# 3D printing: Improved structure and property control

## This new approach to 3D printing may help create new materials that are more effective and efficient.

**THE NEED FOR IMPROVING MANUFACTURING EFFICIENCY** is leading researchers to identify and improve existing technologies for manufacturing metal parts. While metalworking fluids applied by the flood technique are used in most machining applications, efforts are continuing to work with other delivery methods including minimum quantity lubrication and cryogenics.

In a previous TLT article, a process called photochemical machining (PCM) was discussed.[1] This technique uses ultraviolet light to form a specific image on a piece of metal while protecting the rest of the metal surface with a photo-resistant coating. PCM works well to produce intricate metal parts without affecting the properties of the substrate. The problem is that the process can take a few days from drawing up the part to doing the actual machining.

> *'We believe the control of metal properties we have demonstrated will change the way that components are manufactured in the future.'*
>
> *– Dr. Ryan Dehoff*

**KEY CONCEPTS**

- 3D printing fabricates a metal part by adding two-dimensional layers of powdered metal sequentially to a specific substrate.
- A new ARCAM electron beam melting system better controls the microstructure and properties of Iconel 718 parts produced by 3D printing.
- This approach enables the crystallographic texture of the metal part to be designed to meet the desired performance characteristics needed for a specific application.

Another machining technique that has been under development since the late 1980s—but is gaining in popularity—is three-dimensional (3D) printing, also known as additive manufacturing. Dr. Ryan Dehoff, staff scientist and metal additive manufacturing lead in the department of energy's manufacturing demonstration facility at Oak Ridge National Laboratory in Oak Ridge, Tenn., says, "Three-dimensional printing involves producing a physical component from a computer-aided design file by applying sequentially two-dimensional layers of powdered metal to a specific substrate using a powder feeding system."

Initially 3D printing had been used mostly for developing prototypes of metal parts manufactured by other techniques. Dehoff believes that 3D printing is poised to become a more viable commercial manufacturing technique. He says, "A key industry need is to find a way to better control the material properties of the part being fabricated. The quality of metal parts also needs to be improved as there is a continuing need for better surface finish to minimize post-processing."

Dehoff indicates that applications such as aerospace, biomedical and robotics demand unlimited design flexibility. He says, "This is needed in order to lower production costs, tailor mesh structures for maximizing bone growth in the case of biomedical uses and enable robots to be lightweight with improved function."

If a method can be developed that enables 3D printing to better control the structure and properties of metal components with great precision, then this might be able to promote the use of 3D printing commercially. Such a method has now been developed.