



## A New 3D Printing Approach for Semiconductor Packaging

Researchers at UT Austin test new 3D printing approach for semiconductor chip packaging.

The 3D printing market has moved well past its early role as a prototyping mechanism and into broader industry and commercial use. The proof is in the numbers: according to [Markets and Markets](#), the 3D printing market is on track to reach nearly \$36 billion by 2030, compared to \$16.2 billion in 2025. The key growth drivers include advancements in additive manufacturing technologies and growing demand for customized products.

Universities have long played a role in identifying and addressing real-world manufacturing challenges, and the 3D printing field is no exception to the rule. At The University of Texas (UT) at Austin, researchers are developing a new 3D printing approach for semiconductor packaging that uses light-based patterning to create complex electronic structures in a single step. Backed by a \$14.5 million Defense Advanced Research Projects Agency grant, the work offers a glimpse into how 3D printing could begin to influence how chips are designed, packaged and produced.

### Introducing Metasurface Nano-Lithography

Electronics manufacturing today is a complex, time-consuming process that involves layering materials one step at a time. This approach not only limits design flexibility but also generates significant material waste. According to [UT News](#), the university's engineers are working with a team of academic and industry researchers that want to revolutionize the production of semiconductor chips with a new 3D printing method.

The new approach is called Holographic Metasurface Nano-Lithography (HMNL), and it aims for faster, more efficient and environmentally friendly production of advanced electronics.

The university says HMNL has applications ranging from smartphones to robotics to aerospace. "It can create designs that were previously impossible, such as 3D printed capacitors, which store energy in electronic devices, or electronic pack-

ages that fit into unconventional spaces," it says. For example, it would make it possible to embed artificial intelligence in customized configurations to fit the specifications of robots or rockets.

"Our goal is to fundamentally change how electronics are packaged and manufactured," said team leader and associate professor Michael Cullinan. "With HMNL, we can create complex, multi-material structures in a single step, reducing production time from months to days."

The key to this technical leap lies in metasurfaces, or ultra-thin optical masks capable of encoding high-density information. "When exposed to light, these metasurfaces create holograms that enable the simultaneous patterning of a hybrid resin made of metal and polymer into intricate 3D structures," UT News explains. "The process is so precise that it can achieve resolutions smaller than the width of a human hair."

### The Four Prototypes

By eliminating multiple production steps and reducing material waste, HMNL minimizes the environmental footprint of industrial activities. UT News says the increased speed will make it easier to develop unique prototypes. Here are the four prototypes that were created as part of the HMNL project:

- **Commercial electronics.** A fan-out module for consumer devices, showcasing faster production and improved design flexibility.
- **Defense systems.** Advanced prototypes for high-frequency communication and reconfigurable electronics.
- **Nonplanar designs.** Electronics packages that fit into challenging spaces.
- **Active packages.** Structures that serve mechanical and electrical functions, such as precise beam-pointing systems for optical applications.

"This isn't just about making electronics faster or cheaper," Cullinan says. "It's about unlocking new possibilities."

To fund the project, researchers are using a \$14.5 million grant obtained from the Defense Advanced Research Projects Agency (DARPA). The research team includes partners from the University of Utah, Applied Materials, Bright Silicon Technologies, Electroninks, Northrop Grumman, NXP Semiconductors and Texas Microsintering.