SmarTech ANALYSIS

Research Note

The Future of Metal 3D Printing Technologies from a "New" Perspective

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The global manufacturing market seems to be in a state of flux, throwing the metal additive sector into a totally new realm of existence. The last significant global manufacturing downturn in 2009 came largely before metal additive technologies had established itself. In 2009 AM metal implants was only just beginning to see its earliest patients and metal AM in aerospace was still entirely in the R&D lab. While it would be premature to declare anything definitive about metal AM, we believe it's time to view metal additive technologies, and their near-term futures, from the standpoint of both actual and attainable applications from which to base growth projections and investment decisions in what is a tightening manufacturing scenario.

SmarTech maintains that additive technologies will play a key role in creating more agility and responsiveness in global metal manufacturing activity to allow better weathering of global economic speed bumps. However, the advantages aren't truly universally applicable to all given the relatively high barrier to entry that remains, the lower overall state of commercial readiness of emerging high-potential technologies, and the resulting lack of vision and understanding on how to apply each mainstay technology effectively to create more nimble, cost effective metal component supply chains and eliminate costs.

Of the three primary families of metal additive technologies, powder bed fusion variants remain the most widely utilized and industrialized systems with varying degrees of 'factory readiness' depending on the provider. Directed energy deposition systems have played a niche role for many years and continue to subtly infiltrate manufacturing deployments by integrating with CNC technology for hybrid use cases. Finally, bound metal printing variants, which consist of both binder jetting and deposition based systems, both share a common metallurgical principle of final-stage sintering and are still perhaps just coming onto the horizon of metal additive manufacturing (but with much potential).

Manufacturing downturns are inevitable. Whether next year or years from now, metal additive technologies have a unique opportunity to present a value proposition to the manufacturing community as tools to help weather these recurring challenges. SmarTech Analysis has just produced the first ever unified global analysis on metal additive manufacturing parts & applications. Using the perspective of production volumes of metal parts produced additively by functional application, we can demonstrate what is likely to become the potential future of each of the primary metal additive technologies, as well as emphasize their potential value as solutions for leaner manufacturing.

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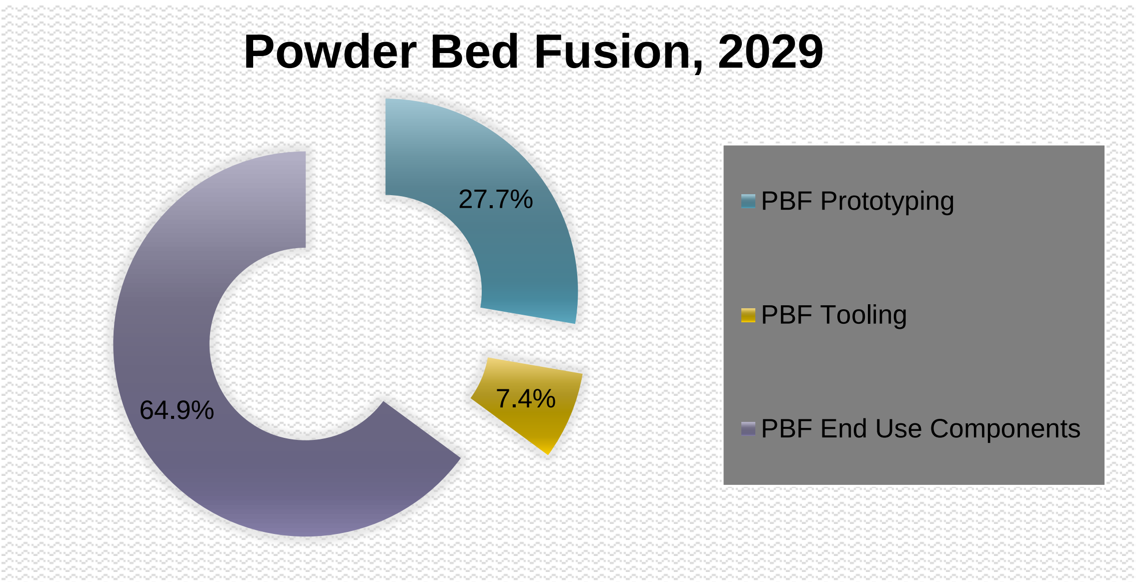
Production Outlooks for Metal AM Technologies by Functional Application Types

Our latest analysis estimates and predicts the volumes and projected market valuation of metal additively produced components using a methodology breaking down various functional roles and specific applications being explored by metal AM technologies today. More specific applications or functional roles of parts produced are categorized and aggregated into three common part types – prototypes, tools and tooling, and end-use production components. The charts below show how SmarTech envisions that each metal AM technology family will settle in terms of making market impact for producing prototypes, tools, and end use parts in the next ten years. The analysis pushes down into specific industries and regions, but the graphs that follow represent aggregated global production value of components produced by each of the three primary technologies across all industries and sub-applications.



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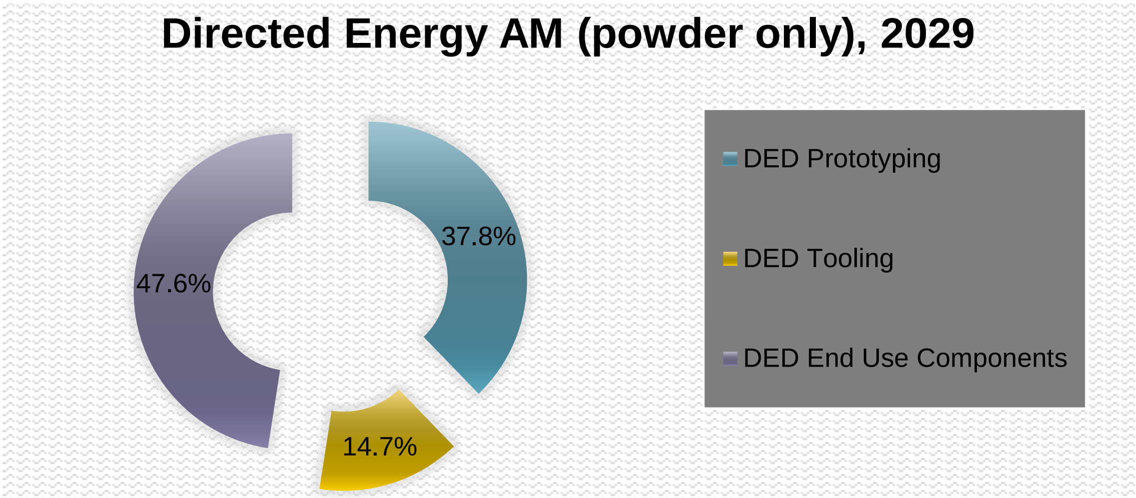

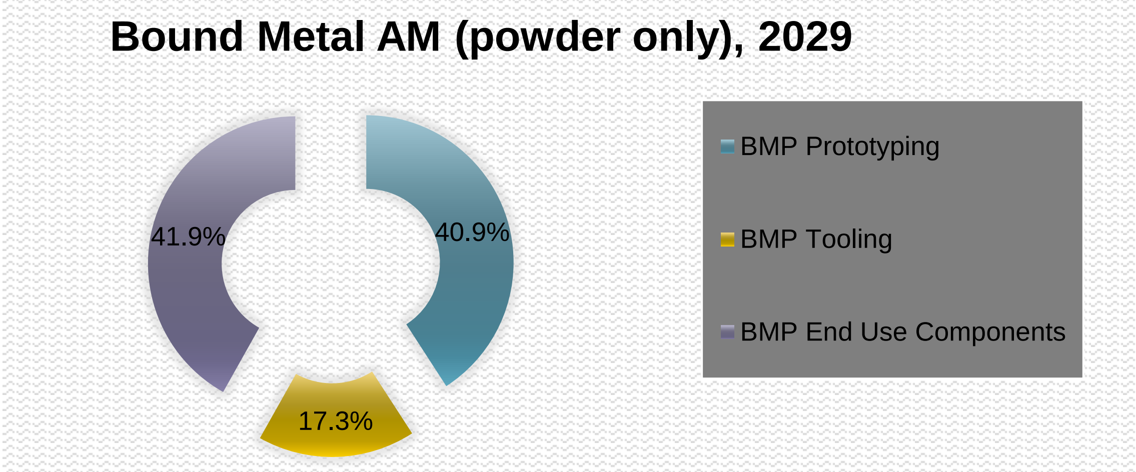

Source: SmarTech Analysis, Metal AM Parts Produced Study

The analysis tracks many nuances in terms of applications from each technological perspective and market, however some interesting conclusions become apparent when aggregating the total market value of all parts produced globally across markets, roughly ten years into the future (as seen in the previous charts).

First, notice that powder bed fusion technology will produce end use components that have a high level of market value/impact. This is without question being influenced by the technology's standing as an incredible tool for healthcare related production. Powder bed fusion of metal, whether with a laser or an electron beam, allows for the production of complex parts in a wide range of sizes depending on industry and application, in a currently-limited selection of alloys from most major metal families, in volumes ranging from low to medium. So much of the operating characteristics are dependent on the design of parts, material choice, and other parameters, however SmarTech believes that powder bed fusion will, for the most part, become a tool aligned to the production of various end use parts that remain expensive in the context of traditional

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manufacturing costs per part, but with economic justification through advanced design, assembly reduction, and improved performance.

Directed energy systems will continue to be utilized to cost- effectively produce both prototypes and end use components, especially large near net shape pieces in one-off and low volumes well into the future. However, the serial repair applications in gas turbine and other high value components will help to drive DED technology more into the realm of end use parts and out of the R&D and specialized manufacturing role. In the context of repairing high value forming tools, DED will also grow to see a much more significant chunk of its per-part market impact come from tooling applications compared to PBF.

Finally, bound metal processes will generate the most tooling-related market value of any metal process through cost effective creation of custom fixtures used in other manufacturing processes, mainly using highly accessible deposition based systems, closely following the adoptive path set forth by polymer extrusion systems over the last several years. In addition, these systems also set the stage for a much greater ability to utilize metal AM to prototype for production designs in a cost effective manner, in a way that powder bed fusion struggles to do on a large scale. All the while, industrial metal binder jetting systems will also begin to scale up to produce significant end-use component impact producing small to medium parts in larger volumes, albeit with lower value per part on average compared to PBF in many applications thanks in part to lower production costs combined with lower expected mechanical performance.

Connecting the Dots: AM Processes Filling Specific Technological Roles in Manufacturing

Using the above projections as a baseline and illustration, how does the future of metal additive manufacturing look in an idealistic future implementation? Companies deploy combinations of metal powder bed fusion and metal binder jetting systems to support both short-run and bridge production applications to get to market quickly with new systems and products with an economically flexible production process. Deposition-based bound metal systems optimize existing manufacturing operations and team-level product development operations. DED systems are brought in for those customers with large fleets of existing high-value parts to reduce costly downtimes where the economics make sense. And ultimately, more and more systems are streamlined in design for performance and efficiency, and powder bed or metal binder jetting systems are scaled necessarily to support ongoing serial production needs of new products as ‘design for additive’ process begins to flourish.

Certainly, not every user will have a need to implement metal AM technologies along these idealistic lines. SmarTech believes that one considerable boost to achieving such a synergistic AM strategy will be the eventual formation of metal AM providers who offer ranges of solutions across all these areas. GE Additive is the most likely to potentially follow this route and achieve the status as the only multi-technology machine vendor to cover all areas of the metal AM technical spectrum. Having developed experience as a user of all these technologies over the last decade certainly boosts their ability to develop businesses around them all, should they so choose.

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If you haven't noticed a trend yet, it's that there are potential messaging points and real value propositions for each metal additive manufacturing technology to address concerns that inevitably come in times of slowing manufacturing. Additive processes share some of these characteristics, while some are more relevant in one technology versus another. As a result, SmarTech expects that the future of metal additive technologies is ultimately one where they are working together for maximum efficiency and flexibility based on their own production characteristics.

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