Imagine That

Additive manufacturing technology offers new opportunities for creative jewelry design—but we're a long way from widespread implementation

By Tina Wojtkielo Snyder

Editor's Note: In the November 2012 MJSA Journal*, we provided an overview of additive manufacturing technology, as well as descriptions of the equipment and precioius metal powders available. In this article, we showcase jewelry being made with this technique and offer global insights about the potential for this technology to change the way we manufacture and design jewelry.*

If you have a hard time imagining that the jewelry pieces pictured on these pages were grown from gold powder, you're not alone. For someone who has been hand-fabricating chain or casting filigree engagement rings for much of his or her life, it must feel futuristic. But it's happening today: Through additive manufacturing technology, intricate and complicated designs can be built overnight, layer by layer, from precious metal powder.

While the technology has been used for more than a decade in the medical, dental, aerospace, and automotive industries to build parts in non-precious metals, its introduction into the jewelry industry has only just begun. "We're currently at the 'bleeding edge' for this technology in our industry," says Steven

Adler of A3DM Technologies in Portland, Oregon. “And what I mean by ‘bleeding’ is that there will be many bumps in the road, both financial and process-related, that need to be ironed out in order to profitably implement this technology for precious metal manufacturing.”

So how many “bumps” are there, and how long before they’re smoothed out and the technology becomes mainstream? Moreover, what will it ultimately mean for the way jewelry is made—will it replace existing techniques, or simply give jewelry makers and designers one more option? Read on…

The Limitations: Supply and Finish

Additive manufacturing is, in some respects, similar to rapid prototyping (RP). As in rapid prototyping, a net shape is produced layer by layer—only instead of a digital printer adding and curing layers of resin materials, as in RP, laser systems melt and add layers of metal powder. However, there are a few critical roadblocks to be worked out before we see this technology making major headway in the jewelry industry:

Powder supply. Currently, the biggest “kink” in applying this technology on a broad level is the availability of precious metal powders optimized for use with laser-melting machines. Today you can purchase 18k gold powder in a variety of colors, as well as sterling silver powder, from a handful of sources—Cookson Precious Metals in the United Kingdom, Hilderbrand & Cie in Switzerland, Legor Group in Italy, and Progold S.p.A. in Italy. The powder is manufactured using an atomization process, which results in the production of microscopic spheres of material in a range of specific sizes. Getting the right mix of sizes is key to improving the surface finishes required for jewelry. And the process of arriving at that magical mix is different for every alloy.

Most of the jewelry pieces featured on these pages were made in 18k yellow gold, the precious metal powder that to date has had the most extensive use in additive manufacturing applications, and on which most research and development has focused. However, companies continue to explore new alternatives. At the Legor Group, for instance, most R&D activities in powder production are currently focused “on optimizing the gas atomization process for 18k yellow and white gold, as well as sterling silver,” says Andrea Trentin, the

company's PLM Division manager. "In the future we are confident to produce 14k yellow gold, various alloys of 18k gold, palladium, and platinum powders." Cookson Precious Metals likewise reports that it is developing a process to manufacture platinum and palladium powders.

One person who is eagerly awaiting those new powders is Bob Romanoff, owner of Romanoff International Supply Corp. in Amityville, New York, which is the sole U.S. distributor for the Mlab laser-melting machine made by Concept Laser. One of the main factors preventing this technology from making inroads in the jewelry industry, he notes, is the lack of a range of precious metal powders. "We need to develop and perfect the higher end alloys so manufacturers who invest in the technology can make a better profit," he says. And platinum is at the top of the list.

According to powder metallurgist Joe Strauss, president of HJE Co. Inc. in Queensbury, New York, platinum is the "holy grail" of additive manufacturing technology. "If a good platinum powder were available right now, the technology would grow by an order of magnitude," he says. "Unfortunately, platinum is extremely challenging to atomize, and current atomization technologies are not suitable for processing platinum."

The fact is, investing in this equipment to make stainless steel jewelry, for which the margins are negligible, isn't the ideal application of this technology in the jewelry industry. Executing high-end, high-design pieces in gold, platinum, and palladium is where the true potential for profitability lies. Eventually, Strauss says, the technology will catch up, and that, along with further particle size classification, will lead to more alloy development.

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From top to bottom: Jewelry by Fratelli Bovo, Cookson Precious Metals, and Lionel Dean FutureFactories.

Imagine That

Page 2 of 2

Surface finish. As Romanoff notes, even the currently available precious metal powders don't offer superior surface finishes. "We can run a stainless steel powder on the Mlab, and the surface finish is very good—but we'd like to get that same surface finish on 18k," he says.

In addition, the cleanup required for pieces built using additive manufacturing technology is time consuming. "There are always supports that anchor your piece to the machine bed, and you have to plan for how those support structures, which will ultimately be removed, will affect your overall design and finishing," says Lionel Dean of FutureFactories in South Rauceby, England, who has had his designs built on the EOS M080 machine distributed by Cookson Precious Metals in Birmingham, England.

Enrico Peruffo, CEO of Fratelli Bovo in Trissino, Italy, has also found this to be an issue. "When the piece comes off the ReaLizer [the ReaLizer SLM, a laser-melting machine produced by ReaLizer GmbH in Borchen, Germany, and distributed by Progold S.p.A.], you have to spend a lot of time removing the support structures and finishing it," he says. "As the technology advances and the surface finishes improve, it will become more feasible for more manufacturers to work this way."

Jean-Daniel Schmid of EB-Futuretech AG in Baar, Switzerland, which has been manufacturing 18k yellow, pink, white, and red gold pieces on the Mlab system for the past two years, has had similar results. "There is surface roughness at the end of the manufacturing process, for which we have developed a manual and mechanical polishing process," he says. "But due to this roughness, very small details cannot be realized with the technology."

Dean also notes that the complex designs possible with additive manufacturing can make finishing even trickier. His Cuore heart-shaped pendant, for example, has a high-polished exterior but a slightly rough interior that's impossible to finish.

"But the contrast is really nice," Dean adds. This might have been a happy accident, but it exemplifies the point that designers who are used to having their pieces cast will now have to learn how to design for this new technology.

The Potential: Making the Impossible Real

Designers and manufacturers who have experimented with additive manufacturing technology see the potential for it to revolutionize the jewelry industry, in due time. Fratelli Bovo, for example, purchased its ReaLizer SLM system two years ago, and it currently uses additive manufacturing to produce 10 percent of its product line. (The other 90 percent is manufactured with traditional lost-wax casting and fabrication techniques.) Using 18k yellow, white, and rose gold powders from Progold, the company grows hollow, bead-like chains with intricate cutouts—designs that would be impossible to cast successfully.

"The flexible chain styles that we have produced on the ReaLizer could never be cast," says Peruffo. "The technology has made these designs possible, and we can manufacture them on-demand."

The important thing to remember about additive manufacturing is that it won't replace the lost-wax casting process any time soon. For simple wedding rings and bands, casting is still the more cost-effective manufacturing avenue. But when it comes to pieces that give casters nightmares, additive manufacturing is the solution.

"The biggest benefits of this technology are the rapid direct metal manufacture of jewelry designs from [CAD] files; the possibility to produce multiple different designs at the same time on the same platform; and the new design possibilities this technology affords," says Schmid.

While designing for laser melting will require some consideration of growing technicalities, it has the potential to be a very freeing creative experience. For example, designers needn't worry about the potential for no-fills in thick-to-thin designs, large pieces with open work, or complex hollow forms.

"You have to think so much about the technical aspects of casting and all its limitations, and that doesn't stimulate design," says Towe Norlen of Towe Jewels in Geneva, Switzerland, who has had her designs made on the EOS system from Cookson. "Additive manufacturing will enable us to create fantastic new forms that are more in the front line of fashion. These will be jewelry pieces we have never seen before. It's a very exciting time."

Implementation: Where Do We Go From Here?

Norlen gives the industry five years to warm up to additive manufacturing before she sees it truly taking off. "As more designers entering the industry learn how to use CAD, and laser melting becomes more familiar to the industry, the demand for the technology will grow," she predicts.

And what form will it take? Don't expect to see laser-melting machines popping up in shops across the country anytime in the near future. For many, the feasibility of owning a system will come down to finances. The average cost of a laser-melting machine suitable for jewelry production ranges anywhere between $160,000 and $300,000—and that's before you account for metal powder. Peruffo says it costs about $185,000 just to load up his ReaLizer machine with the 5 kg of 18k gold powder needed to run it. Not many companies will be able to cough up that kind of cash.

So what's the solution? Some believe service bureaus offering additive manufacturing options are the logical next step for the jewelry industry. "Equipment suppliers who are heavily invested in this technology and have the manufacturing capability to recycle the powder will probably have to start off acting as service bureaus to get additive manufacturing to the designer level," says Adler.

EB-Futuretech AG is an example of this type of business model. It actually is a joint-venture between four Swiss companies: Eichenberger Casting, GYR Edelmetalle AG, Hilderbrand & Cie, and La Manufacture CSC Sarl, all of which have jointly invested in the technology and reap its benefits.

"Not many companies can afford to invest in the equipment and metal powder necessary to operate it, as well as the knowledge needed to operate the machines and clean the parts," says Schmid. "We offer these services to the jewelry industry and include in our prices design analysis, support generation, printing costs, and cleaning and pre-polishing parts."

This type of approach is the most likely business model for getting additive manufacturing technology off the ground in the jewelry industry—and it's not an unfamiliar one.

"Look at what happened with rapid prototyping," says Adler. "Twenty years ago, the machines cost $75,000 and you had to send files to a service bureau to print your models. Today, you can buy an RP system for under $10,000."

If additive manufacturing follows in CAD/CAM's footsteps, in 20 years' time you could be growing a platinum mesh bracelet on your benchtop.

Imagine that.

From top to bottom: Jewelry by Towe Norlen Towe Jewels, Fratelli Bovo, La Manufacture for Concept Laser.

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