Markforged

MARKFORGED WHITE PAPER

COMPOSITES & METALS: COMPLEMENTARY 3D PRINTING

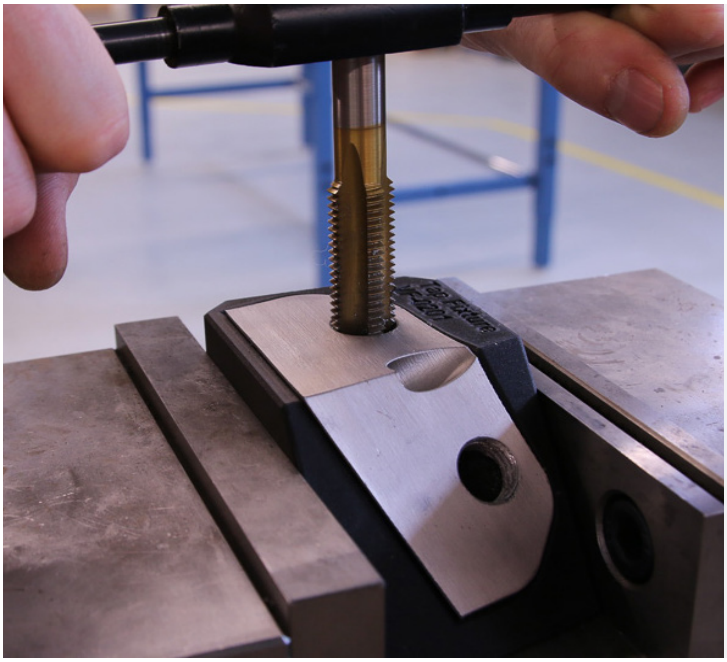
Manufacturing is an ecosystem in which each technology fills a specific niche. Both composite 3D printing and metal 3D printing are valuable resources—they can be used to affordably and efficiently produce many of the low volume, high-strength parts critical to the production line. In this paper, we'll discuss how two high-strength technologies can work together to facilitate affordable and effective manufacturing - from tooling inserts to conformal workholding.

CONFORMAL WORKHOLDING

Workholding for Metal Printed Parts

Complex parts can be manufactured more efficiently via metal 3D printing - while all parts require design for manufacturing, metal 3D printing opens the door for more streamlined and optimized metal parts. Traditional metal fabrication processes like tapping, polishing, or machining go hand in hand with metal 3D printing as post-processing techniques. Fixturing setups for these processes become difficult as part complexity increases, consuming even more design and manufacturing time.

Composite 3D printers enable fabricators to manufacture high-strength conformal workholding without consuming machine bandwidth. This simplifies the workholding design process and ensures the workholding can fit snugly around the part. Composite printers can produce low-cost tooling and fixturing capable of handling the loading, wear, and fluids associated with machining.



APPLICATION

Tapping Fixtures

Composite workholding can be used to align and support metal parts that require post-processing techniques like tapping.

This metal part sits in a conformal composite fixture that orients the holes vertically for easy tapping. The tough composite fixture easily endures the clamping forces applied by the vise to secure the part.

Combining Additive Technologies

Composite and metal 3D printing are built around the same core technology, meaning geometries can be replicated between the two processes. If a part can be 3D printed in metal, conformal workholding for the part can easily follow. Printing composite workholding for processing metal 3D printed parts solves the conformal workholding problem efficiently—whether for tapping, post machining, or QA inspection.

COMPOSITE & METAL 3D PRINTING

CONFORMAL WORKHOLDING

APPLICATION

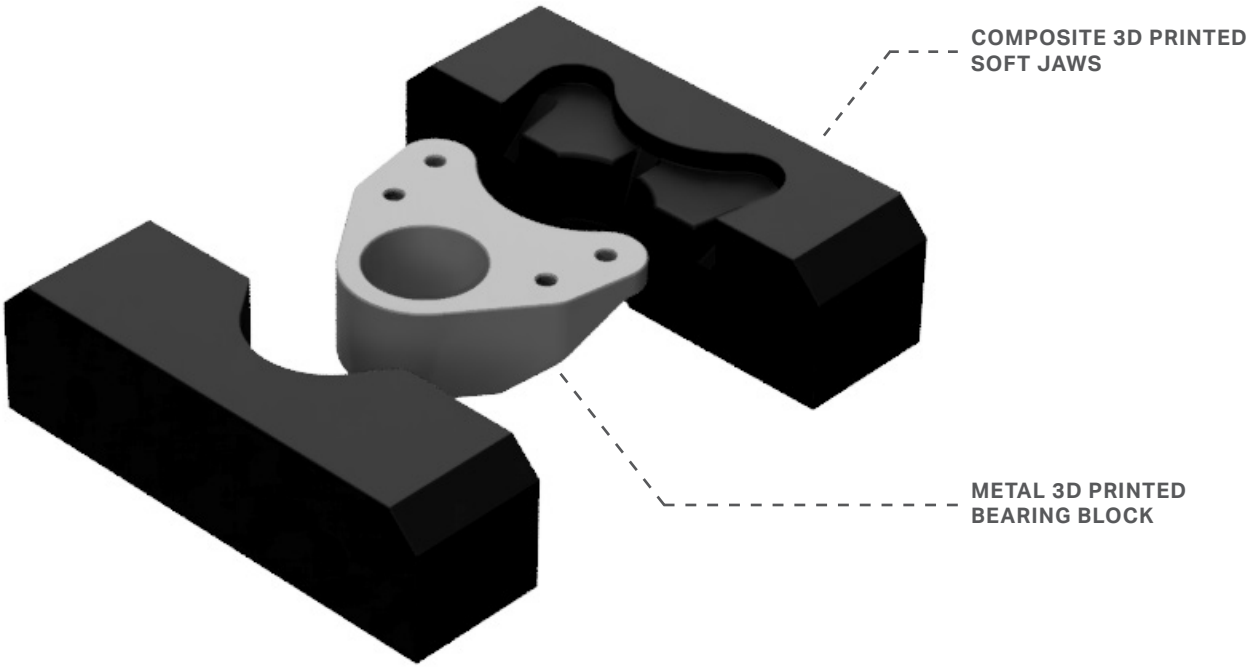
CNC Mill Soft Jaws

In this example, a machinist uses custom printed workholding to fixture a metal 3D printed bearing block that requires post-machining for precision.

The conformal composite soft jaws match the complex contours of the metal part. The composite jaws are tough and chemically resistant, making them durable in the machine shop.

Workholding Design

The design for the composite soft jaws is built off a parametric jaw template set up for the vice mounted in the milling machine. A Boolean subtract operation was performed after the metal part CAD file was located within the soft jaw template to create the conformal profile of the jaws.



COMPOSITES & METAL 3D PRINTING

TOOLING INSERTS

Additive Manufacturing for Tooling

Tooling is a critical application of high-strength 3D printing because low-volume tooling is inefficient and expensive to manufacture either in-house or outsourced. Custom tools are often made of very tough, hard, and corrosion resistant materials—they undergo heavy, repeated cycles. Using industrial 3D printers for tools, jigs, and fixtures can drop costs and cut lead time by over 90%, delivering high-strength, long-lasting parts next day.

APPLICATION

Custom Wrenches

A metal printed insert fitted within a composite grip localizes hardness and wear resistance to the contact area with a metal 3D printed insert.

The composite grip keeps the tool lightweight and ergonomic. Internal continuous fiberglass reinforcement makes it durable and robust, distributing the torsion loads applied from tool use.

Localizing Material Properties

Many tools require specific material properties in different regions based on their loading and contact surfaces. For example, a hammer requires a hard and weighty head, but its handle should be lightweight and shock dampening. Breaking your tools down into material-specific regions can optimize their properties while dropping cost and time to manufacture. Below are some properties that can be localized by splitting parts into metal and composite segments.

Composites		Metals	
Strength-to-weight	Shock Absorption	Isotropic Strength	Wear Resistance
Toughness	Non-marring	Surface Hardness	High Temperature

COMPOSITES & METAL 3D PRINTING

A PRODUCTION ECOSYSTEM

APPLICATION

Line Interactions

Composite and metal 3D printed parts fill different roles on the factory floor and can work together to support production. Here, metal 3D printed end effectors hold threaded couplings during their manufacturing process.

Composite printed fixtures locate and align the couplings on the line. This is just one example of how two 3D printing technologies streamline manufacturing scale-up.

Developing a Modern Manufacturing Workflow

Considering how manufacturing technologies fill different roles on the production floor is critical to a streamlined and modern manufacturing ecosystem. Manufacturers have seen huge improvements to the competitiveness of their operations by leveraging additive manufacturing. By combining these two high-strength processes, you introduce efficient and affordable solutions to many manufacturing roadblocks.

Markforged offers the full ecosystem of industrial 3D printing, with materials ranging from continuous strand carbon fiber to 17-4 PH stainless steel. The Markforged Metal X paired with an Industrial Series composites printer, connected via powerful and simple printer management software, can cut production costs and increase efficiency for tooling and manufacturing. Expand your manufacturing capability with a connected fleet of industrial 3D printers.

INCREASE YOUR MANUFACTURING POTENTIAL

Request a demo to learn how the Markforged ecosystem can streamline your manufacturing workflow.

3d.markforged.com/request-a-demo.html