Sandia National Laboratories

Integrating Blue Laser Manufacturing into LENS for Greater Material Flexibility

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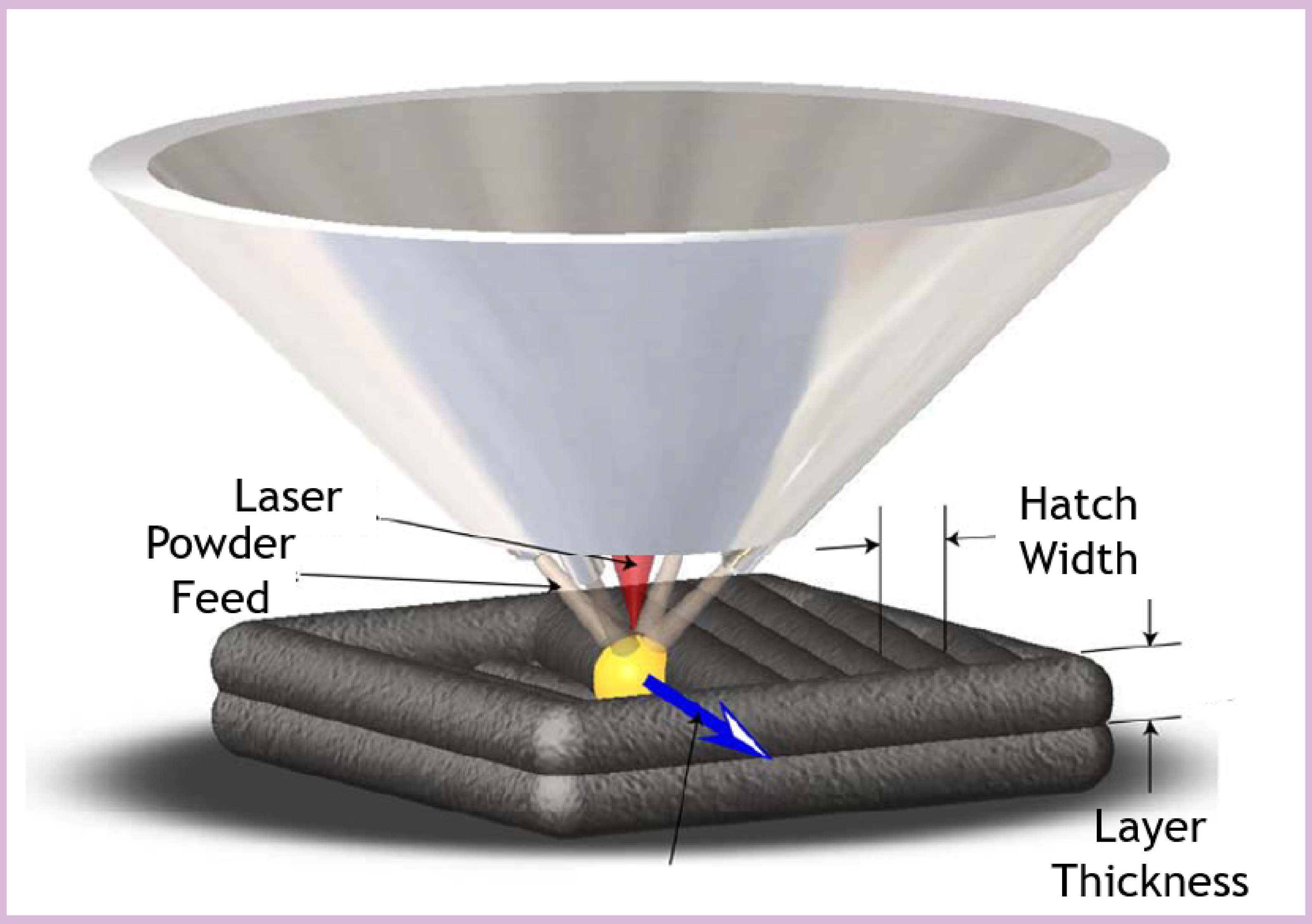
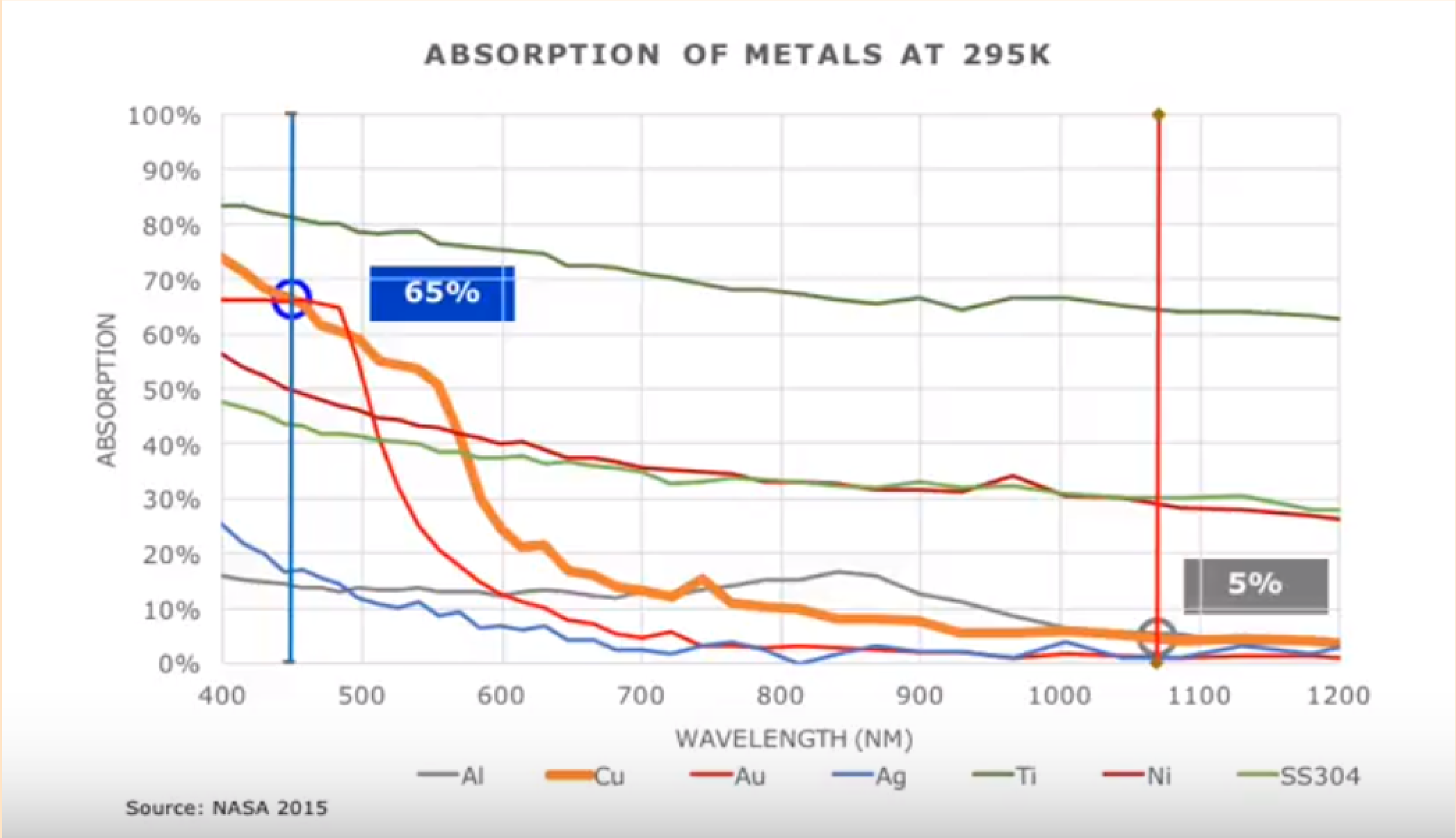
Abstract:

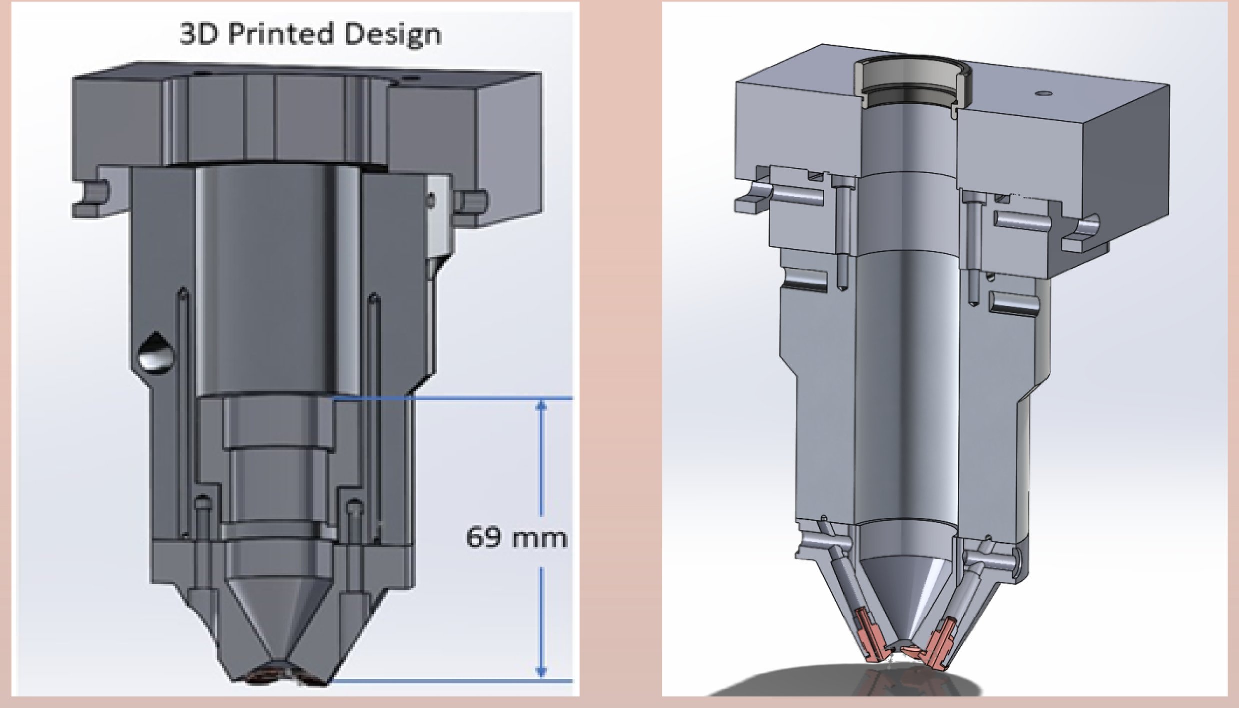
Traditionally, laser based additive manufacturing is done with 1064nm IR laser systems. These laser systems work well for many iron, titanium, and nickel based alloys but it can be difficult to print metals that are more reflective at that wavelength such as copper, gold, silver, and even aluminum. Because the more reflective metals are very thermally and electrically conductive, there is motivation to be able to print them in a fully dense state for various aerospace and defense applications. Modifications were made to the LENS (Laser Engineered Net Shaping) system at Sandia National Laboratories that allowed for an expanded suit of materials to be printed.



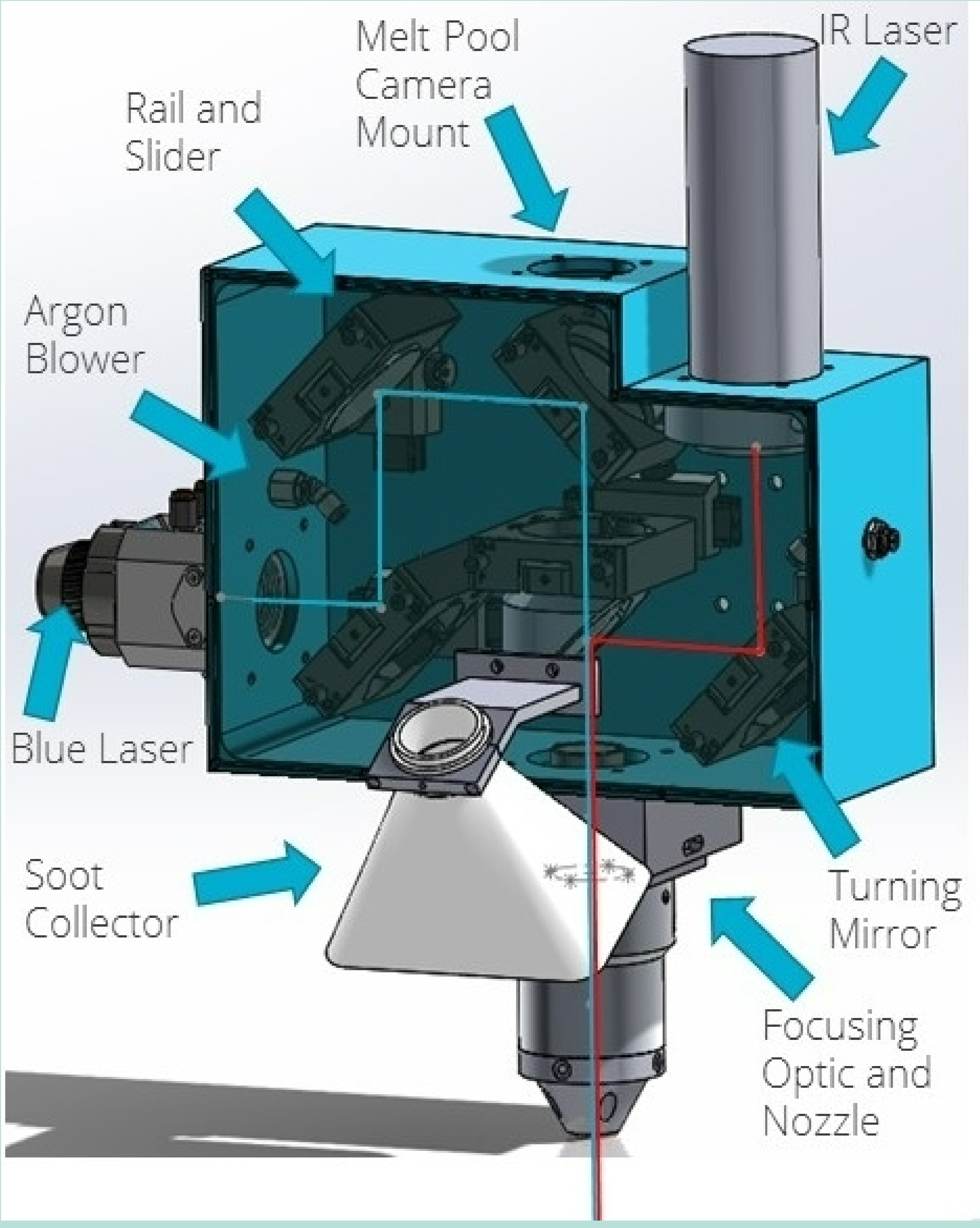
LENS (Laser Engineered Net Shaping) utilizes a laser to create a melt pool and four powder nozzles to flow powdered metal into the melt pool. Multiple powder feeders are to flow powder to the nozzle, and each powder feeder can be loaded with a different material. This characteristic of the LENS printer makes it one of the best 3D printers for creating multi-material samples.



As shown, Cu has a 65% absorptivity with 450nm compared to 5% at 1064nm. Al is also higher with 15% at 450nm compared to 5% at 1064nm. More absorption allows for us to maintain the melt pool lessening the side effects of reflectivity and porosity.



Left: New optics nozzle redesign showing flexibility for shorter focal lengths (less than 3”). Right: Old design had a minimum 6” focal length. This change was made because the beam quality improves with a shorter focal length.



With the introduction of a 450nm laser into the redesigned optics box, we are now capable of having more adjustability with having 3 turning mirrors while also maintaining the 1064nm IR laser in the same box with 2 turning mirrors. This is important because it gives the user flexibility and allows for the usage of both lasers without re-adjustment or re-alignment.

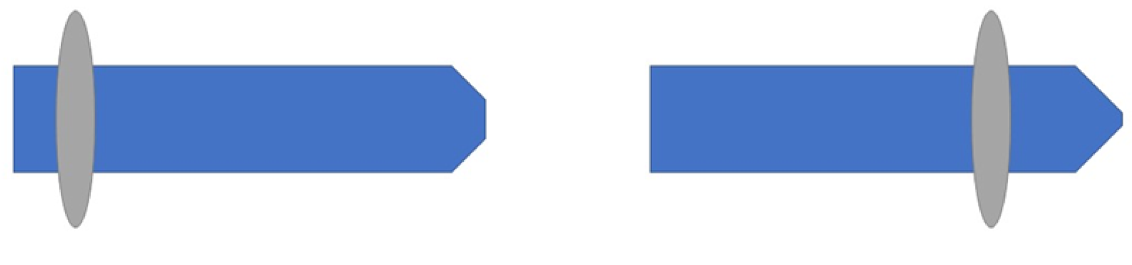
Improving the optical delivery system of the Blue Laser LENS tool

Issues with existing system:

The highly aberrated output beam from the Nuburu laser produces a spot that is so large that lateral resolution of prints is limited and the total thermal load narrows our process window for selectively melting the desired layer of material

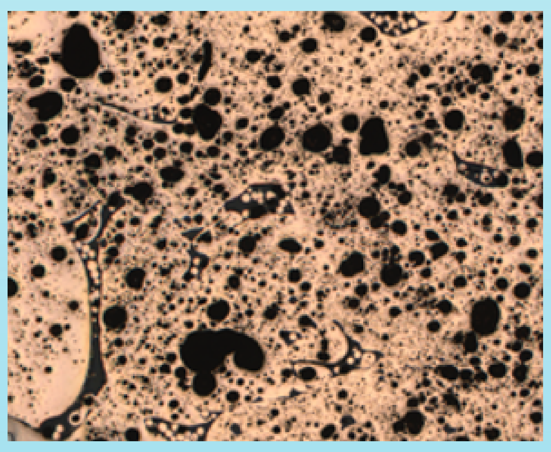
Solution:

While the upstream output quality is fixed, a much tighter focus can be achieved by using a shorter focal length lens. This will require redesigning the print head to accommodate a the optics

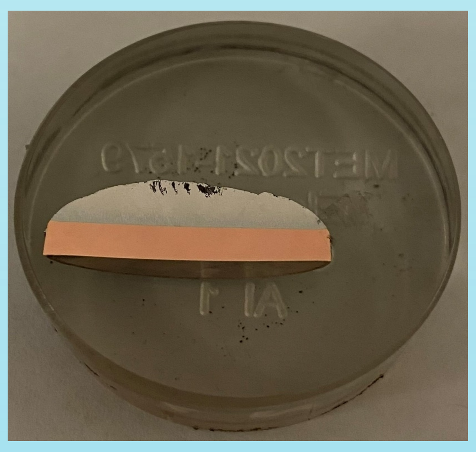


Conclusions

The new optics box and nozzle design allowed for printing copper and aluminum that was near fully dense. This was enabled by the increased laser absorption at 450nm vs 1064nm. The shorter focal length enabled by the new nozzle design also increased the quality of the laser beam, allowing for a better transfer of energy from the laser beam to the printed material. Both of these upgrades were critical in the design of the LENS printer to allow for printing of these highly reflective materials.



Copper before blue laser ~50% dense



Copper and aluminum after blue laser 99% dense

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