Additively Manufactured Pure Copper Revolutionizes Thermal Management

Electric vehicles need more than twice the number of chips that conventional vehicles require. As production of electric vehicles continues to ramp up, the increasing demand for chips presents a significant engineering problem for thermal engineers. They need to design compact high-efficiency thermal management systems that can cool complex power electronics and batteries. Pure copper components are key to this challenge, as they are integral to a myriad of applications ranging from intricate electronic devices to next-generation heat exchangers.

Recognizing this thermal management challenge, 3DEO, a start-up based in Torrance, CA, supported by the U.S. National Science Foundation (NSF), has pioneered a novel additive manufacturing technology to offer a pathway to produce more efficient and compact copper parts to vastly improve heat transfer.

3DEO has developed a novel sinter-based metal additive manufacturing process called Intelligent Layering that combines additive layer-by-layer building with subtractive manufacturing. The process starts with spreading a thin layer of powder over the build platform. Next, spray technology is used to delicately deposit a liquid binding agent onto the entire layer where the electronic parts are located or arranged. Once the layer is bound and cured, an array of precision computer numerical control (CNC) micro-endmills is used to cut the perimeters and internal geometries of parts in that bound layer. The next powder layer is spread, and the subsequent binder application not only binds that layer together, but also laminates it to any previous layers deposited. From then on, these steps are repeated on a layer-by-layer basis until the green part (*i.e.,* the unfinished, intermediate output from the printer) is completely built. After the printing process is complete, the part goes through a thermal debinding and sintering step. Figure 1 shows a schematic of the Intelligent Layering process.

"The support from NSF has been instrumental in our journey to push the boundaries of additive manufacturing," explains Matt Petros, CEO and Co-founder of 3DEO. "With NSF's backing, we've honed Intelligent Layering technology to not only match but also enhance traditional manufacturing capabilities in the production of pure copper components. This advancement represents a significant leap forward for the industry, particularly in sectors where thermal and electrical efficiency are critical."

The successful manufacturing of pure copper parts demonstrates remarkable progress in additive manufacturing. The technical ingenuity of this approach lies in its meticulous control over microstructure. In contrast to laser-based additive manufacturing methods, which can produce parts with anisotropic microstructures, Intelligent Layering ensures isotropy (homogeneity) and integrity. This is particularly crucial for copper's performance in high-stakes applications within the semiconductor space where consistent quality cannot be compromised.

The Intelligent Layering process is already being put to good use in the semiconductor space. "Our partnership with 3DEO marks a leap forward in manufacturing, enabling the creation of differentiated copper heat sinks and complex assemblies previously unachievable," says a leading supplier of semiconductors, and one of 3DEO's top copper customers. "This collaboration is driving the widespread adoption of these innovations, distinguishing our offerings from traditional options with a clear, superior value."

Currently, 3DEO's technology has reached a pivotal point where it demonstrates a clear pathway to commercialization and advancing the state of additive manufacturing by providing a sustainable and high-value alternative to traditional copper manufacturing. With the company at the helm of commercializing this NSF-funded innovation, the horizon is brighter for an industrial leap toward more efficient, reliable, and intricately designed copper components, reinforcing the notion that the future of manufacturing is being rewritten, one layer at a time. CEP

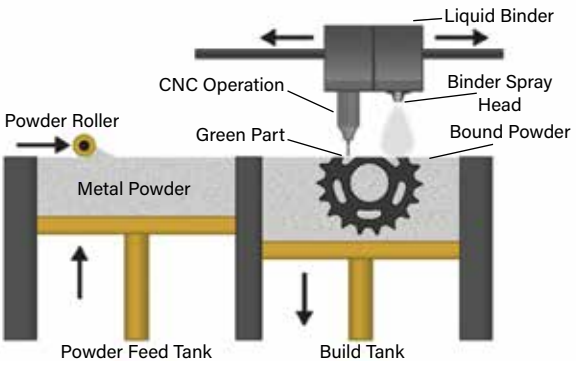

Figure 1. The 3DEO printing process combines additive layer-by-layer building with subtractive manufacturing. Spray technology and computer numerical control (CNC) micro-endmills provide meticulous control in the additively manufactured pure copper components.

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