

# 3D Printing in Jewelry

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**Abstract:** Technology has changed the way beautiful jewelry is made. 3D printing, also known as additive manufacturing, involves building three-dimensional objects layer by layer from a digital model. It lets designers create incredibly detailed and unique pieces in a new way. Jewelry is one of the fields where 3D printing technologies have only started their expansion, becoming a bridge to conventional jewelry manufacturing. 3D printed jewelry has undoubtedly revolutionized the world of jewelry design and production. Its ability to offer unparalleled customization, unleash design freedom, and introduce sustainable practices has propelled it to the forefront of the industry. This paper discusses the impact of 3D printing on the jewelry industry, highlighting its influence on design and customization.

**Keywords:** 3D Printing (3DP), Additive Manufacturing (AM), 3D Printing in Jewelry

## I. INTRODUCTION

Traditionally, a printer is used at home or in the office to print out text and images on paper. This conventional printer prints in a flat two-dimensional (2D) space using the dimensions length and width. A three-dimensional (3D) printer uses length and width but also adds depth to the print. A 3D printer has more manufacturing capacity than a traditional manufacturing machine. It is regarded as a disruptive technology that will change manufacturing. It has been used for decades in the automotive and aerospace industries. The 3D printer is also used by hobbyists, small businesses, creatives, manufacturers, architects, and most importantly contractors to instantly create a variety of products.

Traditionally, handcrafting and lost-wax casting are the two techniques to make jewelry. Both techniques require significant technical expertise, long-time investment, are highly time-intensive, and mistakes in the process can prove expensive. Besides, there are always limitations to human possibilities. The traditional jewelry manufacturing is shown in Figure 1 [1]. It takes a lot of time, patience, and skill to make jewelry completely by hand. Artists throughout history have dreamt of the ability to create as fast as they could imagine. With today's technology, it is no longer a daydream.



Figure 1: The traditional jewelry manufacturing [1].

3D Printing has become a new way to produce jewelry. It enables jewelry production to develop fast prototype, reduce high budget investment, and design freely. The growing demand for 3D printed pieces of jewelry suggests that jewelry manufacturers have been replacing commonly used jewelry traditional manufacturing methods with 3D printing technologies. 3D printed jewelry production augments the principles of investment casting or lost wax casting with the advantages of a digital design and manufacturing process. The transformative impact of 3D printing technologies on the jewelry industry can be assessed from the consistent growth of the worldwide 3D printed jewelry market [2]. When we talk about 3D printing jewelry, most of the time we are referring to 3D printing of the wax model that is then used to make a mold, just like in traditional jewelry making.

## II. WHAT IS 3D PRINTING?

3D printing (also known as additive manufacturing (AM) or rapid prototyping (RP)) was invented in the early 1980s by Charles Hull, who is regarded as the father of 3D printing. Since then, it has been used in manufacturing, automotive, electronics, aviation, aerospace, aeronautics, engineering, architecture, pharmaceuticals, consumer products, education, entertainment, medicine, space missions, the military, chemical industry, maritime industry, printing industry, and jewelry industry [3].

A 3D printer works by “printing” objects. Instead of using ink, it uses more substantive materials—plastics, metal, rubber, and the like. It scans an object—or takes an existing scan of an object—and slices it into layers, which can then convert into a physical object. Layer by layer, the 3D printer can replicate images created in CAD programs. In other words, 3D printing instructs a computer to apply layer upon layer of a specific material (such as plastic or metal) until the final product is built. This is distinct from conventional manufacturing methods, which often rely on removal (by cutting, drilling, chopping, grinding, forging, etc.) instead of addition. Models can be multi-colored to highlight important features, such as tumors, cavities, and vascular tracks. 3DP technology can build a 3D object in almost any shape imaginable as defined in a computer-aided design (CAD) file. It is additive technology as distinct from traditional manufacturing techniques, which are subtractive processes in which material is removed by cutting or drilling [4].

3D printing has started breaking through into the mainstream in recent years, with some models becoming affordable enough for home use. Many industries and professions around the world now use 3D printing. It plays a key role in making companies more competitive. The gap between industry and graduating students can be bridged by including the same cutting-edge tools, such as 3D printing, professionals use every day into the curriculum. There are 3D printed homes, prosthetics, surgical devices, drones, hearing aids, and electric engine components. As shown in Figure 2, 3D printing

involves three steps [5]. A typical 3D printer creating a dress is shown in Figure 3 [6].

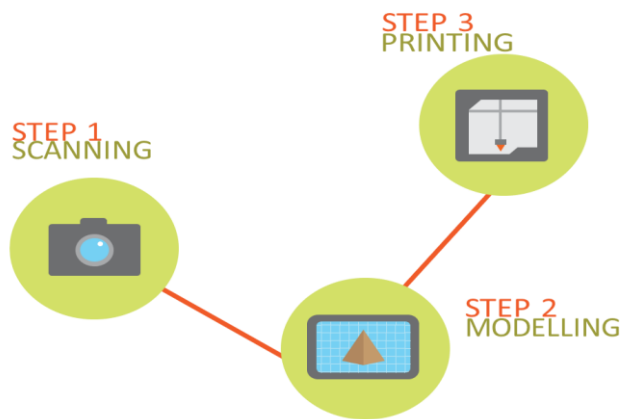


Figure 2: 3D printing involves three steps [5].

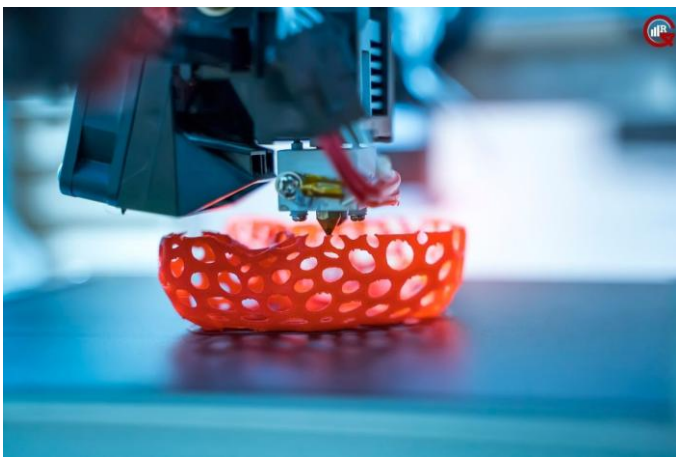


Figure 3: A typical 3D printer [7].

### III. 3D PRINTING IN JEWELRY

The jewelry manufacturers these days create jewelry designs digitally using computer-aided design (CAD). Some of them use 3D technologies at all the stages of production, starting with 3D scanning, and then employing 3D printing for prototyping. When selecting a jewelry 3D printer, the primary consideration is the technology it employs. One should consider resolution, printing speed, material compatibility, cost, and volume. These will ensure optimal results in their jewelry design and production processes [7].

3D printing jewelry manufacturers have been using various 3D printing technologies, fused depositing modeling (FDM), selective laser sintering (SLS), and digital light processing (DLP), to create prototypes. Unlike conventional jewelry manufacturing methods, 3D printing produces pieces of jewelry from digital 3D files. The designers and manufacturers can make changes to the 3D files without putting in extra time and effort. Some customers these days opt for independent jewelry designers to obtain personalized and unique pieces of jewelry.

3D printing revolutionizes the jewelry-making process in several unique ways, making it stand out from traditional methods. In the process of making jewelry or parts, models are a very important part. There are different models use for making jewelry [8]:

1. *3D printing wax model is used for lost wax casting:* With the help of 3D printing technology, complicated manual steps are saved and the wax model production speed is accelerated.

2. *3D printing directly produces jewelry or parts:* Since the application of 3D printing has gradually become popular, some novel jewelry products have begun to emerge in an endless stream. 3D printing equipment can be used to quickly produce enough models for evaluation, which not only saves time, but also reduces design defects.
3. *3D meets personalized customization:* 3D printing, with its high efficiency, can help companies quickly respond to customer customization needs. 3D assembly testing and functional testing can be implemented in order to achieve the goals of improving product functions, reducing production costs, better quality, and increasing market acceptance.

3D printing provides a wide range of materials for making jewelry. Each material has its unique properties and characteristics that need to be considered when selecting the appropriate material for a specific design. Each material has its unique properties and characteristics that need to be considered when selecting the appropriate material for a specific design. Some of the common types of materials used include [9]:

1. *Precious Metals:* Gold, silver, and platinum. Metal 3D Printing is relatively new, but they have become the most common materials for jewelry designers. For example, a gold-plated brass 3D print ring is shown in Figure 4 [10].
2. *Non-Precious Metals:* Brass and bronze.
3. *Resin:* Resin materials offer a range of colors and finishes. Resin 3D printed jewelry has a beautiful smooth surface finish, and enables smooth painting on it. Figure 5 shows some resin jewelry models [11].
4. *Ceramics:* Ceramic materials provide a unique look and feel.
5. *Composite Materials:* Composite materials combine elements to achieve specific properties.
6. *Specialty Metals:* Materials like titanium or stainless steel can also be used to create modern and durable jewelry pieces.



Figure 4: A gold plated brass 3D print ring [10].





Figure 5: Some resin jewelry models [11].

#### IV. APPLICATIONS

3D printed jewelry combines the precision and accuracy of technology with the creativity and artistic vision of designers. Technology provides designers with the tools and capabilities to create intricate and complex designs that were previously impossible to achieve. The use of 3D printing in jewelry has brought together innovation, accessibility, and traditional craftsmanship. Common applications include the following:

1. *Fashion and Accessories:* Some small accessories like 3D printed rings and earrings can also be printed with full details. Dedicated painting can make your 3D printed rings, brackets, and necklaces glow. Jewelry 3D Printing business is relatively new on the market; it can produce gorgeous 3D printed jewelry and accessories. Some these accessories are shown in Figure 6 [12].
2. *Handmade Rings:* Handmade rings are romantic, and beautiful. They are a symbol of enduring love. Typical ones are shown in Figure 7 [13].
3. *Ear Rings:* 3D printing can design collections of rings, bracelets, and matching necklaces, which would be impossible to achieve without 3D technologies. Figure 8 portrays filament 3D-printed earrings [14].
4. *Customized Jewelry:* Most of the sea of rings on show in street stores are carbon copies of each other. There has been a boom in the number of people wanting customized jewelry. With 3D printing, jewelry can be customized to match each person's style, including the size, shape, and placement of gemstones. 3D printing is enabling jewelers to improve customer experience in a variety of ways.



Figure 6: Some 3D-printed jewels [12].



Figure 7: Typical handmade rings [13].



Figure 8: Filament 3D-printed earrings [14].

#### V. BENEFITS

The biggest advantage for jewelry designers is that they no longer need to worry about production. Another big advantage is that 3D files can be easily edited. Other benefits of 3D printing in jewelry making include the following [9,11]:

1. *Customization:* 3D printing allows for a high level of customization, enabling designers to create complicated, unique designs that were previously difficult or impossible to achieve through traditional methods. With 3D printing, customers have a try-on option to make sure the model fits perfectly and completely meets all their needs, before the final part is made.
2. *Complex Geometries:* 3D printing technology eliminates the limitations of traditional machining methods, allowing jewelers to create highly complex and detailed designs. The technology can create far more complex and intricate geometries than what are feasible to carve by hand. The technology enables the creation of jewelry with highly complex geometries and intricate details that would be extremely challenging or even impossible to produce using traditional techniques.
3. *Fast Prototyping:* Making jewelry samples used to be slow and expensive. Now, 3D printing lets designers create quick and exact models. It streamlines the prototyping process, allowing designers to quickly iterate and test new designs. The rapid prototyping

capabilities shorten the design and production timeline. Using this technology, designers can create precise physical prototypes that provide customers with a realistic representation of the final jewelry piece.

4. *Rapid Repair*: When a customer damages a piece of jewelry, you can reproduce the mold to make the replacement piece with your 3D printer. Since you will generate the replacement piece with the same mold as the original, you do not have to worry about crafting and fitting a tiny piece of metal.
5. *Accessible Production*: With 3D printing, jewelry-making becomes more accessible to a broader range of designers and artisans. Customers can actively participate in the design process regarding 3D-printed jewelry and choose the materials they prefer.
6. *Creative Freedom*: 3D printing technology facilitates jewelry creation by design freedom and convenience. 3D printing gives jewelry designers more freedom to be creative. Unlike traditional methods with certain limitations, it allows designers to imagine and create more complex shapes and intricate details, easily bringing their ideas to reality. One can design the jewelry on a computer and make it real by 3D printing.
7. *Customer Satisfaction*: 3D printing in jewelry production contributes to customer satisfaction in many ways. It enables customers to actively participate in the design process, allowing them to provide specific design requirements and choose materials. Customization ensures that each piece is tailored to the customer's unique preferences, leading to higher customer satisfaction through personalized jewelry.
8. *Environmentally Friendliness*: Making jewelry can involve a lot of waste. Lots of leftover materials get thrown away. But 3D printing is like a special kind of printer that wastes less material. 3D printing can be more resource-efficient, as it allows for precise material usage, reducing waste. It makes jewelry in a way that is good for the environment.
9. *Affordability*: Previous generations of jewelry 3D printers required both significant maintenance and a skilled operator in addition to thousands of dollars of investment. 3D printing technology has expanded design possibilities and made jewelry-making more open to everyone. Small jewelers can afford 3D printers due to the decreasing costs and increasing accessibility of this technology. Batch-manufacturing in jewelry 3D printing allows reducing the production costs.
10. *High Quality*: Good FDM 3D printers can print high-resolution objects now. Other professional 3D Printing technologies, such as SLA, SLS, MJF and SLM, can bring you high-quality jewelry with high precision and high resolution, allowing you to build high-quality jewelry at low cost.
11. *Light Weight*: Wearing big earrings sometimes make the ears so painful. However, 3D Printing can reduce the weight of the jewelry to make those 3D printed jewelry comfortable to wear. It is a practical way of reducing the weight while not sacrificing the quality.
12. *Easy Mass Production*: 3D Printing enables easy mass production. It is no doubt that creating mold in injection mold is expensive and there is zero tolerance for any mistakes. 3D printed jewelry is more budget

friendly and guarantees fewer mistakes before mass production. From prototypes, samples to mass production, 3D Printing delivers a lot of possibilities to the jewelry market.

13. *Cost-Efficiency*: Jewelry-scale 3D printing uses very little printing material, cutting material costs. It enables the production of multiple jewelry patterns simultaneously, significantly reducing lead times and costs, compared to traditional methods.

## VI. CHALLENGES

In spite of the numerous benefits, 3D printing has some drawbacks. How to meet the needs of customers, improve efficiency, and quickly make styles that customers want is a new challenge faced by jewelry processing practitioners. Other challenges of 3D printing in jewelry manufacturing include the following [15]:

1. *Technical Limitations*: Currently, most 3D printers can only print with a single material at a time. However, researchers are working on developing printers that can print with multiple materials simultaneously. This would allow for more intricate and complex designs by combining different materials with varying properties.
2. *High Resolution*: One of the technical challenges in the printing process is achieving a high level of detail and resolution. Some designs may require intricate details that can be challenging to reproduce accurately with 3D printing.
3. *Smooth Surface*: Achieving a smooth surface finish can be difficult, especially with certain materials. This requires ongoing research and development to improve the quality and resolution of 3D printed jewelry.
4. *Quality Control*: As with any manufacturing process, there is always a risk of defects or errors. It is crucial to have robust quality control measures in place to ensure that each piece of jewelry meets the desired standards of quality and accuracy.
5. *High Cost*: Cost considerations are also important when it comes to 3D printing in jewelry manufacturing. While the cost of 3D printing has decreased over the years, it can still be more expensive compared to traditional manufacturing methods. Researchers are striving to make 3D printers more affordable by reducing the cost of the material and the specialized equipment required for the printing process.
6. *Expertise*: Despite the advancements in 3D printing technology, skilled craftsmanship still plays a vital role in the production of high-quality 3D printed jewelry. It is the skilled artisans who bring the final touches and polish to the jewelry. Skilled craftsmen can work hand in hand with designers to push the boundaries of what is possible with 3D printing.

Despite these challenges, the benefits of 3D printing technology far outweigh the drawbacks, making it a valuable tool for modern jewelers.

## CONCLUSION

3D printing enables anyone to produce unique quality jewelry, and it gives professional jewelers a new solution for jewelry production that is cheaper, easier, and faster. 3D printed jewelry, despite its potential, currently represents a relatively small fraction of the market. With increasingly easy to use and



accessible jewelry 3D printers, the digital workflows in the jewelry market are poised for growth. As the technology continues to evolve, we can expect improvements in speed, resolution, and material options. This will further enhance the design possibilities and quality of 3D printed jewelry. 3D printing in jewelry has a bright future.

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