Heat sink (passive heat exchanger) model 3D printed on the J55, with microelements represented by different colors.

Expanding Possibilities with J55

Technion Explores Applications of 3D Printed Heterogeneous Microstructures

“The fact that we have design and analysis that is volumetric, and the fact that we can 3D print volumetric parts, is a huge benefit. I believe this is the future.”

Gershon Elber
Technion – Israel Institute of Technology

stratasys

Case Study

A microstructure is the small-scale porous structure of any material, which can typically be viewed only through magnification. The microstructure of a material, whether metal, polymer, or ceramic, can determine physical properties like weight distribution, flexibility, and strength. Microstructure optimization can occur naturally; human bones, for example, are made up of complex structures that make them both strong and lightweight. Analysis is used in a variety of industries and applications to help enhance important physical properties. This often involves simply changing the processing method for a specific material. With additive manufacturing, more researchers are discovering the potential benefits of generating custom microstructures to suit various needs.

At Technion, the Israel Institute of Technology, researchers discovered several ways that additive manufacturing could help simplify and improve their exploration of microstructure design. Gershon Elber, a geometric design scholar and computer science professor at Technion, had been interested in additive manufacturing for years.

“About ten years ago, we realized that the world is changing. The way we manufacture used to be subtractive, with a cutter removing material to achieve the desired shape,” Elber explained. “Now, for the first time, material can be heterogenous, making microstructure-based design easier.”

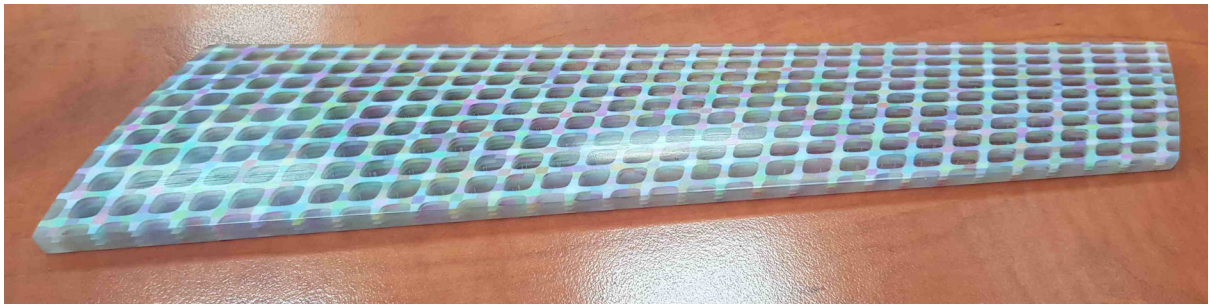
He had 3D printed microstructures in the past, but the design flow wasn’t convenient or time efficient. Until recently, a high-quality, multimaterial 3D printer with voxel level control wasn’t within the computer science department’s reach and budget. Options for representing microstructures were mostly limited to digital renders, which are useful but not always intuitive – especially for students.

That all changed when the Stratasys J55™ became available. It makes PolyJet Technology™ affordable and education-friendly, and it was perfect for researchers at Technion. Elber immediately saw the potential uses for the printer, and accompanying software like GrabCAD Voxel Print™.

3D printed “chalice” model with colored microelements sliced by Voxel Print, and enclosed in translucent VeroClear™ material.

“When we bought this printer, we looked at quite a few other companies,” he said. No one is even close to delivering what Stratasys offers – the PolyJet Technology is extremely unique.”

The multicolor, multimaterial capabilities of the J55 meant researchers could design and print microstructural models that would be impossible to create with traditional methods. Voxel Print allowed researchers to “map out” microelements with continuous color changes, and then apply these elements volumetrically to their models.



Aircraft wing utilizing a volumetric spline composition, 3D printed on J55.

Microstructures in the Real World

Some of the most important academic research lays the groundwork for practical applications. Researchers at Technion explored several areas that could benefit from 3D printed microstructures.

One possible application is heat exchangers, which are components used for heating and cooling functions within systems like radiators and air conditioners. Depending on the specific function, a heat exchanger might require a design that conducts heat well, or one that prevents heat transfer. Traditional heat exchangers are typically pre-manufactured cylindrical or rectilinear shapes, which designers are forced to work around. With PolyJet Technology, it's possible to design customized heat exchangers to fit the application or design.

Researchers also explored applications of 3D printed microstructures for aerospace. Aircraft wings must be strong and robust, but lightweight enough to allow for lift. Traditional aircraft wing internal structures are comprised of spars and ribs to keep the structure light and durable. However, this design means that a significant amount of skin carries part of the load, which can allow buckling – this requires more supports. 3D printing allows for porous internal wing designs that minimize stress on the skin and optimize weight.

"Analysis has always been volumetric, and our volumetric modeling tools allow us to tailor microstructures to serve specific purposes," Gershon said. "The fact that we have design and analysis that is volumetric, and the fact that we can now 3D print heterogeneous volumetric parts, is a huge benefit. I believe this is the future."

Looking Forward

Although much of their exploration is preliminary, researchers at Technion are confident that 3D printed microstructures will change the way parts are designed and manufactured in a variety of industries. According to Elber, the idea is still new but has enormous potential.

"Never before have we had this situation, where the manufacturing technology was ahead of our design and analysis," he explained. "We can 3D print objects that we can't design with commercial CAD systems. We can't wait to see where this brings our research next."

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