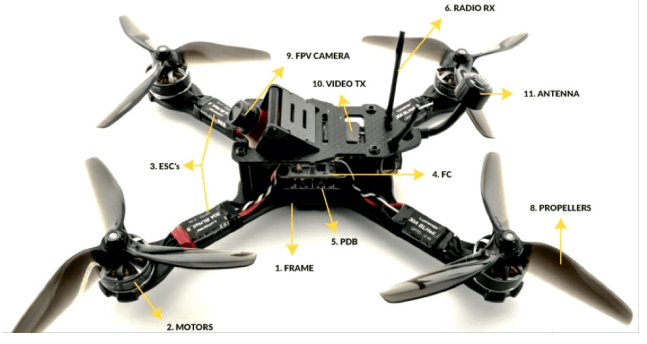
In the recent era, several modern technologies have been added that are likely to have a transformative impact on humanity in the coming years. The list includes artificial intelligence, drone technology, additive manufacturing, Industry 4.0, Web 3.0, self-driving cars. All these technologies interrelate to develop unique and innovative solutions for various industries.

This article discusses the synergy between two disruptive technologies – additive manufacturing and drones, highlighting the interaction between the two

technologies and discusses recent industry trends.

Additive Manufacturing and Drone Technology

Additive manufacturing is the process of building a part through a layer-by-layer approach. Compared with the subtractive manufacturing methods in which material is removed to develop the finished part, the part is produced by adding material in additive manufacturing. These materials can be used for application in aerospace, automobile, biotechnology, space, and supply chain.



Typical drone components (image source: https://oscarliang.com /quadcopter-hardware-overview/)

Drones are also known as unmanned aerial vehicles that can be controlled from a different location without the physical presence of any human being on the vehicle. The drone functions with the integration of software, mechanical and electronic parts.The main parts of the drone are the electronic speed controller, motors, frame, power distribution board, propellers, antenna, and flight controller.

Opportunity for Additive Manufacturing in Drone TechnologyTypical drone components (image source: https://oscarliang.com/quadcopter-hardware-overview/)

The critical design parameters are flight control, aerodynamic stability, and low weight. The primary purpose of the flight control unit is to ensure that all the parts work in integration. It is regarded as a small brain of the drone.Today, drones can be integrated with various accessories that enable its application in multiple industries.

Today Indian Drone companies such as Paras Defense and Space Technologies, Ideaforge and Raphe develop drones mainly for defense application and use additive manufacturing technology for prototype, development and end use drone components utilising technologies such as Material Extrusion, Multijet Fusion, Laser Powder Bed Fusion and others. Similarly companies such as Zen Technologies limited, develop the drones for logistics application, they also use AM technology widely for their production and research use. Similarly, companies such as Rattan India Enterprises Pvt Ltd also use AM to develop their high technology drones.

In addition to this, companies like Zomato are developing drone technology for food delivery. It is likely that they are actively using additive manufacturing technology for drone development. Moreover, some other companies such as Throttle Aerospace, Garuda Aerospace, General Aeronautics, Redwing Labs and Arnav Unmanned Systems also actively use AM technologies for research and development.

Role of additive manufacturing in drone technology

Additive manufacturing is considered a technology that plays a significant role in the design and development process of drones. It mainly plays a critical role in prototype development and new innovation in drones.

In addition, additive manufacturing is also used to develop metal parts that are not possible with conventional manufacturing methods. Certain drone companies require low-cost customized details for drone development and design, and their needs are fulfilled with FDM-based 3D printers. Moreover, some drone companies rely entirely on additive manufacturing to produce drone bodies and propellers.

In addition to this, with the help of composite 3D printing, complex-shaped composite parts can be

designed and developed. The main advantage of composite-based 3D printing is that the parts developed are of high strength compared to polymer parts.

Requirement in Drone Technology	How does additive manufacturing help?
Drone Metal Parts	Complex shaped metal parts can be manufactured at a low cost with metal AM
Low-cost customized parts	Based upon design need, low-cost customized parts can be developed with technologies like FDM
Full-scale production	Some drone companies rely entirely on additive manufacturing solutions for the full-scale production of mechanical parts
Prototyping	Testing and development of new drones are easily performed by additive manufacturing
Composite Parts	High strength composite parts can be developed using additive manfuacturing
Propeller Design	New propeller designs can be tested and propellers manufactured by additive manufacturing
Small parts design and development	Small parts needed to develop the drone can be designed and developed with the AM.

Propeller is considered one of the most critical components of the drone, which can be manufactured using the additive manufacturing process. Small changes in the propeller design can be efficiently tested with additive manufacturing.

A drone frame requires several small parts such as nuts, bolts, bush, bands that can be manufactured with the help of additive manufacturing technologies and also promise for weight reduction in the drone.

The following table summarizes the role of additive manufacturing in drone technology

New Technologies

Additive manufacturing technology is growing rapidly and this growth can serve the ever-growing requirements of drone companies. Moreover, it can also make drones more responsive, effective, smart and safe.

Technologies such as multi-material printing can develop the same part with various materials improving the functionality of parts such as drone frames. Besides these, smart materials, 4D printing and integrated electronics can also be added with drone technology with the help of additive manufacturing. A multifunctional structure is defined as a structure that can perform a wide range of functions on a single platform. With additive manufacturing, it is possible to develop multi-function structures for drones which will help to reduce weight.

In addition to this for military applications, additive manufacturing can help provide on-site on-demand services for drones. This will help to improve the

Technology	Feature	Use of Drones
Multi-material printing	Printing with more than one material	Frame Development
Smart materials	Integrating electronics and 4D printing into drones	Frame Development, cost reduction and safety
Multifunctional structures	Development of structures that can perform more than one function	Frame Development
Printing on-site on-demand	Printing parts with any delay in supply chain	Supply Chain Capabilities
Generative Design	Integrating AI in drone part development for low cost and high-performance frames	Weight reduction
Soft Material Printing	Soft materials for improved performance of landing gears and higher impact strength in drones.	Landing gear design and improvement in impact strength

responsive factor of the military supply chain. In addition to these technologies, such as generative design, may help integrate artificial intelligence and develop low weight and high-performance frames. Additionally, with the help of soft material additive manufacturing, the landing gears can be designed and generated, which helps to reduce the impact on the structure during landing.

The following table summarizes the new AM technologies that can be used to develop the drones

Challenges

The key challenges of using additive manufacturing in drone technology are limited printing space available, which further limits the shape and size of the drone frame. The other limitation is that the evaluation of mechanical performance of the additive manufactured materials is unreliable, resulting in issues during the operations. The other limitation is the defects that occur in the additive manufacturing parts, such as the porosity and warps that may limit the performance of the finished part developed.

Reference:

G.D. Goh et al., Additive manufacturing in unmanned aerial vehicles (UAVs): Challenges and potential, Aerosp. Sci. Technol. (2016), http://dx.doi.org/10.1016/j.ast.2016.12.019

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Chinmay Saraf is a scientific writer living in Indore, India. His academic background is in mechanical engineering, and he has substantial experience in fused deposition-based additive manufacturing. Chinmay possesses an M.Tech. in computer-aided design and computer-aided manufacturing and is enthusiastic about 3D printing, product development, material science, and sustainability. He also has a deep interest in "Frugal Designs" to improve the present technical systems.

Review: India's National Strategy on Additive Manufacturing

Chinmay Saraf and Aditya Chandavarkar

This article by AM Chronicle covers the key highlights of the National Strategy of Additive Manufacturing and provides information about the critical points in the policy.

The Ministry of Electronics and Information Technology, Government of India launched launched the National Strategy on Additive Manufacturing (NSAM), focusing on India's growing 3D printing market on 24th February 2022. The policy aims to advance the manufacturing sector, research and development, and new product development centered around additive manufacturing.

Vision, Mission, and Objectives

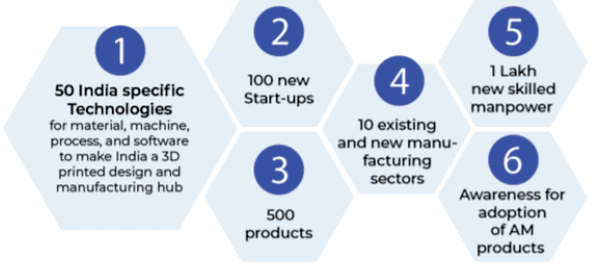
The vision of the NSAM is to promote "Make In India" and make India self-reliant in the area of manufacturing. The goal of NSAM is to make India a global center of additive manufacturing with a focus on creating and protecting intellectual property.

The mission aims to create a sustainable ecosystem in which additive manufacturing businesses grow and provide knowledge and skill to different companies to adopt additive manufacturing to encourage innovation. The key objective is to grow man, machine, and software related to additive manufacturing and develop local skills, technology, and scales India's existing additive manufacturing outputs. The principal is to create long-term economic viability and technology leadership of additive manufacturing in India.

Strategy Outputs

The key output is to gain 5% of the global market share in additive manufacturing and generate one billion dollars in India through additive manufacturing. It also aims to develop India-specific technologies, new startups, new products, and a skilled workforce in additive manufacturing.

The NSAM is also aimed to resolve the technical challenges around additive manufacturing. The key technical challenges are aimed to determine using the process of knowledge and ecosystem development.



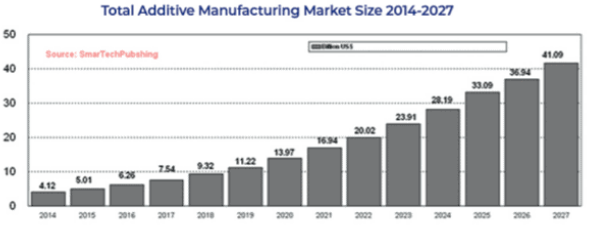
Objective of National Strategy for Additive Manufacturing

The technical challenges that the policy will address include

1. Properties of AM Material
2. Material Availability
3. AM Standards
4. Surface Finish
5. Volume and Speed of Printing
6. Technology
7. Process Monitoring

Global Market Trends

The global market trends of additive manufacturing are constantly growing, and the majority of the share is in the European and American markets. The NSAM aims to increase the market share of Indian companies in this regain and motivate the growth of 3D printed parts in India. Additionally, sustainable development is predicted in additive manufactured parts, software, and hardware. The NSAM aims to improve the share of Indian companies in the NSAM.



AM Market Growth: (Sector includes Hardware, Materials, Services, Software)

Industry Applications and Materials

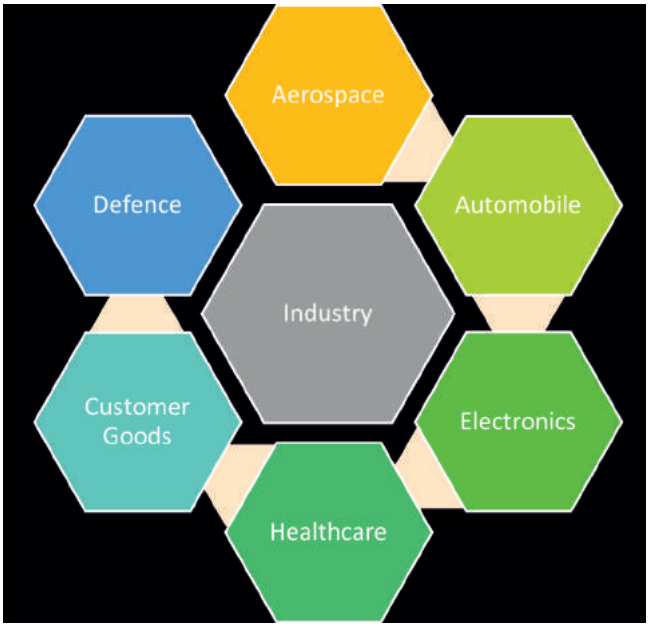
With the help of additive manufacturing, the sectors that can be served are aerospace, automobile, electronics, healthcare, customer goods, and defense. Production of some parts is more profitable and easeful using AM in these sectors. The policy provides examples and uses concerning these six sectors where AM can play a critical role.

In aerospace, it aims at parts such as landing gear engine components, and in the automobile segment, it aims at engine control units and gearbox. Applications such as soft robots and wearable electronics can be produced with additive manufacturing. The healthcare application is aimed at surgical devices, implants, and dental applications. Parts such as toys, furniture, and jewelry can be produced through 3D printing in the consumer goods segments.

The NSAM aims to motivate Make In India through additive manufacturing of different parts and

components in this sector.

The additive manufacturing process can develop a wide range of materials, but the essential materials highlighted in the policy are metals, ceramics, biomaterials, and plastics. The NSAM aims to improve 3D printed materials and develop innovative use of materials in India.



India and Additive Manufacturing

The key initiatives in India for the development of additive manufacturing were also highlighted in the policy. They were classified into two types, the first Government lead initiative and the second private initiative. The critical government initiatives include "Atal Innovation Mission," Gujrat government collaboration with USA companies 3D technology, and OEM 3D Systems. Additive Manufacturing centers in IIT and other engineering colleges and Andhra Pradesh MechTech Zone for 3D printing.

The collaborative efforts include the collaboration of IISC Bangalore with Wipro 3D for metal 3D printing, HPs Collaboration with Center of Excellence AP, and NTTF foundation collaboration with Stratasys. Additionally, various research institutions are associated with the research and development of 3D printing technology. Some important institutions include IIT Bombay, IIT Hyderabad, RRCAT, and ARCI.

Challenges and Additive Manufacturing

The policy aims to solve critical challenges: cost of equipment and materials, lack of standards in additive manufacturing, lack of ecosystem, a foreign monopoly in business, lack of skilled workforce, domestic market translation, lack of clarity, and legal and ethical issues. The solution to these challenges will resolve the difficulties that resist the growth of additive manufacturing in India and provide a pathway for developing new products and technology. Moreover, the policy aims to provide a solution to some of the critical challenges of 3D printing that include ethical, legal, and business aspects such as human organ printing and the development of pharmaceutical drugs.

Conclusion

The NSAM is a much needed boost to provide motivation for the development of additive manufacturing in India. This step by the Government of India and is being seen with great positivity by both the research community and the industry at large. It aims to resolve the critical challenges which are hampering the growth of additive manufacturing in India and develop a roadmap that supports the growth in this segment and makes India a 3D Printing hub in the region. It will need immense effort by all the stakeholders including the government to implement this strategy and catch-up with the adoption of this technology in other region, however this is a surely a step in the right direction to ensure India reaches new heights in the AM sphere in the next decade.

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Chinmay Saraf is a scientific writer living in Indore, India. His academic background is in mechanical engineering, and he has substantial experience in fused deposition-based additive manufacturing. Chinmay possesses an M.Tech. in computer-aided design and computer-aided manufacturing and is enthusiastic about 3D printing, product development, material science, and sustainability. He also has a deep interest in "Frugal Designs" to improve the present technical systems.

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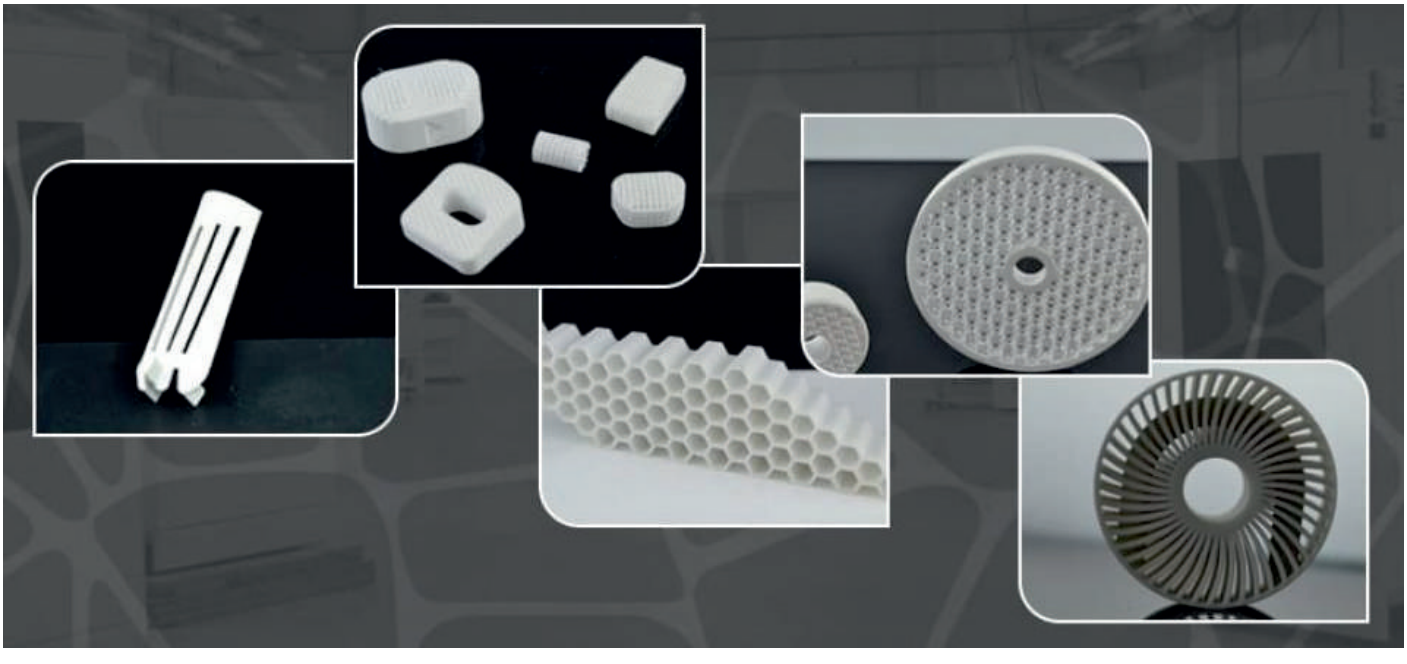
Managing Editor, AM Chronicle

Aditya Chandavarkar is a established entrepreneur with business interests in manufacturing, innovative technology, training consulting. He is closely associated with cutting edge application industries for inkjet, 3D Printing (Additive Manufacturing) and Packaging.

Ceramic 3D Printing: A Revolution within Additive Manufacturing

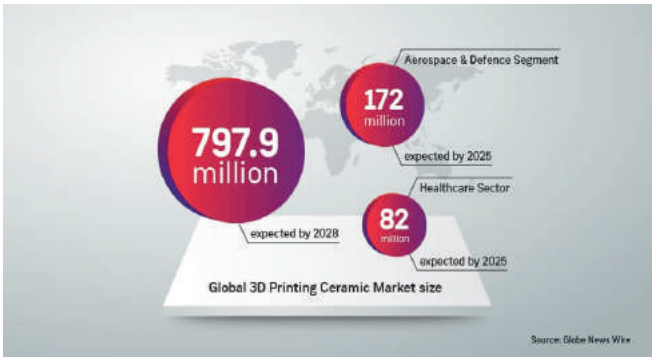
Shree Rapid Technologies

Ceramic Additive Manufacturing is currently used in the chemical industry, machinery, electronics, aerospace, biomedical engineering, and a growing domain. Additionally, new technology and machines are also transforming its industrial application.



As 3D printing is making its cut through various industries and is widening its horizon of scope and applications, Ceramic 3D Printing is now the latest trend to come under the spotlight. Owing to their various excellent properties, ceramics are used in a diverse range of applications, including the chemical industry, machinery, electronics, aerospace and biomedical engineering.

The Global 3D Printing Ceramic Market size is expected to reach 797.9 Million by 2028, exhibiting a Compound Annual Growth Rate (CAGR) of 27.1% during the forecast period. The aerospace & defence segment accounted for a share of 39.7% in terms of value in the 3D printing ceramic market in 2020 and is projected to reach USD 172 million by 2025 at a CAGR of 30.2%. The healthcare sector is projected to experience the second highest



CAGR of 26.5%, growing from USD 25 million in 2020 to USD 82 million by 2025.

According to SmarTech Publishing: 3D ceramic printing showed $98 million in 2018. Which can further be measured against the $3.6 billion expected in 2028.

3DCeram, a French Company specializing in 3D ceramic processes and materials, is dedicated towards providing a 3D printing process for technical ceramics.

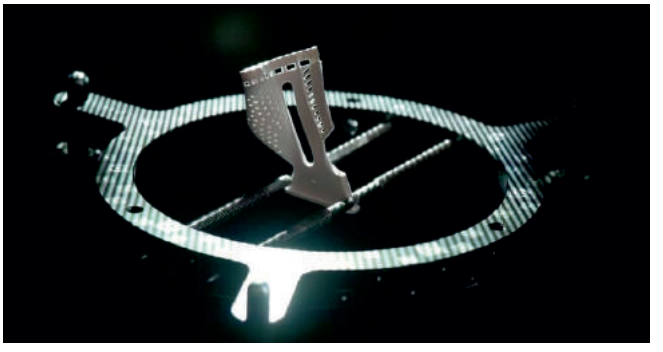
3DCeram has chosen Shree Rapid Technologies (SRT) as its official partner to intensify the foothold of the company and advance 3D Printed Ceramics in the Indian market. Established in 2007, Shree Rapid Technologies is one of the prime suppliers of additive manufacturing technology in India, with global brands as the principal partners.

3DCERAM specializes in three areas of application for ceramic AM: industry (defense, automotive, investment casting/foundry cores), aerospace and aeronautics, and biomedical.

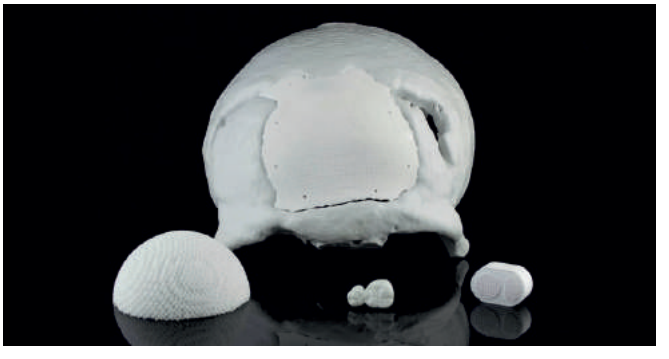
Aerospace/Defence:

Foundry Cores:

3DCERAM and Avignon Ceramic join forces to create U3DC, with the aim to provide the precision foundry industry with proven solutions in both the production of 3D printed ceramic cores and to offer a complete printing solution (machine, materials and process).



Biomedical/Dental:



3DCeram has developed its mastery of the 3D printing ceramics process, its machines, materials and services as maintenance and training. The large range of printers from C100 EASY FAB to C3600 ULTIMATE, depending on production capacity requirements for biomedical devices or dental.

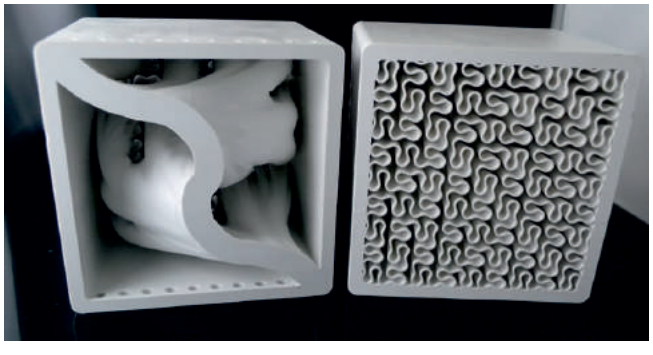
Industrial Applications (Electronic insulators, sanitary applications, heat exchangers, etc.):

The 3D printers by 3DCERAM makes 3D ceramic printing of complex parts that are difficult to produce using traditional methods possible. It allows manufacturing of parts without expensive tooling, which is particularly interesting in cases of small series production, individually designed parts or freedom to change the design of some engineered components.

3DCeram's 3D printed ceramics technology, the stereolithography (SLA), offers enormous flexibility when designing items for different sectors. In addition, the Ceramaker 900 FLEX from 3DCeram, makes it possible to manufacture large items of impeccable quality to drive your innovation process to the next level.

When it comes to ceramic 3D printing, 3DCERAM has achieved milestones in the areas of aerospace, by driving process opportunities for Anywaves https://bit.ly/3tY3PtK , in the areas of hybrid 3D printing processes by creating a technology that has the solution to print materials together https://bit.ly/3q8lf5H and so on.

Moreover, 3DCERAM is the privileged partner of major industrial groups, world-famous players of the engineering industry and has immensely contributed towards application of different industrial segments: chemistry, oil & gas, water treatment, electronic, automotive and other industries.



Industrial applications of Technical ceramics:

- Filtering of fluids and gases because ceramics are chemically inert and are resistant corrosion and temperature applications include filters, dies, tooling, gaskets, tightness rings;

- High temperature applications: injectors, nozzles, temperature probes, pressure and temperature sensors, heating components, heat recovery components;

- Electronic insulation: insulation components, connectors, inserts, tubes with cooling channels inside, different insulation disks and bushings;

- Sanitary applications: handles for tools in contact with food or medical substances;

- Heat exchange: heat exchangers with internal channels, furnace inserts for cooling;

- Electronics for electrical insulation and ionic conduction properties of ceramics: honeycomb solar absorbers, antennas (for satellites, 5G, drones etc..),rigid supports for electronic devices, housings for components, parts for infrared emitters, induction coils;

- Various wearing parts because of resistance to abrasion of ceramics and longer life cycle of ceramic parts: different kinds of nozzles for fluids and gases etc.;

- Different hardware because of good mechanical resistance and stiffness: clamps, fixing supports, housings etc.

With an experience of over 20 years to develop 3D printing of technical ceramics, 3DCERAM brings in a lot of advantages or benefits in this area. Namely building parts with optimized design for more efficient applications. For example, in aeronautics, a printed part allows more compact assemblies with a more optimal integration with the end goal of a significant reduction of the total mass. With vast innovation and constant technological upgradation, 3DCERAM aims to provide complete printing lines (printers, materials, equipment and services to operate the technology transfer) to its customers. For which 3DCERAM has established a strong relationship with Shree Rapid Technologies, to increase their Indian representation.

As the outlook of 3D printing is changing, so is the spirit of production. With focus being on environmental issues, to produce the right quantity of parts with little or no waste, it is heading in the right direction as a

relevant prototyping process that doesn't involve any tooling. It will decrease the need for expensive stocking of multiple parts, enhancing the JIT system and custom part production process. In short, we are heading towards a revolution in 3D printing that has commenced now!

For end-to-end 3D printing solutions, visit www.shreerapid.com

ABOUT THE AUTHOR

Shree Rapid Technologies

SRT provides the best in class 3D Printing technology ranging from scanning to designing to printing and finally post processing. With all the processes under one roof, SRT is one of the only few companies providing its clients an end to end solution for Digital Manufacturing.

Leading aerospace manufacturer improves its productivity with the Russell AMPro® Sieve Station

Kumar Saurabh

GKN Aerospace optimizes powder handling solution, reducing risk of contamination in its powder handling process and improving operator safety.

Global aerospace supplier group GKN Aerospace is a leading manufacturing company, producing innovative systems and components for aircraft ranging from business jets, single-aisle aircraft, and large passenger planes.

GKN Aerospace's journey into the additive manufacturing market started 15 years ago, and since then the company has gone from strength to strength. Whilst it began this process by investing in EBM technology, GKN Aerospace subsequently researched laser bed technology. It has since moved into full- scale production, with an innovative facility that manufactures leading-edge AM components – using both EBM and laser powder bed technology to do this - for the aerospace industry.

Kevin Payne, Head of Production for Additive Manufacturing at GKN Aerospace, states: "We want to make parts faster, better, lighter, and cheaper, to benefit our customers. Additive Manufacturing technology and its benefits are almost untapped right now, and we see it as being a really disruptive technology that will affect everything we do in the aerospace industry."

Having previously purchased a Russell Compact Self-Loading Sieve™ for its EBM line, GKN Aerospace turned to Russell Finex again for a solution. As part of its journey into laser powder bed fusion technology, the company wished to further optimize its process and was recommended the innovative Russell AMPro® Sieve Station as the best machine to suit its needs.

GKN Aerospace uses two different types of powder for its builds: titanium and inconel. It is important to its process to ensure that the powder is qualified properly

Figure 1. The Russell AMPro® Sieve Station is easy to move, and operate, in order to reuse and reclaim AM powder from the build process.

before and after use in order to ensure its quality. In fact, an integral part of the additive manufacturing process for the company is to ensure that powders are properly and effectively reclaimed, as well as making sure the powder is maintained within its quality lifecycle – meaning that the AM process is safe with powders being contained, and the process efficient and fast in order to get the maximum use of the powder possible.

The method originally used was labor intensive, time consuming, and presented serious manual handling issues.

- Prevent cross-contamination - Russell Compact Sieve® style technology with minimal contact parts, allows for easy cleaning of the unit

- Ensure maximum powder recovery - Removes all out of spec powder, recovering all reusable powder ready for use

- Minimize operator involvement - Fully automated and enclosed system with a simple one-button operation for complete process integration

This included contamination concerns as a result of the powder being transferred to and from multiple containers and involved the risk of powder being lost.

The Russell AMPro® Sieve Station addressed and solved several concerns for GKN Aerospace with regards to its powder handling process.

Importantly, the control offered by the Russell AMPro® Sieve Station, alongside the repeatability aspect of the powder handling process for GKN Aerospace has proved invaluable.

The reuse and requalification of AM powder is a feature that is integral to its process, and since using the Russell AMPro® Sieve Station GKN Aerospace has made considerable gains, in terms of its efficiency. The potential for cross contamination of AM powder has been eliminated due to the O2 monitoring system, preserving the quality of powder alongside its vacuum

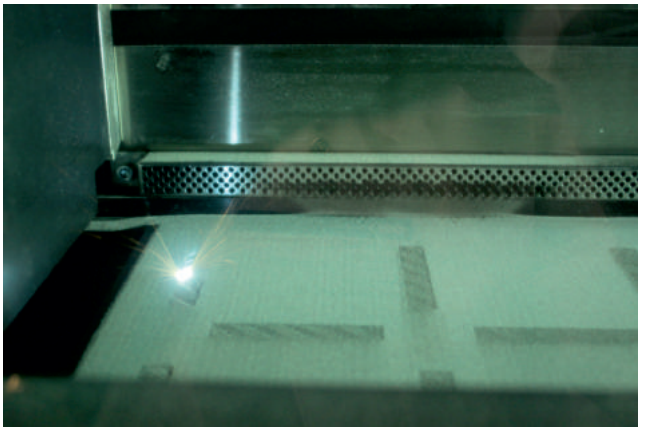


Figure 2. The Russell AMPro® Sieve Station is used to recover titanium and iconel powders, used in GKN's builds.

conveying system, whilst the use of minimal contact parts ensures that the machine is able to be cleaned fast and effectively.

Chief Manufacturing Engineer Ross Studzinski comments: "Using the AMPro has made the turnaround time for builds faster and more efficient. This has been a brilliant investment for our production process, as it has allowed our operators to concentrate on other tasks, speeding up our overall process and improving our material's quality".

Concerns about operator safety were addressed with the installation of this innovative machine. Its one button automated system easily allowed for operators to walk away from the machine during the sieving process and allowed them to focus on other value-added tasks – such as working on preparing multiple builds. This minimized their exposure to powders whilst maximizing their safety.

With the installation of two Russell AMPro® Sieve Stations, time has also been saved. As a result, operators can carry out these other tasks, meaning more AM processes can been conducted in parallel with each other.

This in turn has saved on average around three hours of sieving and handling, allowing for guaranteed turnaround times effectively doubling GKN Aerospace's

Figure 3. A key feature of the Russell AMPro® Sieve Station is its one- button automation system, which allows the operator to concentrate on other important value-added tasks.

efficiency, whilst maintaining the safety of its technicians. Russell Finex is an innovative, global leader in the design and manufacture of machines which are supplied to over 140 countries. Its ability to provide customized solutions for its customers, and ensure collaboration and support was highly important as part of its relationship with GKN Aerospace.

As Studzinski states: "At first it was hard to find a partner that was willing to provide something that was off the shelf, but also something where they were happy to integrate. But with Russell Finex it's been a collaboration from the beginning to the end, and still continues to this day."

Having operated in the AM industry since the beginning, Russell Finex has worked with an array of global manufacturers to provide innovative equipment that will continue to meet the needs of an expanding, changing market. Payne adds: "GKN Aerospace and Russell Finex have been working together for many years and as a result of that collaboration we've ended up with a fantastic piece of equipment that's been in service now for over a year."

With over 85 years' experience in the manufacturing industry, Russell Finex has used its expertise and knowledge to develop the Russell AMPro® Sieve Station, alongside its brand-new range of additive manufacturing equipment. With a variety of different machines to suit a company's every requirement, such as the Russell AMPro® Lab, Russell AMPro® Lite, and closed-loop systems, Russell Finex will continue to develop and expand its knowledge, adapting and ensuring it meets the needs of a new and growing industry.

ABOUT THE AUTHOR

Kumar Saurabh

Assistant Manager Marketing at Russell Finex Ltd

Leading Russell's marketing function for India, Sri Lanka and Bangladesh. Responsible for handling marketing budgets, developing yearly marketing plans covering strategic & tactical initiatives, execution and monitoring of marketing activities.

3D Printing, The Game Changing Skill – Part 1

Raunaq Dua

For all who are curious to learn 3D Printing, now is the perfect time. 3D Printing is already changing the world and you can be a part of it.

Importance of 3D Printing Education

We're all working towards the same goal: the collective enlightenment of mankind. We might contribute to this directly or indirectly, but we all do.

Quoting Elon Musk "if we can advance the Knowledge of the world, if we can expand the scope and scale of consciousness, then, we're better able to ask the right questions and become more enlightened. That's the only way to move forward."

Education is one of the powerful tools that drives knowledge. Therefore, within the domain of education, we need even more powerful tools. Tools that drive our curiosity and creativity.

Now imagine a magical technology that has the power to revolutionise practically anything and everything around you. A technology that can

- make better rockets and satellites to explore the universe
- develop synthetic human heart and organs to save lives
- make prosthetics and dental aligners to improve

healthcare
- build houses faster and cheaper, possibly even in space
- make custom-fit motorbike helmet to reduce impact damage
- customised clothing, shoes and consumer products
- manufacture face-shields to fight a pandemic
- help NASA manufacture a critical component on the ISS
- enable maintenance and repair of defence aircrafts
- develop light-weight surveillance drones
- Even enable us to make things at home!

The list is never ending but the technology is common: 3D Printing. Now, why should such a technology be a part of our education? You have the answer.

For a school student, it sparks imagination and creativity. Concepts such as Problem Solving, Product Development, Design Thinking – that are usually taught at the university level can now be introduced at the school level.

3D Printing, The Game Changing SkillAs an example, here's a shoe model 3D printed by a Curiosity3D student. He's in 6th grade and aspires to be a design engineer. At just 13 years of age, he's not playing with thermocol or cardboard but in fact has the knowledge of how to make a product exactly to his imagination with 3D printing.

For university students, it solves the biggest problem of our current education system- curriculum is focussed more on theory and less on practical hands-on experience. We encourage exams over experimental learning. 3D printing is an affordable and accessible tool that gives them the power to convert their ideas into real projects. Even from their own rooms!

3D Printing, The Game Changing SkillAs an example, this prosthetic hand was designed and developed by our Curiosity3D student who's pursuing an engineering degree. Such learnings build a curious mindset and will prepare them for jobs in the Industry 4.0 future.

For industry professionals and companies, it enables the development of revolutionary products and services such as the long list we discussed above. Companies are essentially a group of people working towards a common goal. Combined with cutting-edge skills like 3D Printing, even startups can reach those goals quicker than legacy companies.

As an example, Agnikul Cosmos, an Indian startup has developed and fired the world's first fully 3D-printed rocket engine.

And for all of us collectively, 3D Printing drives innovation and curiosity.

For all who are curious to learn 3D Printing, now is the perfect time. 3D Printing is already changing the world and you can be a part of it.

ABOUT THE AUTHOR

Raunaq Dua

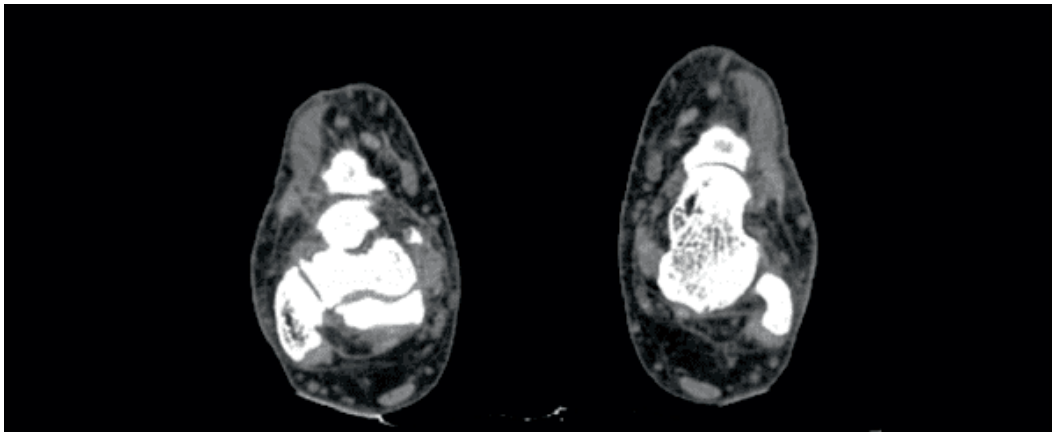
Founder at Curiosity 3D

A young tech entrepreneur, Raunaq founded CURIOSITY 3D with the mission to introduce 3D Printing in Indian education. He is a mechanical engineer with an M.Sc. in Additive Manufacturing and has previously worked with leading 3D Printing companies in the UK. His startup is working with universities and industry to spread knowledge of 3D Printing.

3D printed patient specific Talus spacer that aid in healing a 47-year-old man

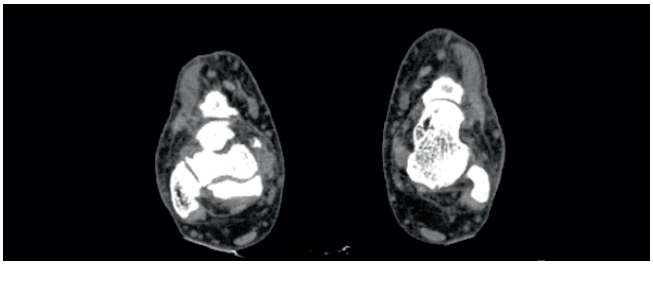
Ravikant Kamal

Jajal Medical has utilized additive manufacturing for talus replacement for medical conditions like osteonecrosis and trauma



3D printing has been hailed as a revolutionary technology, and it is already generating substantial interest among the medical community. One such medical 3D printing solution provider Jajal Medical provides customized orthopedic implants. The patient-specific designs and 3D printed models can be used to create prototypes, duplicate broken parts, and even entire organs.

Jajal Medical's custom Talus spacer could be an ideal solution for trauma cases where the neighboring joint has substantial cartilage. As a design input, bilateral ankle CT was used for 3D talus creation. The healthy side talus was mirrored and registered on the damaged talus. Considering the size variations of the talus due to soft tissue balancing, pre-op planning design proposals consisted at least five sizes (Neutral, Upsize and Downsize).



Challenge:

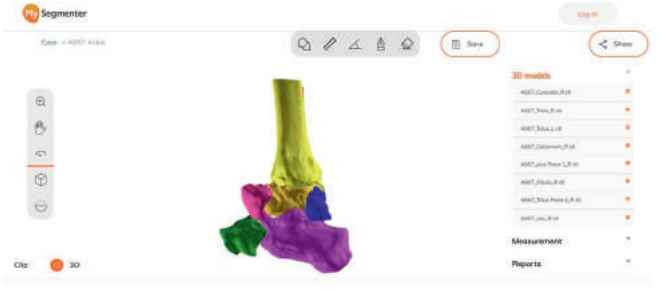
Talus replacement could be used in conditions like osteonecrosis and trauma. Customized talus

replacement is still a rarity in foot and ankle surgeries in India. A 47yr/M was diagnosed with fractured talus in the right leg. The patient was unable to sustain the mobility of his foot.

Dr. Rajiv Shah, Head of Foot and Ankle Surgeries, Sunshine Global Hospital, Vadodara approached Jajal Medical team to provide with the patient-specific solution of 3D printed Talus spacer. The team helped to visualize, plan, and then execute.

Solution:

Detailed preop planning played a pivotal role in the outcome of the surgery. Virtual session through a digital point of care 3D printing platform Mysegmenter.com helped Dr. Rajiv Shah understand the perception and intended use. Once the requirements were clear the complete plan was proposed to the surgeon.



Key steps involved –

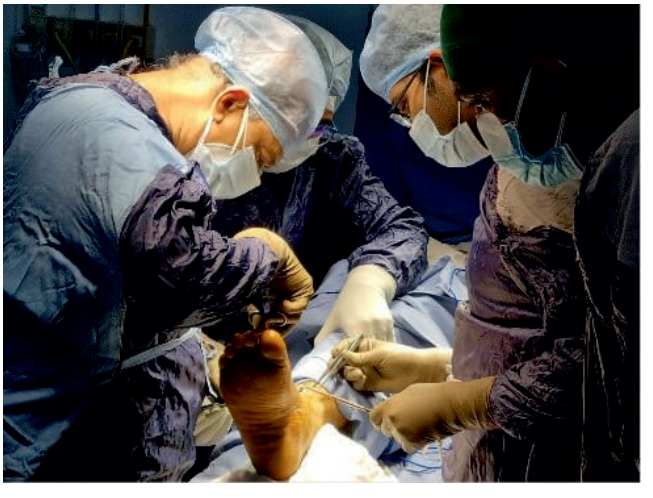
Contra-lateral talus was mirrored and registered with diseased talus using registration tools.

Subsequently, we verified the conformity and location of registered talus with diseased neighboring bone. Fact that 70% of talus bone is involved in articulation, it is critical that the alignment of mirrored talus perfectly matches the articulating surface of all the adjacent bones, including tibia, navicular, calcaneus, and fibula.

For accurate sizing prediction a 3D printed model with current position of adjacent bones was provided with existing talus gap. Five sizes -2, -1, 0 and +1, +2 were provided with as low as 10% volume difference to original.

Range of sizes allowed surgeon to select appropriate one after intra-operative assessment of the joint.

Considering the talus placement could be tedious and cumbersome when placed with hand during the surgery, detachable long handle was developed which was utilized for placing the talus trial and implant intraoperatively.



Outcome:

After the surgeon approval, final polished metal 3D printed talus implants were delivered non-sterile. Surgeon was happy with the customized implant quality and was able to achieve desired results with reduced intra-operative time, and faster recovery of the patient.

ABOUT THE AUTHOR

Ravikant Kamal

Chief Technology Office, Jajal Medical

R&D engineer with 8 years of experience in design and developments of PSI (Patient Specific Instruments/Implant) for TKA (Total knee replacements), RSA (Reverse shoulder arthroplasty), Spine surgery, CMF(Cranio-maxillo facial) Surgeries, THA(Total Hip Arthroplasty), TAA(Total ankle arthroplasty), Revision cases and Trauma cases.

ISO/ASTM 52901:2017 Additive manufacturing - General principles - Requirements for purchased AM parts

Dr. Rafi Khalid

ISO/ASTM 52901:2017 is an international standard for additive manufacturing parts. The standard elaborates the several factors related to buying of additive manufactured parts.

Have you ever used a service bureau or contract manufacturer for an additive manufacturing part? Are you fully aware of the information you need to communicate with the manufacturer to produce the part you require? Whether you are a seasoned AM professional or a novice AM user, this standard is a perfect guide for getting a part printed from a service bureau or a contract manufacturer.

ISO/ASTM 52901 provides guidelines for the elements to be exchanged between the customer and the part provider at the time of the order, including the customer order information, part definition data, feedstock requirements, final part characteristics and properties, inspection requirements, and part acceptance methods.

The requirements vary across different parts depending on the intended applications. For any application, there will be a minimum acceptance

criterion. This standard helps you define such minimum requirements that the part needs to be satisfied. You may specify more stringent requirements at the time of the order, for example, a tighter tolerance in the chemical compositions or results of fatigue properties.

This standard is beneficial for the service bureaus/contract manufacturers. Service bureaus encounter a variety of customers ranging from novice to expert. It's often a challenge to obtain adequate information from the customers on what they are looking for. Some customers come with a design of the part they want to print without providing sufficient information about what kind of material they wish to use or what process they want to choose. Service bureaus can use this standard to create a framework that can capture all relevant information that needs to produce the part. Complying with this standard demonstrates the capability of service bureaus' capability to maintain a streamlined procedure right from the customer onboarding to the final part release.

Outline of the contents in the standard.

Part ordering information

The standard clearly defines what shall be included in the purchase order agreed between the customer and the part provider. A template demonstrating the typical contents of a purchase order is provided as an Annex that users can take as a reference.

Definition of the part to be manufactured

This session includes the details of all the part information that needs to be captured. This covers;

- general information of the part,
- details of part geometry,
- tolerances for functional zones and aesthetic zones,
- surface texture specifying roughness and waviness, desired manufacturing process for building the part,
- material specification mentioning feedstock characteristics and handling and storage requirements,
- details of the repair methods employed, such as welding or bonding
- process control information for assessing repeatability
- details of external vendors who provide any services to the part, such as heat treatment

Part Characteristics, functionality, and performance

This section captures the essential part characteristics the customer is looking for, such as dimensional accuracy and mechanical properties. The section also covers;

- Functionality and performance requirements of the parts
- Test methods and inspection criteria to measure part characteristics
- Post-processing to meet customer requirement for part characteristics

Part Acceptance

The customer needs to specify the acceptance requirements for the parts he ordered with the service bureau. This section covers different stages of acceptance;

Acceptance of qualification part: qualification parts need to be produced and approved by the customer before manufacturing the first production part.

Acceptance of the first production part: Before initiating a production run, the first production part should be inspected and approved.

Acceptance of final or reference part: Acceptance criteria for the final part need to be specified in the purchase order

The manufacturer needs to provide part acceptance documentation that includes an inspection report covering test results of various part characteristics.

Conclusion

ISO/ASTM 52901 is a great resource for purchasing an AM part from a contract manufacturer. This document is equally useful for both customers and the manufacturers to get fully aligned with the part requirements and avoid confusion during the part ordering process.

To get access to the full standard, log on to https://www.astm.org/f3167-16.html

ABOUT THE AUTHOR

Dr. Khalid Rafi

Senior Lead, Additive Manufacturing Program Development at ASTM International

Dr. Khalid Rafi is the Senior Additive Manufacturing Program Development Lead for ASTM International. In his role, he is responsible for developing programs on AM education and workforce development, and programs on standardization and certification. He holds Masters and Ph.D. in Metallurgical and Materials Engineering from Indian Institute of Technology Madras (IITM). Prior to joining ASTM, Dr. Rafi was the global technical lead for Additive Manufacturing Programs (Materials & Process) at Underwriters Laboratories (UL). He was a key contributor to UL AM training programs, of UL Blue Card program for plastics in AM, and in establishing validation program for metal additive manufacturing. He has co-authored over 25 publications in peer-reviewed international journals. He has made over 30 presentations in conferences, symposiums and trade shows.

Part 3: Safety of Additive Manufacturing facilities

Dr. Sastry Kandukuri

Technical Reference on Safety of additive manufacturing (TR 87 -2021) is discussed in this article, which has been published by Singapore Standards council

The purpose of the articles in this series is to provide introduction, awareness, insights on AM standards related to topics on safety, risk, production and quality issues to help you in gathering enough information to make an informed decision. Standards are the distilled wisdom of people with expertise in their subject matter they represent.

In this article, I would like to introduce you TR 87 -2021, Technical Reference on Safety of additive manufacturing facilities which is a Technical Reference published by Singapore Standards council. A Technical Reference (TR) is a pre-Singapore Standard, that is used by the market before a full consensus is reached. It could be about making a product, managing a process, delivering a service or supplying materials etc. Users of the TR are invited to provide feedback on its technical content, clarity and ease of use.

Scope of TR 87 -2021 :

This is a document with total 54 pages. Among other things TR 87-2021 This TR specifies the safety for designing, operating and maintaining an AM facility using powder as the feedstock material. It seeks to equip local AM companies, especially new entrants, with internationally recognized provisions on the safe setup, operations and maintenance of additive manufacturing facilities.

Important topics:

- Pre-startup safety review
- Exposure monitoring and surveillance
- Personal protective equipment (PPE)
- Material and powder handling
- Hazardous waste management
- Emergency response and planning
- Site assessment
- Facility layout
- Safety devices and first-aid facilities
- Fire protection system
- Infrastructure requirements

Other topics covered:

- Identification and understanding of hazards
- Risk assessment
- Process hazard analysis (PHA)
- Dust hazards analysis (DHA)
- Storage of flammable, reactive or hazardous AM material
- Maximum allowable quantity (MAQ)
- Handling and transport of flammable, reactive or hazardous AM material

Useful charts and Tables:

- Schematic of Process hazard analysis (PHA) process
- Maximum allowable quantity (MAQ) in working storage
- Requirements for additional fire safety cabinets in working storage
- Storage requirements for dedicated storage area
- Requirements of PPE types

Highlights of some sleeted topics

Material and powder handling

Section 10.5 of TR 87-2021 provides a requirement framework to guide the users on topics related to material and powder handling by stating all powder, print materials, solvents, liquids and other agents shall be tracked and inventoried.

This section outlines the requirements in various subsections for various scenarios such as action points to prevent dust cloud, eliminate all sources of ignition, Eliminate generation of static electricity and good housekeeping practices.

Hazardous waste management

Section 11 of TR 87- 2021 provides guidance to users in the form of requirements to help them to establish a policy on hazardous waste management that spells out the direction, accountability, implementation framework and monitoring regime. It also states that the hazardous waste management framework is in compliance with applicable statutory and regulatory requirements

Maximum allowable quantity (MAQ) of powders in a facility

Annex B of TR 87 -2021 provides calculation methodology and example calculation for quantifying powder that is allowed to be stored in the facility.

Classification of AM hazards

Annex E of TR 87 -2021 provides guidance on various hazard types such as material hazards, equipment hazards, facility hazards, area classifications.

Relevance:

Target users of this TR are AM facility owners, auditors, facility managers, certification bodies, industry associations, research institutions and government agencies. However, this document is useful as a reference for other AM industry stakeholders also.

Concluding remarks:

TR 87-2021 guide the AM facility owners/ manufacturers on issues related to safety for designing, operating and maintaining an AM facility using powder as the feedstock material. It seeks to equip local AM companies, especially new entrants, with internationally recognized provisions on the safe setup, operations and maintenance of additive manufacturing facilities.

It provides a wealth of qualitative information related to topics discussed this document that is very helpful for new AM facility /manufacturers to expedite their learning curve with regards to safety requirements.

The requirements are voluntary in nature except when it is made mandatory by a regulatory authority. It can also be cited in contracts making its application a business necessity. Users are advised to assess and determine whether this document is suitable for their intended use or purpose. If required, they should refer to the relevant professionals or experts for advice on the use of the document.

Link to document :

TR 87 can be purchased from the Singapore Standards eShop

ABOUT THE AUTHOR

Dr Sastry Y Kandukuri

Senior Principal Specialist - Materials and Additive Manufacturing at DNV, Norway

Dr. Sastry Kandukuri is a passionate and experienced digital materials and manufacturing technology professional with Doctorate/Maters/Bachelor degrees in Metallurgy and Materials Engineering and Masters degree in Computer Science coupled with more than 20 years of diverse experience in Maritime, Oil & Gas and Manufacturing sectors.

AM NEWS

Bharat Fritz Werner Ltd launches the first Made in India Laser-DED machine

Bharat Fritz Werner Ltd (BFW) and m2nxt (a BFW subsidiary), India's leading CNC and Industry 4.0 machines and solutions companies are proud to announce the launch of its PHOTON 4000G Laser-DED machine, Made in India and available Worldwide. BFW specializes in cutting-edge advanced manufacturing technology platforms, with more than 50,000 machines and systems installed worldwide.

BFW sensed the industry need and opportunity for cost-effective and large format metal additive manufacturing in the Laser-Powder & Laser-Wire Directed Energy Deposition (DED) segment. It entered the DED metal AM industry in September 2021 and has a very Technology-driven Global team to drive this business.

BFW's 60 years of expertise in machine tools gives it the capability and infrastructure to develop and manufacture the world's largest, fastest, and lowest price L-DED machine to exact specifications and reliability. BFW also prides itself in its capability, commitment, and track record to provide world-class customer support for installation, commissioning, training, and expert consultancy to any customer worldwide.

BFW's first system is the PHOTON 4000G, which will be available from January 2023. This system boasts, among many other advantages:

- 36 cubic m hermetically sealed Argon Chamber (33% larger than any other commercial AM system)
- 10.4 cubic m part build envelope (200% larger than any other inert chamber commercial AM system)
- Industry-first dual-deposition heads on dual ram gantry – for Powder & Wire deposition
- Industry-first standard spec 6KW fibre laser with a beam splitter to direct variable power to both heads
- Standard features include a 3mx3mx4m argon chamber with a stainless steel interior, multiple laser safe viewports & glove ports, full-size front & rear doors, motorized parts table, heavy-duty tilt/rotate the table, real-time process monitoring via pyrometry/thermography/machine vision, full 5-axis control/build software, ID cladding head with 2m length, and much more, a game-changer in the DED industry.

BFW has announced a starting MSRP of Euro 1,990,000, which translates to Euro 190,000 per cubic meter of part build volume, 2.5x to 20x lower than other L-DED machine manufacturers.

Printing large/huge parts in the Photon 4000G will be significantly more economical, by an order of magnitude, than other L-DED argon chamber machines. Such compelling economic business cases bring game-changing opportunities, competitive advantages, and technical capability to potential users for printing large/very large metal alloy components. specialising in freeform fabrication, hybrid manufacturing and repair applications for the aerospace, defence, oil and gas, power, mining, and heavy industries. BFW intends to install Photon 4000G machines in its Dr. Abdul Kalam Centre of Excellence in Bangalore for contract manufacturing, as well as effectively market & support the machine in India and globally.

"I have applied and marketed the most premium DED equipment in the industry over the past 20 years. I talked to hundreds of potential & existing industrial users and identified a large global opportunity to satisfy a glaring unmet need – the significant gap

between demand and availability of truly industrial-grade yet affordable L-DED systems and the practical experience required to ensure good results and economic viability. I have contract-printed parts priced at more than $250,000, and the BFW Photon 4000G can print similar parts at less than half that cost once amortization and operational costs are considered. It is also evident that the new wave of metal AM industrial manufacturing will be driven by Laser-DED" stated DED industry veteran Ashok H. Varma, EVP & Global Leader, Additive Manufacturing at BFW.

"Most currently installed systems are in laboratories or light industrial applications, many are "Do It Yourself systems", many are underpowered, undersized, or overpriced systems, many are idle or under-utilised, with few suppliers and users having the practical experience to optimally utilise this technology and reduce 'time to value'. We believe we at BFW will be instrumental in closing the gap between supply and demand of large, very large, and huge 3D printed parts using laser-powder and laser-wire metal deposition, for free form fabrication and fine/heavy cladding/repairs." adds Varma.

"BFW and m2nxt have introduced market disruptive high technology products for the last six decades. Photon 4000G is one more such product which will not only bring technology differentiators but would be the First IoT enabled Smart AM machine" adds Ravi Raghavan, MD BFW.

The fact that this world-leading metal AM machine is being manufactured entirely in India is a testament to the Indian Government's "Make in India" initiative and will address significant, critical and strategic applications in the Defence/Space/Aerospace/Heavy Industries segment.

BFW will soon announce the rollout of several other Photon machine models including Photon 2500 and Photon 1000 series, with gantry and robot, mobile systems for in-situ repair/manufacturing and hybrid AM configurations.

ASTM is developing a Standard to Control Cleanliness of Metal Powder Feedstock in AM

ASTM International's additive manufacturing (AM) technologies committee (F42) is developing a proposed standard that will help to control the cleanliness of metal powder feedstock used in AM processes and thus ensure quality of final AM components.

Chemical powder from the chemistry kit with macro lens photographed in studio

The proposed standard will help AM users to perform cleanliness assessment of unused and re-used powders. According to ASTM International member Aneta Chrostek-Mroz, powder handling and processing practices used in AM, particularly during powder reuse, may lead to deterioration of powder properties through the introduction of contamination. This can result in inclusions and defects in final components.

"The proposed standard will help manufacturers and users of metal powder feedstock used in additive manufacturing to identify suitable methods for detecting and quantifying different types of contamination," says Chrostek-Mroz, research engineer, at the MTC. "The guide will define and classify typical contamination that can be present within metal powder feedstock." The committee invites interested parties to help develop the proposed standard (WK80171). Technical experts with experience in cleanliness assessment and/or have researched

contamination of metal powder used in AM are particularly encouraged to get involved.

ASTM welcomes participation in the development of its standards. JOIN ASTM.

About ASTM

ASTM International, formerly known as American Society for Testing and Materials, is an international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services.

CRP GULF has partnered with 3DTIV TECH to accelerate Additive Manufacturing

CRP GULF has partnered with 3DTIV to further accelerate Additive Manufacturing and bring CRP Technology's Windform composites in UAE and GCC region. CRP GULF streamlines its facilities with the advanced Farsoon Technologies to achieve large formats and to slash lead times of accurate, quality centred 3D printed parts.

The new subsidiary of crp technology empowers its assets to accelerate additive manufacturing in uae and gcc region

The Farsoon HT403P SLS range is the perfect match to make the most use of professional 3D printing and Windform industrial grade innovative composites, which offer an unrivalled level of resistance to fatigue and stressful conditions for long lasting applications.

CRP GULF representatives state, "We chose 3DTVI as partners as they align with our mission to provide technologies that solve workflow gaps that exist in today's Additive Manufacturing solutions."

"As CRP Group's subsidiary we benefit from their immense expertise in professional 3D printing and high performance materials. With this new partnership we will maximize CRP's know-how offering to the UAE and GCC markets unique technological solutions using Windform composites."

Indeed, Windform materials and elastomers are ideal for a wide gamut of components from functional prototypes for R&D to end-use parts in the most demanding industries such as Aerospace, Automotive, Aviation, Energy, Defence, Motorsports, Medical, Oil & Gas, Rail, Space, UAV.

TechNova Now Offering 3D Printing Technology For the First Time Through Partnership with Markforged

One of the world's leading suppliers of state-of-the-art solutions to the printing industry, TechNova Imaging Systems announced an alliance with U.S.-based Markforged, the creator of The Digital Forge, the integrated metal and carbon fiber industrial 3D printing platform.

Markforged offers an end-to-end 3D printing platform, with its 3D printers, cloud-based software and a wide

range of proprietary, manufacturing-ready materials. The Markforged solution helps manufacturers solve problems at the point of need by bringing mini-factories directly to the floor, shifting to digital inventory. Companies around the world use Markforged's solution, The Digital Forge, in industries like aerospace, industrial automation, space exploration, military & defence and automotive to deliver mission-critical, end-use parts on demand at the point of need.

In today's global market, this best-in-class additive manufacturing solution will empower Indian manufacturers and designers to rapidly bring composite and metal parts to market that are strong, lighter than metal, easy to implement and operate, backed up by uncompromising service and support.

Mr. CG Ramakrishnan, CEO TechNova Imaging System says "There is now a real shift in the industry from prototyping to small scale production. With Markforged's Digital Forge, Indian manufacturers will have unprecedented access to both ground-breaking technology and essential fundamental infrastructure. This will enable them to produce affordable, strong parts in a range of exciting new materials while accelerating their speed-to-market and reducing inventory cost, spares management and long lead times."

Amit Khurana, COO of TechNova's Digital & Offset Print Solutions Business group & head of the TechNova-Markforged alliance, says "India is standing on the cusp of Industrial revolution 4.0. With more than 250,000 manufacturing sites available in India, the time is now ripe for taking a leap from subtractive to additive manufacturing".

Shelina Parikh, Joint Managing Director TechNova adds, "Markforged, with their approachable and easy-to-use product portfolio, and TechNova, with its market reach and five decades of presence in Indian manufacturing, will work together to transform the market and take the Indian 3D printing industry to the next level"

Ved Narayan, President, APAC, Markforged, said, "We're thrilled to be partnering with TechNova Imaging System to provide Indian manufacturers with the essential tools to unlock their manufacturing potential and help build the factories of the future. Our additive technology can solve critical manufacturing applications, and we are looking forward to spearheading improvement across India's manufacturing landscape. TechNova Imaging Systems has the experience, skills and ecosystem to help Markforged provide unprecedented levels of access and support to the world's leading manufacturing providers."

About TechNova

TechNova is one of the world's largest suppliers of print solutions. TechNova's innovative and world-class products cater to a wide range of industries, such as Commercial & Newspaper Printing, Publishing, Packaging, Signage, Photo, Textile, Engineering & Medical Imaging.

TechNova's name is derived from the words "technology" and "innovation", and it is these two tenets that form TechNova's core mission. Globally recognised as a pioneer, TechNova has introduced several breakthrough technologies and innovative products that have transformed various print processes and created new markets.

With its wide distribution and logistics network in India, TechNova's products & services are used by every printer in the country. In addition to its leadership position in India, TechNova markets its products to over 60 countries through its international offices and distribution network.

Uniting all of TechNova's businesses is its value system – a strict code of ethics, commitment to excellence, business conduct based on honesty, fairness & mutual trust, and a "Customer First" philosophy.

CAES Celebrates Opening of Additive Lab

The CAES lab is dedicated to bringing additive

manufacturing solutions to the U.S. aerospace and defense industry. Image courtesy of CAES.

CAES, provider of electronics, has opened its new radio frequency additive manufacturing operations in Exeter, NH. The lab supports CAES' partnership with SWISSto12, provider of 3D printed technology for RF applications, and is dedicated to bringing additive manufacturing solutions to the U.S. aerospace and defense industry.

Its official opening was hosted by Mike Kahn, CEO of CAES, and the team celebrated with a ribbon-cutting ceremony attended by customers, employees as well as government officials including U.S. Senator Jeanne Shaheen and U.S. Representative Chris Pappas of New Hampshire.

"CAES is investing in the future and we are excited to open the doors to our new additive manufacturing lab which helps us further meet our customers' next generation design needs for mission-ready RF systems," says Kahn, president and CEO, CAES. "3D printing has been a game changer in many manufacturing disciplines and we are excited in what this technology will do for RF components. This flight-proven technology will allow us to rapidly go from design to manufacturing with much more complex components that were possible using traditional manufacturing."

"This cutting-edge technology will help this Exeter facility produce advanced electronics for space systems—which not only strengthen our national security but also help track weather systems to improve agriculture and commerce," says Shaheen.

CAES' new laboratory is a facility outfitted with equipment dedicated to 3D printing of RF technology and has been identified as a facility to provide additive manufacturing services by top U.S. aerospace and defense prime manufacturers. The printing and metal finishing offers high RF performance. The operations consist of dedicated equipment for 3D-printed RF technology design and manufacturing including a qualified laser powder bed fusion machine, associated process support equipment, metal finishing and plating line, and complete RF testing capability.

GE Aviation and Tamil Nadu state collaborate to undertake additive manufacturing research

GE Aviation and Tamil Nadu Industrial Development Corporation (TIDCO) will work together on aerospace research and development. The two have established a "Centre of Excellence" in the south Indian state that will focus on additive technologies, according to GE Aviation.

The pair has previously signed a memorandum of understanding related to the project in 2021. Over five years, the pair plan to invest Rs.1.4 billion ($18.3 million) in the centre.

As for specific components, the center will focus on compressor heat exchangers, combustor components, casings, frames, gears, and splines. GE Aviation has extensive work in India. In February it signed a five-year contract with Hindustan Aeronautics (HAL) to develop and supply ring forgings for GE's commercial and military engine programs. In addition, its F404 engine powers the TEJAS Light Combat Aircraft, and its F414 will power the developmental Advanced Medium Combat Aircraft.

Siemens announces new strategic collaboration with Xerox® Elem™ Additive Solutions

Today, Siemens announced a new collaboration effort with Xerox® Elem™ Additive Solutions aimed at strengthening the metal additive manufacturing (AM) capabilities of both businesses. This relationship highlights both companies' strong commitment to advancing the future of industrial additive manufacturing through innovation and partnerships.

Includes installation of Xerox® ElemX™3D printer at the Siemens Charlotte Advanced Technology Collaboration Hub

Siemens has purchased an ElemX metal 3D Printer, adding it to their fleet of additive machines inside their Charlotte Advanced Technology Collaboration Hub (CATCH). The CATCH facility focuses on the industrialization of additive manufacturing, working with machine builders, material suppliers and end-customers. The ElemX leverages Xerox's liquid metal AM that uses cost-effective aluminum wire and incorporates the state-of-the-art Siemens SINUMERIK 840D sl control platform with its embedded digital twin technology to optimize the printing process.

ElemX is a groundbreaking 3D metal printer that's simpler and safer to use and addresses supply chain resiliency for transportation, aerospace, defense and industrial manufacturing. The printer is easily deployed, requiring no special facility modifications for operation. Unlike many metal 3D printing technologies, the ElemX requires minimal post-processing and therefore provides a faster time-to-part.

Siemens and Xerox have a mutual interest to explore technical developments in automation, software, materials and processes of the current and future ElemX systems.

"We are pleased to join forces with Xerox and drive the industrialization of additive manufacturing through digitalization," said Tim Bell, Head of Additive Manufacturing, Siemens Industry, Inc. "Working together with Xerox, we're bringing decades of proven Siemens automation experience and technology to additive manufacturing helping customers mainstream mission critical production tools for future manufacturing strategies."

This collaboration provides early access opportunities for Xerox and Siemens to share advancements in digitalization solutions and automation software designed to impact the distributed manufacturing model. Siemens is the latest addition to the Xerox Manufacturing Partner Network (MPN) and continues its trajectory as a prominent and reliable partner in the AM industry.

"Siemens and Xerox share a similar vision to advance

manufacturing through creative and collaborative partnerships that collectively push us forward in the right direction," said Tali Rosman, VP and GM of Xerox® Elem™ Additive Solutions. "This is another important milestone for our ElemX technology and we look forward to working with an innovative and forward-thinking organization such as Siemens. Together, Siemens and Xerox Elem Additive Solutions will enable our customers to manufacture parts on-demand with confidence and maximize new opportunities to improve supply chain resiliency."

Morf3D Partners with Siemens to Create Additive Manufacturing Facility

Morf3D Inc, a subsidiary of Nikon Corporation and a leader in metal additive manufacturing (AM), today announced its partnership with Siemens Advanta, the IoT consultancy and solutions integration arm of the global technology powerhouse. The two entities have committed to an ongoing technology development partnership as Morf3D continues to build its new Applied Digital Manufacturing Center (ADMC) in Long Beach, California.

Morf3D's ADMC is a new 90,000 square foot state-of-the-art facility that harnesses applied research, advanced engineering and application development, serial production and most significantly, new industry partnerships with global leaders to drive the industrialization of digital manufacturing in high-growth markets. As part of Siemens Advanta's inaugural project, the consultancy will leverage advanced design and simulation software from Siemens Digital Industries to develop a scale up plan and bottleneck analysis, as well as explore novel manufacturing and logistic concepts for the Long Beach center. Material flow and space demand will be validated based on a digital twin of production. For further information see the IDTechEx report on 3D Printing Hardware 2022-2032: Technology and Market Outlook.

"Siemens Advanta is proud to contribute to the forward-thinking innovation that is transforming the additive manufacturing industry," said Rani Shea, CEO of Siemens Advanta, North America. "In working with Morf3D and its new ADMC, we look forward to helping optimize additive manufacturing capabilities for the aerospace industry."

Siemens Advanta's work at the new ADMC will transition into additional ongoing software innovations and on-site personnel support.

"We are constantly thinking about how to further our industry and this partnership with Siemens Advanta gives us a great sense of optimism for the future," said Ivan Madera, CEO for Morf3D Inc. "Morf3D is experiencing growth at a rapid rate. We wanted to make sure that our factory was flexible and that we had a team able to understand the challenges that we might face, not just today, but in the future too."

Morf3D's investment in the new California facility underscores the company's commitment to developing a strong industrial base that improves the quality of its products, enhances technical capabilities, and enriches customer applications worldwide. The center is projected to be one of the largest aerospace additive manufacturing solution integrators in the US. At peak, the center will be home to 150 multi-discipline engineers, research staff, and technical teams.

About Siemens Advanta

Headquartered in Munich, Germany, Siemens Advanta

was founded in 2019 to help clients unlock their digital futures by offering end-to-end support on their unique digitalization journey. Siemens Advanta is a strategic advisor and a trusted implementation partner in digital transformation and industrial IoT with a global network of more than 9,000 employees in 19 countries and 89 offices. Highly skilled and experienced experts offer services ranging from consulting to design & prototyping to solution & implementation and operation. Further information is available at www.siemens-advanta.com.

Siemens Corporation is a subsidiary of Siemens AG, a technology company focused on industry, infrastructure, transport, and healthcare. From more resource-efficient factories, resilient supply chains, and smarter buildings and grids, to cleaner and more comfortable transportation as well as advanced healthcare, the company creates technology with purpose adding real value for customers. By combining the real and the digital worlds, Siemens empowers its customers to transform their industries and markets, helping them to transform the everyday for billions of people. Siemens also owns a majority stake in the publicly listed company Siemens Healthineers, a globally leading medical technology provider shaping the future of healthcare. In addition, Siemens holds a minority stake in Siemens Energy, a global leader in the transmission and generation of electrical power. Siemens has been supporting the industries and creating the infrastructure forming the backbone of America's economy for more than 160 years, with more than 40,000 employees, 17,000 suppliers, and customers in all 50 states and Puerto Rico. In fiscal 2021, Siemens Group USA generated revenue of nearly $20 billion.

About Morf3D

Morf3D Inc., a subsidiary of Nikon Corporation, specializes in metal additive manufacturing technology that transforms engineering design into full production systems. Morf3D's mission is to enable client proficiency in fully exploiting the benefits of additive engineering and manufacturing, while delivering innovative solutions that solve complex design and manufacturing challenges. For more information about Morf3D, visit https://morf3d.com

SPEE3D demonstrates world's fastest metal 3D printer at Melbourne Grand Prix

Australian additive manufacturing company, SPEE3D, showcased their world-leading metal 3D printing technology at the Melbourne Grand Prix.

The company's flagship product, the WarpSPEE3D, is the world's fastest metal 3D printer and can produce parts up to 1000 times faster than traditional methods. This makes it the perfect solution for on-demand production and rapid prototyping applications. For the event SPEE3D teamed up with Gary Rogers Motorsport to demonstrate the high-speed production of aluminium parts for the s5000 open-wheelers.

With a growing global customer base, SPEE3D has made a name for themselves in the additive manufacturing industry. In recent years they have claimed many awards for their technology, and hold the record for the world's fastest print of a 1kg part. Headquartered in Melbourne, the company offered punters and global race teams the opportunity to witness this world-leading technology in action.

It was the first time crowds of motor racing enthusiasts were able to see dozens of metal parts printed on demand at the Melbourne Grand Prix. One of the many

metal automotive parts featured at the event included a s5000 Support Arm. This 2.4 kilogram aluminium part was printed in only two hours on a WarpSPEE3D metal 3D printer for the low cost of just $180 dollars.

The live demonstration at the event's Versor Tech Hub highlighted how the printers are not restricted to workshop or lab environments. SPEE3D's technology is currently the only metal additive manufacturing technology proven to have the ability to print metal parts anywhere and in some of the world's toughest environments. Since 2020, SPEE3D, and the Australian Army, have been taking the equipment on off-road field trials, proving that it is possible to 3D print and validate their own spare parts in rugged bushland and extreme conditions.

Byron Kennedy, CEO of SPEE3D states, "It was exciting to showcase our technology at this fantastic event here in Melbourne. SPEE3D's technology is the world's fastest way to make metal parts, and what better place to show this off than at the Grand Prix which is all about speed and innovation!"

Deltasys E Forming Delivers concrete 3D printer to IIT Bombay

Deltasys E Forming developer and manufacturer of 3D printing machines from Belagavi have delivered its indigenously developed concrete 3D printer to Indian Institute of Technology Bombay, SEMT Lab Department of Civil Engineering.

Deltasys E Forming is Hard-core Machine Developer and Manufacturer situated in Belagavi Karnataka. The company develops all kinds of 3D printing machines such FDM, DLP, High-performance FDM, Large FDM, Pellet extrusion technology, Composite 3D printer, Clay 3D printers and Now Concrete 3D printer.

In the concrete 3D printers, the company can build Big gantry systems as well as robotic arms. Right now the company is making a Big gantry concrete 3d printer for one multinational construction company from India which can build 4storey buildings. The company is working with all major research institutions of India to develop indigenous 3D printing technology in India.

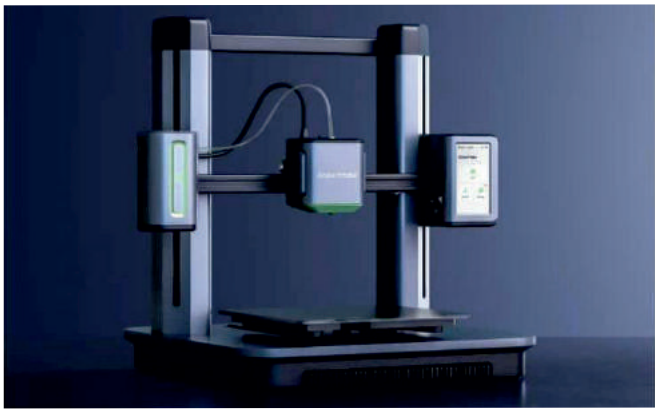
About Deltasys E Forming

Deltasys E-Forming design, develop and manufacture purpose built 3d printers. Company manufactures various sizes of machines which supports various materials. Size ranges from small format 250 cubic mm to Large format 2000cubic mm. company aim is to provide reliable, robust and consistent working machines to its customer.

Company has one dedicated plant located at udyambag Belgaum Karnataka having present plant capacity of manufacturing any variant of machines. Equipped with world class infrastructure like state of art machine shop includes CNC Machining and Turning centers, CNC Laser cutting, sheet metal fabrication, welding, Assembly shop, paint shop and other allied infrastructure

Anker Innovations launches its 3D printer with integrated AI and improved speed

AnkerMake, Anker Innovations new 3D printing brand, announced today the launch of the AnkerMake M5, the first 3D printer designed to improve the user experience by reducing printing time up to 70%. The AnkerMake M5 is available today on Kickstarter.com, starting at an super early bird price of $429.



"3D printers help us imagine a world where ideas and creative concepts can be instantly transformed into physical form. However, the reality is 3D printing can be slow, cumbersome, and difficult to figure out," said Steven Yang, CEO of Anker Innovations. "AnkerMake is committed to removing these pain points so that artists, inventors, hobbyists and DIY enthusiasts can take advantage of a more practical tool to bring their creations to life."

The AnkerMake M5 solves the most critical issues that have prevented 3D printing from becoming a more mainstream endeavor. These issues include slow print speeds, the need to constantly supervise printing for errors and a needlessly complicated user experience.

X faster print speeds and AI monitoring makes 3D printing a more practical tool for consumers

AnkerMake M5 3D printer reduces average print time by up to 70 percent
The AnkerMake M5 solves these issues by delivering:

Quick and Easy Assembly

3D printing has never been this accessible. The M5 is designed is easy to set up in just three steps within 15 minutes. Several user-friendly features including 7×7 auto-leveling, PEI soft magnetic printing bed, auto-resume after power outage and printing notifications. These enhancements help the user focus completely on their prints instead of technical aspects and handcrafting.

A New Standard in Print Speeds

Thanks to its new PowerBoost technology, the AnkerMake M5 basic print speed is 250 mm/s, which can be used for printing jobs that require a smoother and more detailed finish. For faster print jobs, perfect for prototyping and less detailed finishes, the M5 can save even more time with an acceleration of the extruder up to 2,500 mm/s^2. In this print mode, the M5 can reduce the average print times by up to 70% in comparison to other 3D printers.

Stable, Quality Printing

The aluminum alloy die-casting design increases the weight of the base, reducing the center of gravity of the machine. The sleek design makes printing more stable and allows fast speeds and extreme acceleration. The installation error of the base is also reduced, improving the accuracy of the printing tool and surface even at high speeds with 0.1 mm precision.

AI Print Monitoring

The built-in HD camera will monitor print jobs for issues like layer splitting, spaghetti mess or nozzle plugging. When it detects an issue, the AnkerMake M5 will alert users. This feature helps avoid wasting time and valuable printing materials.

Live WebCam View With Time Lapse

Users can view live feeds of their print jobs from anywhere using the AnkerMake mobile app. Time lapse videos are also automatically generated after the printing job is complete. With an adaptive light-sensing algorithm, users can see the printer output clearly, even at night.

Smart, Connected Printing

The AnkerMake M5 can be seamlessly connected and controlled through both the AnkerMake mobile app and AnkerMake slicing software1. Multi-device management and remote messaging notifications

enable the user to start printing from their smartphone or computer anytime, anywhere.

Additional Specs:

- 5X industry average print speed (250 mm/s in standard print mode)
- 2,500 mm/s^2 in accelerated print mode
- Can reduce average print time by up to 70 percent
- AI print monitoring with auto shut-off
- Integrated HD cam with remote viewing
- Supports WiFi and USB connectivity
- Easy filament loading and extraction with heat assist
- Magnetic base for easy removal and cleaning
- Weight: 12.4 kg / 27.3 lb
- Measurement: 502x438x470 mm / 19.76×17.24×18.50 inches

Price & Availability

The AnkerMake M5 3D printer is available on Kickstarter.com starting today for special, limited super early bird price of $429. The normal early bird price is $499. Additional press materials, including product images, can be found here.

1 AnkerMake App and software will be available later this year at the commercial launch of AnkerMake M5.

About Anker Innovations

Anker Innovations is a global leader in charging technology and a developer of unique, consumer electronic products that support premium audio, mobile entertainment, and the emerging smart home space. This innovation is being led by its six key brands: Anker, AnkerWork, eufy, Nebula, Soundcore and now, AnkerMake. More information on Anker Innovations and its various brands can be found at anker.com.

About AnkerMake

AnkerMake is committed to becoming the world's #1 brand for intelligent manufacturing by helping artists, hobbyists, DIY enthusiasts and professional users bring their creations to life. More information about AnkerMake can be found at AnkerMake.com

MolyWorks announces partnership with Singapore Polytechnic

Singapore Polytechnic ("SP") and MolyWorks Materials Corporation ("MolyWorks") have signed a Memorandum of Understanding ("MoU") today. The MOU aims to accelerate the adoption of metal additive manufacturing ("AM") and metal recycling technology for the maritime and offshore industry to digitally transform the supply chain and drive sustainability.

The signing ceremony took place at the MarineTech Exhibition, held in conjunction with the Singapore Maritime Week ("SMW") 2022, and was witnessed by Senior Minister of State for Transport Chee Hong Tat.

The MoU will see both parties enter collaborative efforts through:

- Advocating industry best practices in AM of ship components and spare parts for digital inventory and innovations in materials recycling to improve sustainability in the maritime and offshore industry,
- Developing new metal alloys and AM processes to expand the range of materials suitable for the maritime and offshore industry,
- Building a shared database for AM data and knowledge, and

- Training the industry workforce to ensure that the professionals in the maritime and offshore sectors are equipped with the right mix of skills, knowledge and competencies to adopt and implement AM.

Both parties would engage more than thirty (30) local maritime and offshore companies to initiate joint industry and R&D projects, and recruit over ten (10) students to be part of the growing deep tech startup ecosystem in Singapore.

Georgina Phua, Deputy Principal (Development), Singapore Polytechnic, said: "Additive manufacturing is a promising technology that creates opportunities in driving sustainability and transforming sustainable business practices in the maritime and offshore sector. This is an excellent collaboration where Singapore Polytechnic's Innovation Centre for Additive Manufacturing will contribute and share its expertise and facilities to accelerate the design maturity and adoption of additive manufacturing in Singapore. We share a common vision with our industry partners to harness the potential of this emerging technology to foster innovation in metal materials development and recycling, and reduce the costs in new materials production and digital inventory management. As part of our sustainability education efforts, we are committed to equipping our industry professionals and young learners with the knowledge, competencies and values to apply this technology to make a greater sustainability development impact for the maritime and offshore businesses."

Phil Ward, Global Chief Executive Officer, MolyWorks Materials Corporation said,"Molyworks is very pleased to partner with Singapore Polytechnic, jointly applying our expertise to accelerate additive manufacturing capabilities for the Maritime industry by enabling the use of green, low carbon, sustainable metal alloys. Our expansion into Singapore brings local production of existing and new alloys, further enhancing the capabilities of the local AM ecosystem for the Maritime sector which has been developed over recent years with the help of MPA, NAMIC, SSA and other stakeholders. We are very much looking forward to enabling the cyclic economy for metals in Singapore."

Kenneth Lim, Assistant Chief Executive (Industry), Maritime Port Authority of Singapore (MPA) said, "MPA welcomes the partnership between Singapore Polytechnic and Molyworks as their collaboration will complement Maritime Singapore's efforts to promote greener materials for AM supply chain and supports upskilling of talents and capabilities. Singapore's maritime industry has been an early pioneer in additive manufacturing (AM) technology for ships and port technologies. Through these past 3 years of joint industry programmes, the Maritime and Port Authority of Singapore, together with the National Additive Manufacturing Innovation Cluster and the Singapore Shipping Association, has catalysed a growing community of maritime users, service providers and technology developers for AM."

3D Systems Revolutionizes Production with Introduction of the SLA 750 – the Fastest Stereolithography Printer

3D Systems SLA 750 Dual high-speed, synchronous dual-laser 3D printer, part of the company's full workflow solution for the factory floor. Inside: Accura AMX Rigid Black production-grade resin parts.

3D Systems (NYSE:DDD) announced the SLA 750 stereolithography additive manufacturing (AM) solution. Designed to address large format or high volume production applications, the solution

comprises the SLA 750 and SLA 750 Dual – the first synchronous, dual-laser stereolithography printer – as well as the company's new Accura® AMX Durable Natural material and the PostCure™ 1050 post-processing system. The solution is optimized for cost-effective SLA batch part production at up to twice the speed and triple the throughput of other available stereolithography solutions. Additionally, the entire solution can be seamlessly integrated into the factory floor through the power of the Oqton Manufacturing OS. The result is a first-of-its-kind solution to deliver large, production resin parts and batch part production for industries such as transportation & motorsports, consumer technology & durable goods, manufacturing services, aerospace, and healthcare.

Highlights

- SLA 750 Dual – the world's first synchronous, dual-laser SLA printer – delivers up to 2X speed, 3X throughput for cost-efficient, high-quality production manufacturing
- New printer anchors full production workflow that includes new Accura® AMX Durable Natural – the industry's toughest production-grade SLA material – and PostCure™ 1050 for high-volume post-processing
- Oqton Manufacturing OS enables factory-level integration, management, and control
- SLA 750 is field-upgradeable to SLA 750 Dual for future-proof AM productivity

"I see the launch of this new platform – which includes a synchronous dual-laser option, Accura materials, and the specialized curing oven – as an example of how we are executing on a global AM strategy that focuses on our strengths," said Dr. David Leigh, executive vice president & chief technology officer for additive manufacturing, 3D Systems. "I believe we are entering an era where there will be a path of rapid evolution to our innovations. In this light, our multi-purpose SLA platform will become a system that can help scale production applications through built-in functional and throughput enhancements."

SLA 750 & SLA 750 Dual for Large Production Parts at Unparalleled Speed

With the introduction of 3D Systems' SLA 750 and SLA 750 Dual, manufacturers now have access to the fastest stereolithography solutions available. The platform is designed to deliver the industry-leading combination of print size, speed, accuracy, and resolution for final parts that possess unmatched finish and mechanical performance. The SLA 750 Dual, which is a synchronous, dual-laser system, delivers up to 2X faster print speeds and up to 3X faster throughput than previous generation SLA printers. The SLA 750 is a single-laser configuration that delivers up to 30% faster print speeds and is field-upgradable to the SLA 750 Dual. Both printers feature a 15% larger build envelope and smaller hardware footprint than previous models, allowing manufacturers to optimize and scale production. The system features a self-calibrating dual-rail recoater to improve print process reliability and final part mechanical properties.

The SLA 750 and SLA 750 Dual utilize Hyper-Scan™ vector technology – a proprietary scanning algorithm developed to address the unique requirements of production additive manufacturing applications. Hyper-Scan optimizes key speed and productivity elements such as laser focus and power, as well as vector motor kinematics to deliver significantly improved printer speed and throughput. The printers include downstream automation readiness and are robot compatible for 24/7 lights-out operation (e.g., fully automatic printer turnover, job-offloading, washing, on-boarding).
Both printers include 3D Sprint®, all-in-one software to prepare, optimize, and print 3D CAD data. 3D Sprint delivers all the tools needed to quickly and efficiently go from design to high quality, true-to-CAD printed parts without relying on multiple software packages.

The SLA 750 is already receiving positive feedback from 3D Systems' customers.

"We produce hundreds of SLA parts every week, so time-to-finished-part for us is everything," said Matt

Harman, technical director, BTW Alpine F1 Team. "The SLA 750 increases our productivity and efficiency, allowing us to deliver superior quality production parts faster than ever. The entire system has been engineered for ease of operation, including automation. This is a huge step forward for our additive manufacturing capabilities and we are eager to extend our fleet with two more SLA 750s in 2022."

"We depend upon our fleet of 3D Systems SLA printers to deliver accurate, superior quality parts with maximum availability and uptime," said Roger Neilson, Jr., co-CEO, VP, sales & marketing, In'Tech Industries, Inc. "The SLA 750 will allow us to be even more productive with its new user-friendly design and automation features. Our customers love the finish of the parts we produce using the new production-grade Accura AMX materials. The result is the closest we've seen to injection molded parts while allowing engineers the freedom to design for true functional applications."

General availability of the SLA 750 is planned for the second quarter of 2022, and the SLA 750 Dual is planned to be available in the fourth quarter of 2022.

Extremely Tough Accura AMX Durable Natural Material for High Elongation, High Impact Applications

3D Systems' range of production-grade SLA resins utilizes patented chemistry to deliver long-term mechanical performance and stability for large-scale plastic parts. The company is enhancing its portfolio today with the introduction of Accura AMX Durable Natural. This resin is designed to withstand repeated high mechanical loads and shocks with a unique combination of mechanical properties including impact resistance, tear strength, and elongation at break. Accura AMX Durable Natural is tested per ASTM D4329 and ASTM G194 for indoor mechanical performance for up to eight years, and outdoor weathering stability for up to one and a half years. This material exhibits similar stress/strain toughness performance to standard thermoplastics, and its isotropic mechanical properties ensure superior part strength in any build orientation.

These properties make Accura AMX Durable Natural an ideal material to deliver large, complex, mandrel tooling cores that can be easily removed from convoluted tubing as a single piece. These are invaluable as manufacturing aids for large cooling ducts, pipes, and manifolds used in automotive, aerospace, energy, and consumer goods applications.

Accura AMX Durable Natural is available for immediate order.

PostCure 1050 Industrial Scale Post-processing for High Yield, Repeatability

An integral aspect of any polymer additive manufacturing workflow is drying and curing. To meet the requirements of 3D Systems' high yield SLA 750 production workflow, the company is introducing the PostCure 1050. This industrial-scale, post-processing system offers high-volume, high-speed drying and curing for batch jobs and large parts up to 1050mm x 750mm x 600mm. The PostCure 1050 delivers cure times and throughput that are 5X faster than comparable solutions due in part to consistent 360° light uniformity which allows more parts to be cured in less time without manual intervention (e.g., part flipping). Long-life LED light sources, automatic detection and alert of light failures, and a one-step light output calibration routine help ensure more predictable, consistent part and job outcomes. Additionally, optimized light wavelengths, a separately configurable UV intensity, and actively cooled LEDs each with its own adjustable heating enable optimal part cooling without thermally-induced warp.

PostCure 1050 is compatible with all 3D Systems resin printers and suitable for all current and future material innovations. General availability of the system is planned for the third quarter of 2022.

Seamless Integration into Existing Workflow with Oqton Manufacturing OS

Additive manufacturing solutions are only one piece of an entire production workflow. To maximize true

production agility, AM must seamlessly integrate with the manufacturer's existing workflow. This can be facilitated by Oqton's best-in-class Manufacturing OS, an agnostic platform that enables manufacturers to increase innovation and efficiency by intelligently automating production. Powered by artificial intelligence, the Oqton Manufacturing OS unifies engineering and production, connecting specialist applications across design, CAM, 3D printing, simulation, reverse engineering, and inspection. Combined with Industrial Internet of Things (IIOT) and machine learning technologies, manufacturers can connect technologies and machines across multiple sites, increasing traceability and visibility across an organization.

To learn more about 3D Systems' new SLA 750 stereolithography additive manufacturing solution, the company will have experts on hand at this year's Additive Manufacturing Users Group (AMUG) conference and will also showcase parts and applications in its booth (#P17) on April 3 & 4. The new SLA 750 printer will be in 3D Systems' booth (#2613) at RAPID+TCT, May 17-19 in Detroit. For more information, please visit the company's website.

Voxeljet revenue grows over €21.5M showing 15% growth

Voxeljet AG (NASDAQ: VJET), a provider of high-speed, large-format 3D printers and on-demand parts services, closed its Voxeljet FY 2021 with revenues of €24.826 million, up 15% from €21.567 in the previous fiscal year.

Among other highlights, total revenues for the fourth quarter increased 22.9% to €10.885 million from €8.859 million. The total gross profit margin for the fourth quarter slightly decreased from 33.6% to 32.7%. Systems revenues for the fourth quarter increased 26.5% to €8.470 million from €6.695 million. Services revenues for the fourth quarter increased 11.6% to €2.415 from €2.164.

Revenue for full-year 2022 is now expected to be between €25 million and €30 million. These are altogether excellent results for the german sand binder jetting and HSS company which has gone through a bit of a rough patch in previous years, with the global manufacturing industry and wall street analysts failing to fully comprehend its technology's huge potential.

Dr. Ingo Ederer

Dr. Ingo Ederer, Chief Executive Officer of voxeljet, commented: "We ended 2021 with a number of notable achievements that underscore the growing demand across our product portfolio, increasing market dynamics and greater recognition of voxeljet's leading 3D printing technology for industrial applications. In September 2021 we announced that, together with GE Renewables, we plan to develop the world's largest binder jet 3D printer for the production of critical components for next-generation wind turbines, called Haliade-X. In the fourth quarter, we announced that Brose, a leading global supplier to the electric car industry, is the first client in the beta program for our

new, large High Speed Sintering 3D printer.

We also announced a partnership in the fourth quarter with Covestro, a billion-dollar chemical company, to advance additive manufacturing in series production. Last but not least we received the final acceptance of the first VJET X units from our partner in the fourth quarter, related to the project with a leading German automotive manufacturer. The VJET X is a new 3D printer with extreme performance for high volume, industrial applications. Overall, the fourth quarter 2021 was a record sales quarter for our company and we are pleased that this momentum has continued in the first months of the new year."

Boeing debuts small satellite production facility that uses 3D printing

Boeing on Wednesday unveiled a new high-throughput small satellite production, integration and test facility designed for efficiency and rapid delivery timelines.

Housed in the world's largest satellite factory, Boeing's 1-million-square-foot El Segundo facility (92,903 square meters), the small satellite production line will be powered by Boeing subsidiary, Millennium Space Systems. The companies are applying advanced and additive manufacturing techniques, including 3D printing entire space-qualified satellite buses, to offer faster cycle times while improving performance, the announcement said. "Our customers need satellites on-orbit faster than ever," said Jim Chilton, senior vice president of Boeing Space and Launch. "Much like an airplane or auto production line, we're employing lean production principles and advanced manufacturing techniques to accelerate delivery and pass on cost savings to our customers." According to the company, the initial operating capability took place in September 2021, and the small sat factory's full operational capability is expected in late 2022.

About Boeing Satellites

Boeing builds adaptable satellites to meet changing business cases and fulfill even the most demanding missions. We're well into our sixth decade of providing advanced space and communications systems for military, commercial and scientific uses. Boeing satellites reliably deliver digital communications, mobile communications, broadband internet connectivity, telephone calls, television programming and direct-to-home entertainment around the world.

Boeing Commercial Satellites designs and sells communications satellites and payloads for commercial telecommunications, broadband, scientific and environmental applications. Boeing-built spacecraft routinely relay digital communications, mobile communications, internet connectivity, telephone calls, video conferences, television programming and direct-to-home entertainment.

HP and Legor Group Collaborate for 3D Printing of Stainless Steel Accessories for Jewelry and Fashion Markets

HP Inc. and Legor Group SPA today announced a strategic collaboration for the development of innovative precious metal materials for HP's Metal Jet system. Legor, a leader in metals science and production of best-in-class alloys, powders, and plating solutions, is the first to produce specialty precious metal materials for the jewelry and fashion accessories markets designed to work with HP's revolutionary 3D metal binder jet platform.

Highlights

- Speed, quality and economic advantages delivered by HP Metal Jet enable rapid path to serial production of 3D-printed metal parts
- Legor developing specialty precious metal materials enabled for HP Metal Jet
- Industry leaders collaborating on functional stainless steel accessories for the jewelry and fashion markets

"Our vision for additive manufacturing goes beyond small series and prototyping," said Massimo Poliero, President & CEO of Legor Group SPA. "We see a future where every modern business will have one or more of HP's state-of-the-art binder jetting printers in its facilities, enabled by Legor's technology, design and support to reduce the time to market for both precious and non-precious metal parts. This strategic partnership with HP is the keystone to accelerate this vision and move the industry toward more sustainable manufacturing."

"Our work with Legor aligns perfectly with HP's vision to disrupt manufacturing norms, accelerate digital manufacturing and sustainable impact for customers around the world," said Didier Deltort, President, HP Personalization & 3D Printing. "The combination of our breakthrough Metal Jet 3D printing platform with Legor's materials expertise and customer-centric approach will disrupt the luxury jewelry and fashion industries. This is an exciting milestone as we prepare to make Metal Jet more broadly available to the market later this year."

The collaboration will initially focus on enabling the production of functional stainless steel accessories for the jewelry and fashion markets. In parallel, the companies will implement a rigorous R&D program to parameterize and characterize bronze and silver powders and eventually gold powders, the core material in the precious sector. HP and Legor will work to optimize the printing and sintering parameters for these new materials and the surface finish results. Research will take place in the new Legor 3DMetalHub in Bressanvido, Italy, a center of excellence focused on accelerating additive manufacturing for the luxury industry.

In addition, working closely with HP, Legor is creating opportunities for its customers to take advantage of the cost, quality, and productivity benefits of HP Metal Jet and helping them integrate sustainable manufacturing into their businesses. The advantages of HP Metal Jet enable Legor to transform product manufacturing on behalf of customers in the precious sectors and beyond. Along with design freedom, production flexibility, and lowering development costs, HP Metal Jet enables customers to economically manufacture high-quality metal parts at scale.

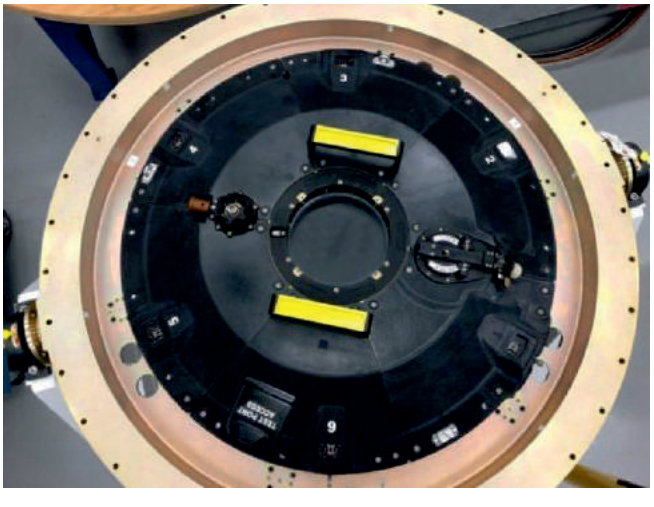
Poliero added, "Producing metal powders and 3D metal objects is part of our DNA and we have always been collaborating with customers in the jewelry and fashion accessories world. The digital capabilities of HP Metal Jet provides an alternative method to the classic investment casting which requires the combustion of waxes or resins and the use of gypsum (calcium sulphate) as casting material, containing free breathable silica. It is our way to promote more robust and intentional sustainability into production processes."

HP Metal Jet in Action

Stratasys Collaborates With Lockheed Martin to Qualify Material for Space and Aviation End-Use Parts

Stratasys Ltd., a leader in polymer 3D printing solutions, today announced that it is providing the public with baseline material qualification data for Antero 840CN03 filament material in collaboration with Lockheed Martin (NYSE: LMT) and Metropolitan State University of Denver.

The release of this qualification data allows those in the industry to use the material for additively manufactured aerospace parts, such as those on the Orion spacecraft, using Stratasys production-grade 3D printers.



Hatch cover for the Orion spacecraft by Lockheed Martin printed in Antero840CN03. (Photo: Business Wire)

Designed for space-ready performance, Antero 840CN03 is a blended and functionalized PEKK-based high-performance, ESD thermoplastic composite material developed specifically for production-grade Stratasys FDM® 3D printers that meets ESD performance and NASA outgassing requirements while also exceeding the flame, smoke, and toxicity (FST) characteristics required for aviation applications.

"We want to demonstrate a new model for how industry, manufacturers and academia can collaborate to gather and release material qualification data that helps accelerate the adoption of additive manufacturing across the aerospace industry," said Foster Ferguson, Director of Aerospace for Stratasys.

During this first phase of qualification, a baseline set of data was collected by printing over 280 test coupons in Antero 840CN03 on Stratasys Fortus® F900® 3D printers at Lockheed Martin in Littleton, Colo., and Stratasys Direct Manufacturing in Belton, Texas. Coupons were tested for tensile strength properties which is a key mechanical property for design. Data collected confirmed the high performance of the Antero material as well as the consistent mechanical properties which have been previously shown in academic studies. Future phases of testing will expand to additional relevant properties, giving design engineers additional data to work with in applying Antero to other part types and environments.

"We are continually looking for ways to drive innovation for flight-qualified materials and additive manufacturing is key to that endeavor," said Cris Robertson, Associate Manager of Advanced Manufacturing at Lockheed Martin Space. "Through our collaboration with Stratasys and MSU Denver, we have collected the data necessary to qualify Antero 840CN03 for flight parts and we are now able to expand our use of the material beyond our initial applications on the Orion vehicle."

MSU Denver is educating and training the manufacturing workforce of the future using additive and subtractive manufacturing that can reduce costs and increase application capabilities.

"These types of research and development collaborations with leading companies like Stratasys and Lockheed Martin enable our students to be well prepared to help their future aerospace employers with adopting the latest technology in the industry," said Mark Yoss, Director of the Advanced Manufacturing Sciences Institute at MSU Denver. "By publishing this material qualification data, we can help move the aerospace industry forward by establishing more standards in additive manufacturing."

Stratasys and Lockheed Martin previously worked together to collect and release material characteristics data. Most recently in 2018, as members of America Makes, the companies released allowable data for SABIC ULTEM™ 9085 resin printed on a Stratasys Fortus 900mc 3D printer. By continuing to publicly release material qualification data, the companies hope to enable further adoption of additive manufacturing in aerospace applications and use-cases.

"Through our collaboration with Lockheed Martin and MSU Denver, we hope to provide confidence in our preferred materials, demonstrate the repeatability of the F900 3D printer and deliver process documentation that supports qualification specifications for flight applications," said Ferguson.

Through this collaboration with Metropolitan State University of Denver, full access to the data report is available to the public online. Further material testing will take place in future phases providing for full characterization of this material.

The Stratasys and Lockheed Martin teams will both be present at this year's Space Symposium in Colorado Springs, Colo., You can also learn more about Stratasys materials and applications for the aerospace industry online.

About Metropolitan State University of Denver

As one of Colorado's leading public universities, MSU Denver is reimagining what is possible in higher education through the power of access, diversity, excellence and innovation. Founded in 1965, MSU Denver offers high-value, real-world education to nearly 18,000 students through career- and community-focused bachelor's and master's degree programs. And 80% of our 100,000 alumni live and work in Colorado, advancing their communities and the state economy. Based in the heart of the Mile High City, MSU Denver's thriving urban campus provides unparalleled access to internships and professional networks that jump-start careers.

Stratasys is leading the global shift to additive manufacturing with innovative 3D printing solutions for industries such as aerospace, automotive, consumer products and healthcare. Through smart and connected 3D printers, polymer materials, a software ecosystem, and parts on demand, Stratasys solutions deliver competitive advantages at every stage in the product value chain. The world's leading organizations turn to Stratasys to transform product design, bring agility to manufacturing and supply chains, and improve patient care.

To learn more about Stratasys, visit www.stratasys.com, the Stratasys blog, Twitter, LinkedIn, or Facebook. Stratasys reserves the right to utilize any of the foregoing social media platforms, including the company's websites, to share material, non-public information pursuant to the SEC's Regulation FD. To the extent necessary and mandated by applicable law, Stratasys will also include such information in its public disclosure filings.

Report made public by Metropolitan State University of Denver delivers qualification data for Antero® 840CN03 for additively manufactured end-use parts requiring high thermal and chemical resistance, and ESD properties

3D Systems & Dussur Joint Venture to drive Additive Manufacturing adoption

3D Systems, the leading additive manufacturing solutions provider, and the Saudi Arabian Industrial Investments Company (Dussur) have signed an agreement intended to expand the use of additive manufacturing (AM) within the Kingdom of Saudi Arabia and surrounding geographies, including the Middle East and North Africa. The announcement was made during a ceremony in Riyadh on March 29, 2022. The purpose of the new Joint Venture is to enable the development of Saudi Arabia's domestic additive manufacturing production capabilities, consistent with the Kingdom's 'Vision 2030,' which is focused on diversification of the economy and long-term sustainability. The Center for Innovation and Additive Manufacturing will initially focus on energy, with planned expansions into other industrial sectors as well as healthcare solutions.

3D Systems brings industry-leading application expertise and a wide range of 3d printing solutions to the Middle East with this partnership

Commenting on the new Joint Venture, Dr. Jeffery Graves, president and CEO, 3D Systems said, "Our partnership with Dussur will accelerate the adoption of additive manufacturing in the region, enabling diversification of the Saudi Arabian economy. While the energy segment will be one area of focus, a broad range of applications across industrial, aerospace, and healthcare segments will be addressed. We are excited about the partnership and believe it will provide a strong foundation within the Kingdom to expand local engineering and manufacturing and encourage green energy sources."

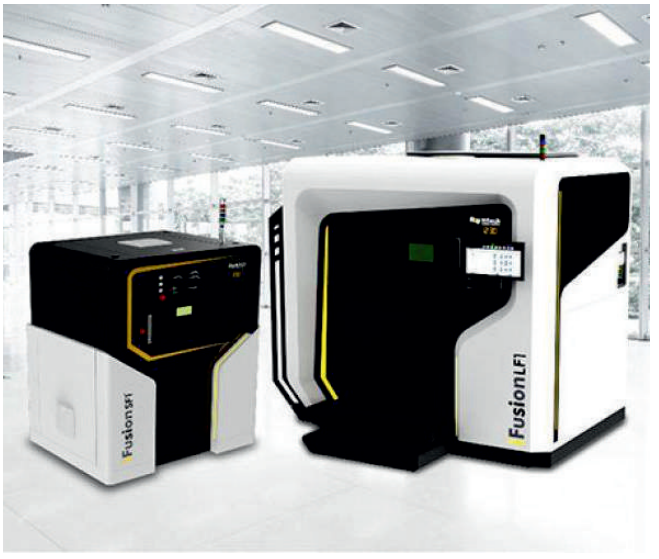
The joint venture follows a selection process in which 3D Systems was chosen due to its breadth of additive technology as well as depth of application expertise. Modeled upon 3D Systems' application development and advanced manufacturing sites located in Littleton, Colorado, and Leuven, Belgium, the new facility is expected to open in late 2022 and is meant to include a breadth of plastic and metal 3D printing technologies as well as 3D Systems application engineers who bring deep industry-specific expertise. The customer innovation and advanced application facility will benefit from the Kingdom's strategic geographic location at the crossroads of important international trade routes between three continents and represents another step to cement the Kingdom's position as a unique regional logistical hub for global seaborne trade.

"Establishing in Saudi Arabia the first Center for Innovation and Additive Manufacturing with a world-class player such as 3D Systems will unlock further localization initiatives across the supply chain," said Dr. Raed Al-Rayes, CEO, Dussur. "This partnership is linked to Dussur's mission to support the Kingdom's industrialization journey and localize disruptive technologies that will revolutionize the way we think of manufacturing. We are looking forward to commencing our work with 3D Systems to contribute to the security of supply in the region and build local capabilities for the jobs of the future."

Intech Additive Solutions Collabrates With MachineWorks

Intech Additive Solutions partners with Polygonica from Machine Works to enhance the Metal 3D Printing Ecosystem.

Intech is home to a comprehensive range of Metal 3D Printers—iFusion SF1, iFusion MF and iFusion LF along



with its build preparation software, AMBuilder, and parameter optimization software, AMOptoMet.

"We are of course very pleased to announce that Intech is our second Polygonica customer in India. Moreover, we are very excited to be working with Intech. Their undoubted knowledge and experience in the metal additive industry will help the Polygonica team meet the ever more demanding requirements of handling DfAM geometries," says Dr. Fenqiang Lin, managing director of MachineWorks.

"At Intech, we are working hard to accelerate the adoption of metal printing in modern manufacturing by providing a complete end-to-end ecosystem, from design for additive manufacturing (DfAM), through printing, post-processing, and quality assurance. Adding Polygonica's world-renowned mesh algorithms to AMBuilder was an important step for us, and we also plan to introduce new and innovative software powered in part by the Polygonica engine," says Murari Venkataraman, VP of Operations at Intech Additive Solutions.

Polygonica from MachineWorks, with its features, complements Intech's efficient Metal 3D Printing system. This collaboration between MachineWorks and Intech mutually benefits both organizations in the AM sector in India and globally.

Dubai's RTA to adopt 3D printing to maintain roads, facilities

Dubai's Roads and Transport Authority (RTA) to use 3D printing technology to manufacture spare parts for electromechanical systems and cladding materials used in the maintenance of RTA's roads and road facilities.

Eng Maitha bin Adai, CEO of Traffic and Roads Agency, RTA, underlined the importance of keeping pace with modern technologies and systems in the operational plans and programmes of RTA to realise Dubai Government's objectives in using 3D printing for the manufacture of spare parts.

"During the past few months, RTA developed a new initiative and conducted various studies and experiments to increase the availability of spare parts for roads maintenance systems, in cooperation with specialist 3D printing companies. The initiative has proved to be successful in extending the sources of spare parts such as propeller fans, control equipment, and cladding for tunnel walls in Dubai's road facilities," said bin Adai.

"As part of the initiative selected types of spare parts were chosen to be 3D printed; based on specific criteria, such as the lack of spare parts in local markets and taking into consideration safety measures. The initial results of implementing the technology revealed a 50% saving in the operational cost of purchasing spare parts. Additional improvements were introduced on the factory-based spare parts on account of historical data

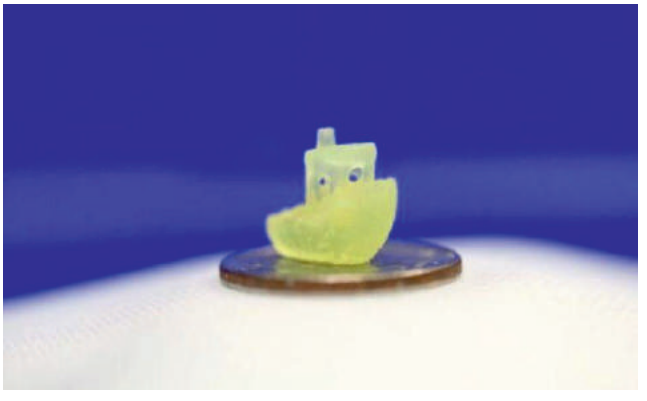
analysis, which reduced breakdown rates to record-low levels. 3D printing technology also contributed to reducing the cost of transportation and the time needed to import spare parts to Dubai," she added.

In the early stages of the initiative, the Traffic and Roads Agency cooperated with three leading companies in 3D printing in manufacturing to develop plans and studies to improve spare parts manufacturing processes. It also aimed to ensure their efficiency as required before being used in service in road maintenance and facilities in Dubai.

Research and Development News

Stanford and Harvard engineers develop new kind of 3D printing technique

A boat figurine produced by a new 3D printing process that makes it possible to print an object within a volume of resin – like an action figure floating in the center of a block of Jell-O – rather than having to build the object layer by layer. (Image credit: Dan Congreve)



A boat figurine produced by a new 3D printing process that makes it possible to print an object within a volume of resin – like an action figure floating in the center of a block of Jell-O – rather than having to build the object layer by layer. (Image credit: Dan Congreve)

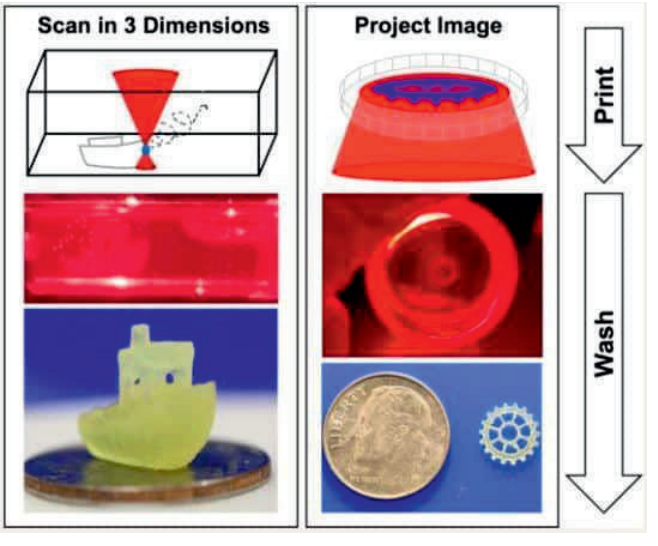
Engineers at Stanford and Harvard have laid the groundwork for a new system for 3D printing that doesn't require that an object be printed from the bottom up.

While 3D printing techniques have advanced significantly in the last decade, the technology continues to face a fundamental limitation: objects must be built up layer by layer. But what if they didn't have to be?

Dan Congreve, an assistant professor of electrical engineering at Stanford and former Rowland Fellow at the Rowland Institute at Harvard University, and his colleagues have developed a way to print 3D objects within a stationary volume of resin. The printed object is fully supported by the thick resin – imagine an action figure floating in the center of a block of Jell-O – so it can be added to from any angle. This removes the need for the support structures typically required for creating complex designs with more standard printing methods. The new 3D printing system, which was recently published in Nature, could make it easier to print increasingly intricate designs while saving time and material.

"The ability to do this volumetric printing enables you to print objects that were previously very difficult," said Congreve. "It's a very exciting opportunity for three-dimensional printing going forward."

Printing with light



At its surface, the technique seems relatively straightforward: The researchers focused a laser through a lens and shone it into a gelatinous resin that hardens when exposed to blue light. But Congreve and his colleagues couldn't simply use a blue laser – the resin would cure along the entire length of the beam. Instead, they used a red light and some cleverly designed nanomaterials scattered throughout resin to create blue light at only the precise focal point of the laser. By shifting the laser around the container of resin, they were able to create detailed, support-free prints.

Changing the contents of the nanocapsules controls

the power of red light required to cure the resin and allows for different types of volumetric printing. Two types of printing shown here: scanning and tracing an image using a high-powered laser (on left) and projecting an image all at once using a low-powered LED (on right). (Image credit: Dan Congreve/Tracy H. Schloemer/Arynn O. Gallegos)

Congreve's lab specializes in converting one wavelength of light to another using a method called triplet fusion upconversion. With the right molecules in close proximity to each other, the researchers can create a chain of energy transfers that, for example, turn low-energy red photons into high-energy blue ones.

"I got interested in this upconversion technique back in grad school," Congreve said. "It has all sorts of interesting applications in solar, bio, and now this 3D printing. Our real specialty is in the nanomaterials themselves – engineering them to emit the right wavelength of light, to emit it efficiently, and to be dispersed in resin."

Through a series of steps (which included sending some of their materials for a spin in a Vitamix blender), Congreve and his colleagues were able to form the necessary upconversion molecules into distinct nanoscale droplets and coat them in a protective silica shell. Then they distributed the resulting nanocapsules, each of which is 1000 times smaller than the width of a human hair, throughout the resin.

"Figuring out how to make the nanocapsules robust was not trivial – a 3D-printing resin is actually pretty harsh," said Tracy Schloemer, a postdoctoral researcher in Congreve's lab and one of the lead authors on the paper. "And if those nanocapsules start falling apart, your ability to do upconversion goes away. All your contents spill out and you can't get those molecular collisions that you need."

Next steps for light-converting nanocapsules

The researchers are currently working on ways to refine their 3D-printing technique. They are investigating the possibility of printing multiple points at the same time, which would speed up the process considerably, as well as printing at higher resolutions and smaller scales.

Congreve is also exploring other opportunities to put the upconverting nanocapsules to use. They may be able to help improve the efficiency of solar panels, for example, by converting unusable low-energy light into wavelengths the solar cells can collect. Or they could be used to help researchers more precisely study biological models that can be triggered with light or even, in the future, deliver localized treatments.

"You could penetrate tissue with infrared light and then turn that infrared light into high-energy light with this upconversion technique to, for example, drive a chemical reaction," said Congreve. "Our ability to control materials at the nanoscale gives us a lot of really cool opportunities to solve challenging problems that are otherwise difficult to approach."

New laser-based volumetric additive manufacturing method can 3D print glass in seconds

Photo by Garry McLeod/TID. Lawrence Livermore National Laboratory co-author Caitlyn Krikorian Cook, a

Photo by Garry McLeod/TID. Lawrence Livermore National Laboratory co-author Caitlyn Krikorian Cook, a group leader and polymer engineer in the Lab's Materials Engineering Division, characterized the curing kinetics of the nanocomposite silica glass resin with light exposure.

group leader and polymer engineer in the Lab's Materials Engineering Division, characterized the curing kinetics of the nanocomposite silica glass resin with light exposure.

Versatile and ubiquitous, glass is increasingly found in specialized applications such as fiber optics, consumer electronics and microfluidics for "lab-on-a-chip" devices. However, traditional glassmaking techniques can be costly and slow, and 3D-printing glass often results in rough textures, making them unsuitable for smooth lenses. Using a new laser-based Volumetric Additive Manufacturing (VAM) approach—an emerging technology in near-instant 3D printing—researchers at Lawrence Livermore National Laboratory and the University of California, Berkeley have demonstrated the ability to 3D-print microscopic objects in silica glass, part of an effort to produce delicate, layer-less optics that can be built in seconds or minutes. The results are reported in the latest edition of the journal Science.

Nicknamed "the Replicator" after the fictional device in "Star Trek" that can instantly fabricate nearly any object, the Computed Axial Lithography (CAL) technology developed by LLNL and UC Berkeley is inspired by computed tomography (CT) imaging methods. CAL works by computing projections from many angles through a digital model of a target object, optimizing these projections computationally, and then delivering them into a rotating volume of photosensitive resin using a digital light projector. Over time, the projected light patterns reconstruct, or build up, a 3D light dose distribution in the material, curing the object at points exceeding a light threshold while the vat of resin spins. The fully formed object materializes in mere seconds—far faster than traditional layer-by-layer 3D printing techniques—and then the vat is drained to retrieve the part.

Combining a new microscale VAM technique called micro-CAL, which uses a laser instead of an LED source, with a nanocomposite glass resin developed by the German company Glassomer and the University of Freiburg, UC Berkeley researchers reported the production of sturdy, complex microstructure glass objects with a surface roughness of just six nanometers with features down to a minimum of 50 microns.

UC Berkeley Associate Professor of Mechanical Engineering Hayden Taylor, the project's principal investigator, said the micro-CAL process, which produces a higher dose of light and cures 3D objects faster and at higher resolution, combined with the nanocomposite resins characterized at LLNL proved a "perfect match for each other," creating "striking results in the strength of the printed objects."

"Glass objects tend to break more easily when they contain more flaws or cracks or have a rough surface," Taylor said. "CAL's ability to make objects with smoother surfaces than other 3D printing processes is therefore a big potential advantage."

The team compared the breaking strength of micro CAL-built glass to objects of the same size made by a more conventional layer-based printing process, and found the breaking loads of CAL-printed structures were more tightly clustered together, meaning that researchers could have more confidence in in the breaking load of a CAL-printed components over conventional techniques.

LLNL co-author Caitlyn Krikorian Cook, a group leader and polymer engineer in the Lab's Materials Engineering Division, characterized the curing kinetics of the nanocomposite resin with light exposure. Printing higher viscosity resins are challenging, if not impossible, with current traditional stereolithography systems at LLNL, Cook said, adding that the benefit of VAM for micro-optics is that it can produce extremely smooth surfaces without layering artifacts, resulting in faster printing without additional post-processing time. "You can imagine trying to create these small micro-optics and complex microarchitectures using standard fabrication techniques; it's really not possible," Cook said. "And being able to print it ready-to-use without having to do polishing techniques saves a significant amount of time. If you can eliminate polishing steps after forming the optics—with low roughness—you can print a part ready for use."

Cook performed in-situ resin characterization with a spectrometer to measure the thresholding response of an inhibitor modifier in the material's photopolymerization kinetics. The modifier, combined with the preciseness of the laser VAM method, was the "secret sauce" to printing high-resolution optics at a microscale.

"By creating a thresholding response, we're able to significantly improve the resolution," Cook said. "We're taking advantage of the similar thresholding response reported in our previous work, except we're implementing it in a different class of photopolymer chemistry. We're beginning to better understand the necessary kinetics for volumetric manufacturing."

For the past several years, the LLNL/UC Berkeley VAM collaboration has experimented with different resins and materials to create intricate objects. The latest advancement stems from a study with UC Berkeley to discover new classes of versatile materials that could expand the range of chemistries and material properties achievable through the VAM method.

Cook and the UC Berkeley researchers said VAM-printed glass could impact solid-glass devices with microscopic features, produce optical components with more geometric freedom and at higher speeds and could potentially enable new functions or lower-cost products.

Real world applications could include micro-optics in high-quality cameras, consumer electronics, biomedical imaging, chemical sensors, virtual reality headsets, advanced microscopes and microfluidics with challenging 3D geometries such as "lab on a chip" applications, where microscopic channels are needed for medical diagnostics, fundamental scientific studies, nanomaterial manufacturing and drug screening. Plus, the benign properties of glass lend themselves well to biomaterials, or in cases of high temperature or chemical resistance, Cook added.

The Berkeley/LLNL team is also examining applications in bioprinting, such as fabricating organs or "lung-type" structures using a combination of VAM and projection micro-stereolithography.

At LLNL, Cook said she and her team will further tune the resolution of VAM and the doses required for variable range of resolutions and print speeds. Cook is continuing to support characterization and materials development, and Dominique Porcincula and Rebecca Walton, members of her Functional Architected Materials Engineering group, currently have a VAM feasibility study to advance the VAM glass printing efforts for larger optics.

"The challenge with printing glass is that the larger the part, the more significant the shrinkage stresses are when going from a green state to burning out the binder between the silica particles into a brown part to fusing the particles together into a fully dense glass part. Cracking problems typically arise in larger prints due to these shrinkage stresses," Cook said. "Our teams at LLNL are developing custom formulations to produce larger optics and glass printed parts that will not crack during the de-binding and sintering processes."

The latest work at LLNL was funded by the Laboratory Directed Research and Development (LDRD) program.
Co-authors on the Science paper included lead author Joseph Toombs and Chi Chung Li of UC Berkeley, Manuel Luitz and Sophie Jenne of the University of Freiburg in Germany, and Bastian Rapp and Frederik Kotz-Helmer of Glassomer and the University of Freiburg.

New 3D Printing Alloy by NASA built to Withstand Extreme Conditions

This turbine engine combustor (fuel-air mixer) was 3D-printed at NASA Glenn and is one example of a challenging component that can benefit from applying the new GRX-810 alloys. Credits: NASA

NASA innovators recently developed a new metal alloy using a 3D printing process that dramatically improves the strength and durability of the components and

This turbine engine combustor (fuel-air mixer) was 3D-printed at NASA Glenn and is one example of a challenging component that can benefit from applying the new GRX-810 alloys. Credits: NASA

parts used in aviation and space exploration, resulting in better and longer-lasting performance.

NASA Alloy GRX-810, an oxide dispersion strengthened (ODS) alloy, can endure temperatures over 2,000 degrees Fahrenheit, is more malleable, and can survive more than 1,000 times longer than existing state-of-the-art alloys. These new alloys can be used to build aerospace parts for high temperature applications, like those inside aircraft and rocket engines, because ODS alloys can withstand harsher conditions before reaching their breaking point.

"The nanoscale oxide particles convey the incredible performance benefits of this alloy," said Dale Hopkins, deputy project manager of NASA's Transformational Tools and Technologies project.

It's challenging and expensive to produce ODS alloys for these extreme environments. To develop NASA Alloy GRX-810, agency researchers used computational models to determine the alloy's composition. The team then leveraged 3D printing to uniformly disperse nanoscale oxides throughout the alloy, which provides improved high-temperature properties and durable performance. This manufacturing process is more efficient, cost effective, and cleaner than conventional manufacturing methods.

Impacts and Benefits

These alloys have major implications for the future of sustainable flight. For example, when used in a jet engine, the alloy's higher temperature and increased durability capability translates into reduced fuel burn and lower operating and maintenance costs.

This alloy also affords engine part designers new flexibilities like lighter materials paired with vast performance improvements. Designers can now contemplate tradeoffs they couldn't consider before, without sacrificing performance.

Breakthrough Performance: A Revolution in Materials Development

NASA's new alloys deliver enhanced mechanical properties at extreme temperatures. At 2,000° F, GRX-810 shows remarkable performance improvements over current state-of-the-art alloys including:

- Twice the strength to resist fracturing
- Three and a half times the flexibility to stretch/bend prior to fracturing
- More than 1,000 times the durability under stress at high temperatures

"This breakthrough is revolutionary for materials development. New types of stronger and more lightweight materials play a key role as NASA aims to change the future of flight," said Hopkins. "Previously, an increase in tensile strength usually lowered a material's ability to stretch and bend before breaking, which is why our new alloy is remarkable."

Discovery/Development: Coupling Additive Manufacturing with Material Modeling

The team applied thermodynamic modeling and leveraged 3D printing to develop the new high-temperature alloy that delivered this breakthrough performance.
"Applying these two processes has drastically accelerated the rate of our materials development. We

can now produce new materials faster and with better performance than before," said Tim Smith, a material research scientist at NASA's Glenn Research Center in Cleveland and one of the inventors of this new alloy.

"What used to take years through a trial-and-error process, now takes a matter of weeks or months to make discoveries," added Hopkins.

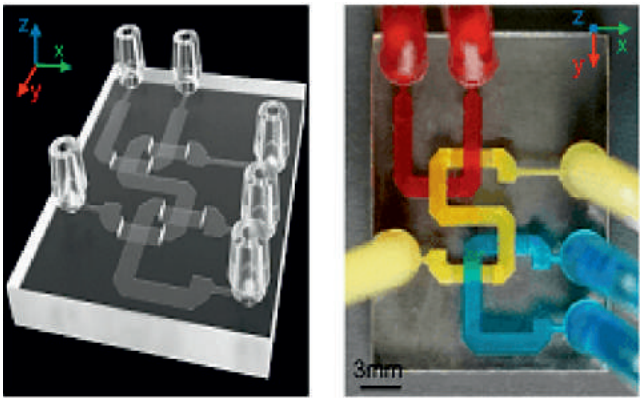
Using thermodynamic modeling, one of many computational tools discussed within the NASA 2040 Vision Study, the team discovered the optimal alloy composition after only 30 simulations.

This modeling tool produces results in much less time and with lower costs than traditional trial-and-error processes. The tool also avoids dead ends by showing researchers not just what metal types to incorporate but how much of each element to infuse into the composition. "The performance of this alloy clearly demonstrates the modeling tool's maturity and ability to produce significant results," said Steve Arnold, materials and structures technical discipline lead at NASA Glenn.

This new alloy is just one example of how the Transformational Tools and Technologies project delivers innovative solutions through foundational research and cross-cutting tools. Watch NASA's Additive Manufacturing Alloys for High-Temperature Applications Webinar to learn more about the technical details of this innovation and how NASA technology is available to industry and other organizations.

Innovation in 3D-printed microfluidic channels for biomedical devices by researchers of University of Southern California

An example of a microfluidic chip created by the USC research team The researchers' method microfluidic device fabrication is compatible with commonly used 405?nm light sources and commercial photocurable resins. Courtesy of Yang Xu.



An example of a microfluidic chip created by the USC research team The researchers' method microfluidic device fabrication is compatible with commonly used 405?nm light sources and commercial photocurable resins. Courtesy of Yang Xu.

Researchers at the University of Southern California (USC) developed a printing technique that could provide the precision required to successfully 3D-print microfluidic channels on chips at a scale not previously seen. The technique is called in situ transfer vat photopolymerization (IsT-VPP).

The use of microfluidic devices — compact testing tools composed of tiny channels carved on a chip — can lower the cost of drug development and aid in medical diagnostics. The traditional approach to fabricating these devices, soft lithography in a cleanroom setting, requires multiple labor-intensive processes.

While 3D printing offers many advantages for biomedical device manufacturing, it is not yet sensitive enough to build layers with the minute detail required for microfluidics.

Using the IsT-VPP technique, the researchers were able to produce microfluidic channels 10 µm in height and of high accuracy (within the 2-µm level), without use of a liquid resin with reduced transparency or decreased fabrication speed. Vat photopolymerization (VPP) uses liquid photopolymer resin to build the item to be printed layer by layer. The item is then irradiated with ultraviolet (UV) light, which cures and hardens the resin at each layer. A build platform moves the printed item up or down so additional layers can be built onto it.

Although VPP allows for one-step fabrication, its control of the microfluidic device's micron-size channels falls short. The UV light source has a tendency to penetrate deep into the residual liquid resin, curing and solidifying material within the walls of the channels.

"When you project the light, ideally, you only want to cure one layer of the channel wall and leave the liquid resin inside the channel untouched, but it's hard to control the curing depth, as we are trying to target something that is only a 10-μm gap," professor Yong Chen said.

While opaque resin allows less light penetration than transparent resin, it is not suitable for building a microfluidic device whose contents will be examined under a microscope.

To create channels in clear resin at the microscale needed for microfluidic devices, the team developed an auxiliary platform that moves between the light source and the printed device, blocking the light from solidifying the liquid within the walls of a channel.

When the channel roof (i.e., the top layer portion of the device that encloses the channel) is printed, the auxiliary platform is used to prevent the light from penetrating into the residual liquid resin inside the channel. The channel roof is then in situ transferred to the built part. All the other layers are printed using the standard VPP process. Any residual resin in the channel remains in a liquid state and can be flushed out after the printing process to form the channel space.

According to Chen, current commercial processes only allow for the creation of a microfluidic channel height at the 100- m level and provide poor control over accuracy.

"This is the first time we've been able to print something where the channel height is at the 10- m level," he said. "We can control it really accurately, to an error of plus or minus 1 m. This is something that has never been done before, so this is a breakthrough in the 3D printing of small channels."

The USC VPP-based technique is compatible with commonly used 405-nm light sources and commercial photocurable resins. The researchers verified the technique by fabricating multifunctional devices, including 3D serpentine microfluidic channels, microfluidic valves, and particle sorting devices.

Chen said that the new 3D-printing platform, with its microscale channels, could offer significant benefits to cancer detection and research.

"Tumor cells are slightly bigger than normal cells, which are around 20 m. Tumor cells could be over 100 m," he said. "Right now, we use biopsies to check for cancer cells, cutting organ or tissue from a patient to reveal a mix of healthy cells and tumor cells. Instead, we could use simple microfluidic devices to flow the sample through channels with accurately printed heights to separate cells into different sizes so we don't allow those healthy cells to interfere with our detection."

The IsT-VPP technique for microfluidic device fabrication could advance VPP's use for 3D-printing devices for applications requiring small gaps with high accuracy.

"There are so many applications for microfluidic channels," Chen said. "You can flow a blood sample through the channel, mixing it with other chemicals so you can, for example, detect whether you have COVID or high blood sugar levels."

The research team is filing a patent application for the 3D-printing method, and it is seeking collaborators to commercialize the fabrication technique for medical testing devices.

3D Bioprinting Artificial Bone for Emergency Medicine in Space

This artificial bone sample is an early step towards making 3D bioprinting a practical tool for emergency

This artificial bone sample is an early step towards making 3D bioprinting a practical tool for emergency medicine in space. Credit: ESA-Remedia

medicine in space. Credit: ESA-Remedia

This artificial bone sample is an early step towards making 3D bioprinting a practical tool for emergency medicine in space. An ESA R&D effort aims to develop bioprinting techniques capable of giving astronauts on an extended mission ready access to the 'spare parts' needed for bone or skin grafts, and even complete internal organs.

3D bioprinting may soon be practical on Earth, and could help meet the challenging conditions of spaceflight. Astronauts in zero or low gravity lose bone density, for example, so fractures may be more likely in orbit or on Mars.

Or, treating a burn often involves a graft of skin taken from a patient's body – manageable on Earth with full hospital care but more risky in space, as the secondary damage may not heal easily.

Skin or bone can be bioprinted using a nutrient-rich 'bio-ink' of human blood plasma, available from the astronauts themselves. By working upside down – in 'minus 1g' gravity – the team has shown they can probably do it in space.

This bone sample is part of the first selection of items on the 99 Objects of ESA ESTEC website, a set of intriguing, often surprising artifacts helping tell the story of more than half a century of activity at ESA's technical heart.

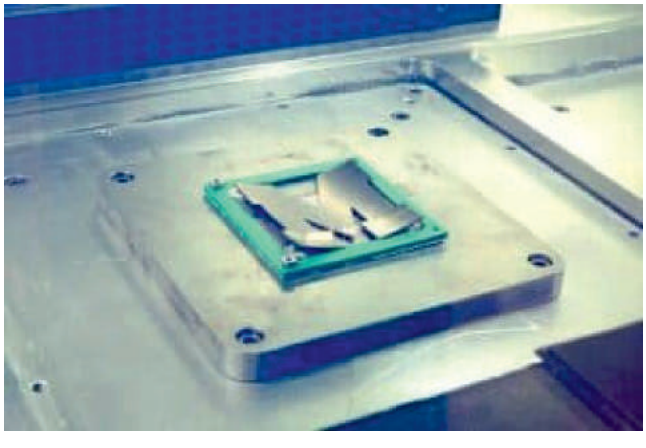
University of Michigan developed a software "Smart Scan" to make parts faster for metal AM

3D printers may soon get better at producing intricate metal and plastic parts, thanks to new software developed at the University of Michigan that reduces harmful heat buildup in laser powder bed fusion printers. Called SmartScan, the software demonstrated a 41% improvement in heat distribution and a 47% reduction in deformations in a recent study.

A steel plate in the shape of a Block M is marked with a laser inside the LPBF Panda 11 printer. Image credit: Evan Dougherty/Michigan Engineering

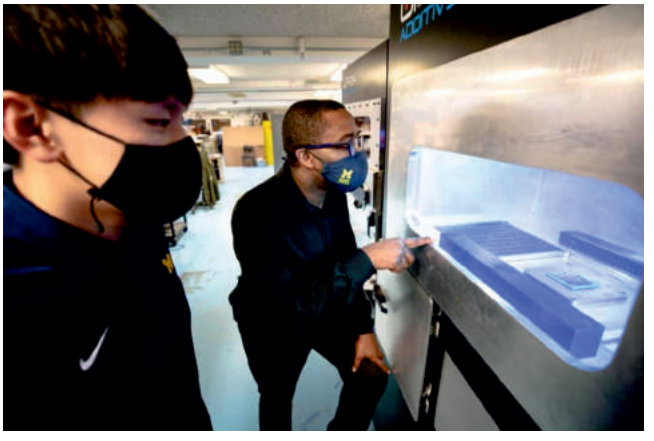
It's also likely to speed the manufacturing process in two ways: by reducing the need for printers to slow down to help with cooling and by significantly reducing heat-caused defects that must be corrected after printing.

Laser powder bed fusion is a form of 3D printing used in aerospace, automotive and biomedical industries to manufacture parts that are too intricate to make with conventional manufacturing. It uses a laser to fuse layers of powdered metal or plastic together. But the laser's heat can build up in the delicate parts being printed, causing deformation and other defects.



A steel plate in the shape of a Block M is marked with a laser inside the LPBF Panda 11 printer. Image credit: Evan Dougherty/Michigan Engineering

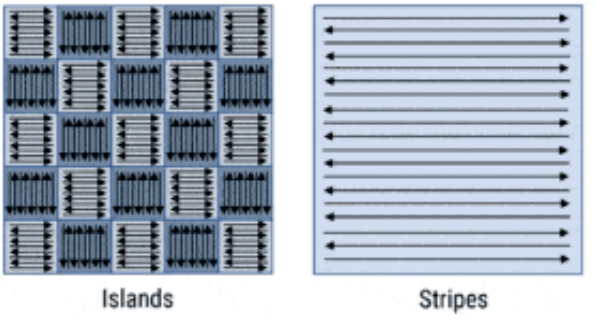
"This problem gets even more serious for parts with really thin features," said Chinedum Okwudire, U-M associate professor of mechanical engineering and corresponding author of the paper in Additive Manufacturing. "The heat doesn't have a lot of room to spread, so you need to be smart about how you move the laser around, otherwise your part will deform in really weird ways."



Mechanical engineering Ph.D. candidate Chuan He and associate professor Chinedum Okwudire demonstrate the laser marking procedure using a Panda 11 LPBF printer. Image credit: Evan Dougherty, Michigan Engineering

SmartScan tackles the problem by considering how heat flows within a given part and mapping an optimized scan sequence to limit heat accumulation in any given area. It analyzes the shape of the part and the thermal properties of the material being used, including conductive and convective heat transfer.
Others in the field have experimented with varying printing patterns to reduce heat buildup, for example by jumping from one area to another or alternating between horizontal and vertical scanning directions. But Okwudire says SmartScan is the first solution that uses a thermal model to optimally guide the laser to distribute heat more evenly.

"When you bring science into it, you can do it in a way that is better and works for even the most intricate parts," Okwudire said.



Islands and stripes are two popular scan sequence patterns for LPBF printers. Image credit: Smart and Sustainable Automation Research Lab

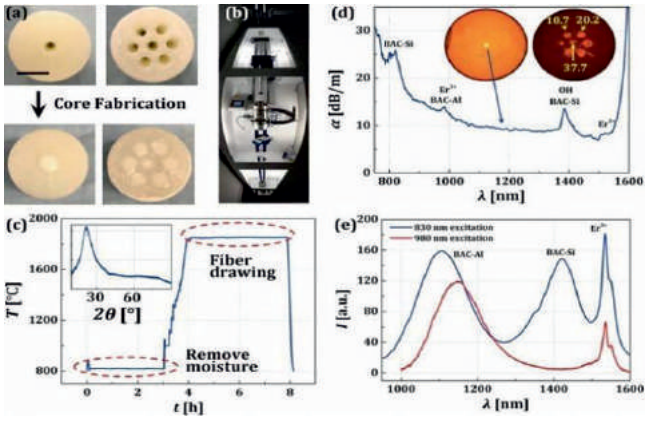
To determine the effectiveness of this first version of SmartScan, the researchers used a laser to imprint an identical pattern on two stainless steel plates. They used the SmartScan process for the first plate and switched to traditional printing patterns for the second plate. The prints made with SmartScan were consistently less warped and showed more uniform heat distribution during the marking process than the other methods.

Based on the results of the experiment, the team is confident that, with further research, they'll be able to adapt SmartScan to build full 3D parts. They plan to further improve the software by factoring the fusing of metal or plastic powder into their thermal modeling, as well as enabling active updating of a scan sequence during printing based on real-time observed temperature measurements using an infrared camera.
"The results are very promising, and we've gotten a lot of positive feedback," said Okwudire, who has started to demonstrate the software to industry partners. "We went with a simple model because it works, and it works better than the trial-and-error approaches used today. We wanted to focus in a direction that is practical and truly has the chance to make a difference."

The study was supported by the U-M College of Engineering and Department of Mechanical Engineering. The University of Michigan has filed for patent protection and is seeking partners to bring the technology to market.

New Additive Manufacturing Method Could Transform Optical Fiber Fabrication

Researchers at Harbin Engineering University and the University of New South Wales demonstrated the additive manufacture of silica optical fiber preforms. According to the research team, additive manufacturing, also known as 3D printing, could transform the way specialty optical fibers are fabricated.



(a) Images of the 3D-printed preforms and subsequently filled cores; (b) optical fiber drawing tower used in this experiment; (c) temperature change of the fiber drawing process; (d) loss spectrum of the 3D-printed single-core and loss of seven-core fibers at 632.8 nm; (e) emission spectra of a single-core fiber excited by the 830 and 980 nm lasers. Courtesy of Y. Chu, X. Fu, Y. Luo, J. Canning, J. Wang, J. Ren, J. Zhang, and G.D. Peng.

Using digital light processing (DLP) 3D-printing technology, the researchers extended small-scale glass "bulk or slice" printing of optical fiber preforms beyond a few millimeters to the centimeter scale. They constructed single- and multimode optical fibers by controlling the printing parameters during the fiber draw process. The capability to 3D-print complex geometries such as multicore fibers could help advance the development of Internet of Things (IoT) technologies.

The fabrication of the 3D-printed preforms involved five steps. First, the researchers prepared ultraviolet (UV)-sensitive resin embedded with amorphous silica nanoparticles. They printed the preform using a commercial DLP 3D printer; then they filled the prepared resin into the holes of the printed cladding preform. This step was followed by thermal polymerization.

The fourth step was a de-binding and pre-sintering process, driven by annealing, to remove moisture. Finally, the researchers performed high-temperature sintering to remove any additional impurities and fuse silica nanoparticles into glass during fiber drawing.

By introducing several active dopants into the additive manufacturing process, the researchers showed that a diversity of materials can be used for 3D printing of optical fiber preforms. Germanium, titanium, and aluminum were used to form waveguides and enhance the core glass network structure of the optical fiber preform, making it conducive to luminescence. As the researchers increased the number of cores, they adjusted the drawing conditions to allow for lower melting points in the preform.

The researchers used bismuth and erbium ions to create additively manufactured bismuth-and-erbium co-doped optical fiber (BEDF). The bismuth and erbium ions were co-doped into single-core and seven-core fibers drawn from 3D-printed preforms. The team fabricated multicomponent fibers and structured fibers.

The BEDFs exhibited an ultrabroadband, near-infrared (NIR) luminescence covering all telecommunications O-L bands with 830-nm pump excitation. The researchers believe that BEDFs could become an active medium in fiber amplifiers for the next generation of fiber communication systems.

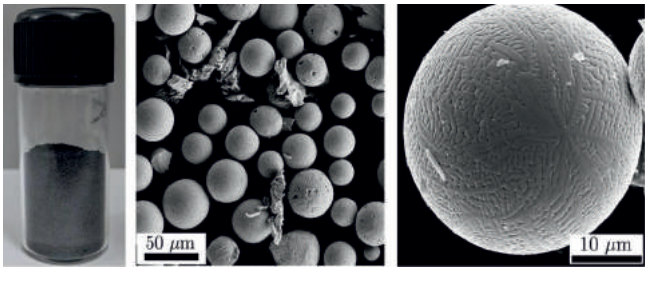
Additionally, the researchers found that the fiber loss in the single-core fiber was substantially diminished when moisture was reduced through the additional annealing and sintering treatment included in the five-step printing process. Improving the symmetry of the fiber by increasing the roundness of the core and cladding also reduced the moisture in the optical fiber, effectively reducing fiber loss.

Current optical fiber manufacturing, based on chemical vapor deposition (CVD) technologies and the stack-and-draw approaches used for structured optical fibers, faces numerous challenges in the fabrication of multimaterial composite fibers and multicore fibers, which could drive evolving technologies such as IoT. The researchers believe that optical fibers are moving away from being a single-function transmission technology to being able to perform multiple functions. As such, the researchers said, there will be a growing need for custom-designed, application-specific optical fibers.

The researchers see additive manufacturing as a potential disrupter in the optical fiber fabrication space, expanding the functionality of specialty optical fibers and enabling applications such as multicore fiber fan-in/fan-out and ideal mode coupling in space division multiplexing without the need for optical fiber splicing.

IISc develops cost-effective technique to produce metal powders for 3D printing

A team of researchers at the Indian Institute of Science (IISc) has found an alternative low-cost technique to produce metal powders for 3D printing.



Researchers at the Indian Institute of Science (IISc) have identified that a waste product of the metal grinding industry called swarf when refined performs just as well as commercial gas atomised powders in the context of metal Additive Manufacturing (AM) also known as 3D printing.

Swarf is often discarded as a waste product. It is commonly stringy in shape, like metal chips, but it often also throws up perfectly spherical particles. A team of researchers at the IISc led by Koushik Viswanathan, Assistant Professor at the Department of Mechanical Engineering, has found that these powdery metal bodies form as a result of melting due to high heat from oxidation, an exothermic reaction, at the surface layer. They then refined this process to produce large quantities of spherical powders, which are collected and processed further to be used as stock material in AM. Their study shows that these particles perform just as well as commercial gas atomised powders in the context of metal AM. This process can be used as an alternative technique to produce metal powders.

Priti Ranjan Panda, a PhD student at IISc's Centre for Product Design and Manufacturing and one of the authors of the study, adds, "We have an alternative, more economical and inherently scalable route for making metal powders, and the quality of the final powders appear to be very competitive when compared with conventional gas atomised powders."

Viswanathan explains, "There has been significant recent interest in adopting metal AM because, by nature, it enables significant customisation and allows design freedom. However, the large cost of stock metal powders has been the stumbling block. We hope that our work will open new doors to making cheaper and more accessible metal powders."

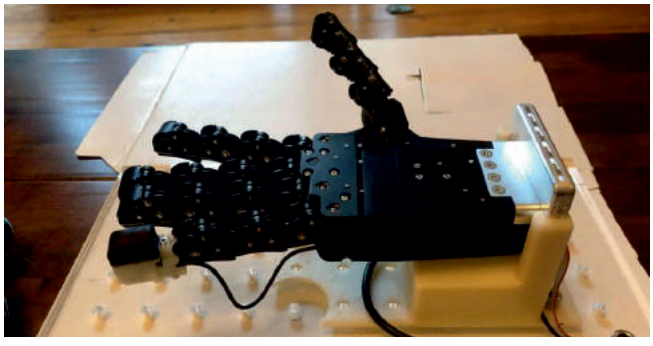
"Reducing the cost of the AM process (via economical powders) can widen the range of materials in situations such as manufacturing of biomedical implants, which could become cheaper and more accessible," adds Harish Singh Dhami, a PhD student at the Department of Mechanical Engineering and co-author of this study.

The researchers say that making metal powder using abrasion also has potential in other high-performance applications such as in aircraft engines, where a high degree of specificity and sophistication are required.

Traditional metal powders used for 3D printing have drawbacks. The major source material for AM is metal powder, which is predominantly produced using a technique called atomisation, in which a molten metal

stream is broken up into fine droplets using air or water jets. However, despite its widespread use, atomisation returns poor yield, is expensive and is inflexible in the types of materials it can handle. However, this new technique side-steps these issues.

Scientists create 3D-printed fingertip with human-like sense of touch



The 3D-printed fingertip has a sense of touch like human skin. Pic: Bristol University

Scientists have created a 3D-printed fingertip that uses artificial nerve signals for a sense of touch similar to human skin. It could revolutionize the fields of soft robotics and prosthetics by mimicking the way nerve endings detect fine details. Researchers from the University of Bristol say their aim is "to make artificial skin as good – or even better – than real skin".

The aim is to create artificial skin for prosthetics that is as good – or potentially even better – than the real thing.

Our sense of touch is produced by complex structures inside our skin, according to Professor Nathan Lepora from the University of Bristol's department of engineering mathematics. Recreating this involved 3D-printing a mesh of pin-like bumps called papillae that combine soft and hard materials to create similar complicated structures to what is found in biology.

"We found our 3D-printed tactile fingertip can produce artificial nerve signals that look like recordings from real, tactile neurons," added Prof Lepora, based at the Bristol Robotics Laboratory.

"Human tactile nerves transmit signals from various nerve endings called mechanoreceptors, which can signal the pressure and shape of a contact."

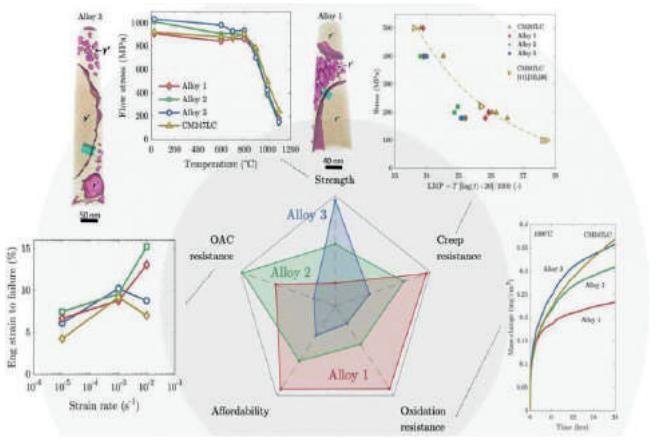
The professor explained: "In our work, we tested our 3D-printed artificial fingertip as it 'felt' those same ridged shapes and discovered a startlingly close match to the neural data." The move was "an exciting development in the field of soft robotics", he added.

"Being able to 3D-print tactile skin could create robots that are more dexterous or significantly improve the performance of prosthetic hands by giving them an in-built sense of touch," he said. But while the signals produced by the artificial fingertip and human nerves were a close match, the artificial fingertip was not as sensitive to fine detail. Professor Lepora suspects this is because the 3D-printed material is thicker than real skin.

His team is now exploring if there might be a way to create 3D-printed structures on the microscopic scale of human skin with the aim of making "artificial skin as good – or even better – than real skin". The findings are published in two papers published in the Journal of the Royal Society Interface.

Oxford researchers develop a new class of super alloy for 3D printing

In a recent paper published in the journal Additive Manufacturing Oxford researchers demonstrated their study on a new class of crack-resistant nickel-based super alloy . The super alloy had improved mechanical properties and printability.



A team of researchers from this department and Engineering, and the University of Southampton, used micro-focus X-ray computed tomography to characterize the processability of a new class of alumina-forming super alloy for 3D printing, using the heritage alloy CM247LC as a benchmark.

In all cases, some processing-related porosity was present in thin wall sections such as the trailing edge, which can be avoided by judicious processing. The cracking seen in CM247LC (in solid-state, liquidation and solidification forms) was avoided.

In this paper, Joseph Ghoussoub and his collaborators propose a novel sub-solvus heat treatment strategy which takes advantage of AM not requiring solutioning. The tensile strength, oxidation resistance and cracking resistance are explained; in all cases they were equivalent or superior to that of CM247LC, however a processing/property trade-off is noted.

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The aim of event is to bring the entire Metal AM ecosystem on one platform including Users, Software Providers, Hardware and Material Manufacturers, Research and Standards to advance the utilization of this technology.

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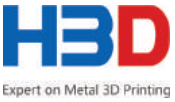

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