
TITLE: High-Throughput Binder Jetting of Copper Heat Exchangers

RELATED ROAD-MAPPING DESIGNATION ID#: AM73.

SUPPORTIVE INDUSTRY:

PROJECT TYPE: General Project

PROBLEM STATEMENT (What Are We Trying to Solve?):

Binder jetting (BJT) of copper (Cu) alloys has emerged as a promising manufacturing route for advanced heat exchangers tailored to the thermal management needs of modern data centers. Copper's exceptional thermal conductivity makes it ideal for high-performance cooling, yet its high reflectivity and thermal diffusivity pose challenges for laser-based additive processes such as L-PBF or DED. Binder jetting overcomes these limitations by forming parts without melting. Instead using selective binder deposition followed by sintering. This approach not only eliminates optical absorption issues but also offers shorter printing times, lower equipment costs, and higher throughput, enabling both rapid prototyping and cost-effective series production. Compared to conventional machining or brazed assemblies, monolithic BJT components eliminate joint failures and reduce thermal resistance, leading to improved system reliability and efficiency. OMIC recognizes that such a solution provided for heat exchangers, would resonate with numerous industry partners.

PROJECT DESCRIPTION: This project carries with it a very specific focus as outlined below:

- This project aims to design and fabricate complex copper heat exchanger geometries—such as triply periodic minimal surfaces (TPMS), lattice networks, and integrated manifolds—that maximize heat transfer efficiency while minimizing flow resistance.
- The research should demonstrate the success of binder jet-printed copper heat exchangers depend on precise control of powder, binder, and sintering parameters. It is recognized that high-purity, spherical Cu powders ensure excellent layer uniformity and green density, while controlled debinding and hydrogen sintering enable near-wrought densities required for leak-tight performance.
- The research should demonstrate optimized process control to mitigate distortion and porosity, and post-processing techniques—such as hot isostatic pressing (HIP)—further improve dimensional accuracy and flow uniformity.

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- The research should explore the full process chain, from powder characterization and process parameter optimization to the evaluation of thermal performance and mechanical reliability of printed Cu heat exchangers.
 - The design freedom of BJT enables compact ,high-effectiveness heat exchangers tailored for various cooling media, including water, glycol mixtures, or dielectric fluids, while batch sintering allows efficient parallel manufacturing.

Identify Related OMIC R&D Resources: Proposing researchers should use their best judgment in deciding on the optimal resources for the research. To further aid in this decision, the OMIC staff has taken the initiative to best identify on-site resources (machines, equipment, and staff) that may relate to the scope of this research. Please recognize that researchers are not limited to these resources.

- o Machines and equipment at OMIC can be reviewed at:
<http://omic.us/applied-research/additive/>
<http://omic.us/applied-research/subtractive/>
<http://omic.us/applied-research/materials/>
<http://omic.us/applied-research/robotics/>
<http://omic.us/applied-research/inspection/>
- o OMIC Staff or SMEs
<http://omic.us/applied-research/>

PROJECT DELIVERABLES:

- Final report
- Final presentation
- Final machined parts

SPECIAL NOTE: It should be recognized that this Conceptual Abstract is written based on comments collected during OMIC R&D Road-mapping workshop and based on industries need for applied research. However, researchers as SMEs, are encouraged to lend specific technical feedback to further refine the Project Description and/or Project Outcomes. The proposing researcher may do so either directly to OMIC R&D, or in the submitting proposal.

OMIC R&D TECHNOLOGY BOARD CONCEPTUAL ABSTRACT



UTILIZATION OF OMIC RESOURCES: Researchers are encouraged to utilize the capital and personnel resources available on the OMIC R&D campus in their proposals. Use of OMIC time and machines should be included in the Proposal funding request. If use of OMIC resources are not identified in a proposal and are requested during the project, sponsor will be responsible for requesting a costed project amendment from the Tech Board.

PROJECT UPDATE EXPECTATIONS: Researchers are required to have monthly update discussion with OMIC R&D to provide a summary update on project status. This is done by way of a user-friendly format known as the OMIC 6-Block update. Depending on the scope of the project, OMIC R&D's industry Tech Board representatives are often interested in periodic project updates, and even in project participation. Researchers are required to communicate with supportive industry and facilitate communications as required.

ADDITIONAL COMMITMENTS TO FACTOR: Researchers may be asked to present their final project at an OMIC R&D biennial Technology Exchange Symposium. This symposium is an in-person event, held at the OMIC R&D campus in Scappoose Oregon. The Symposium is held in the spring, and researchers should factor in their availability when bidding on projects.

Researchers may be invited to participate in OMIC R&D's marketing efforts that showcase the working history of the project.

PROJECT DURATION: It's OMIC R&D's strong preference that duration of a General Project aligns with the academic calendar cycle (July 2026 to June 2027). It is preferred that the project be completed by June 2027. Researchers are encouraged to factor in variables such as contracting, student hiring (if needed), procurement, holidays, and travel. It has been OMIC R&D's experience that a project's useful working duration is typically 9 to 10 months. Researchers are also encouraged to give feedback, and to adjust the scope of work to best fit this preferred timeframe. Additionally, it is reasonable to even recommend phasing breakdowns to the project. In some unique circumstances, if the project is to take significantly longer than the duration of the academic year, this reasoning should be explicitly explained in the proposal.

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OMIC R&D TECHNOLOGY BOARD
CONCEPTUAL ABSTRACT



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