MECHANICAL BEHAVIOUR AND MICROSTRUCTURAL ANALYSIS OF COPPER FABRICATED BY THE ADAM PROCESS

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INTRODUCTION

- Copper is widely used in industry because of its high electrical and thermal conductivity.
- Traditional copper manufacturing produces dense parts but restricts complex internal geometries.
- ADAM (Atomic Diffusion Additive Manufacturing), used on the Markforged Metal X platform, offers a low-cost, powder-free route to printing pure copper with near-net-shape capability.

RESEARCH GAP

- Limited work exists on printed copper, especially regarding its mechanical properties, pore morphology, and microstructural integrity.
- Existing datasets come mostly from manufacturer datasheets rather than independent studies.
- Understanding microstructure and porosity is essential for assessing suitability for high-performance electrical, thermal, and structural applications.

AIM

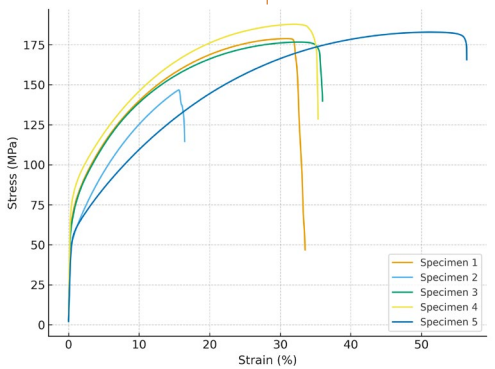
- To evaluate the mechanical behaviour and microstructural characteristics of copper produced using the ADAM process.

METHODS

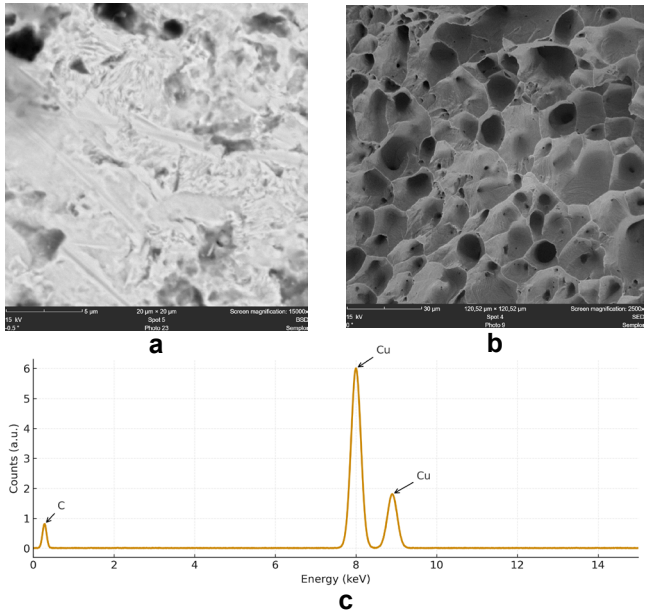
1. **Print – Debinding - Sintering**
   - Metal-polymer filament extrusion
   - Solvent wash removes core polymer
   - Furnace densification
2. **Mechanical Testing**
   - n = 5 tensile specimens
   - Tested according to ASTM E8.
   - Print orientation: Solid-XY focusing on primary load-bearing direction in ADAM.
3. **Microstructural Analysis**
   - SEM imaging and EDS mapping.

MECHANICAL PROPERTIES

Property	ADAM Copper
UTS	193 Mpa
YS	26 Mpa
Elongation	35-45%
Rel. Density	96-98%



MICROSTRUCTURE



a. SEM surface microstructure showing fused copper particles and small isolated pores.

b. Cross-section SEM image showing larger internal pores typical of ADAM-sintered copper.

c. EDS confirming Cu with small C/O peaks

CONCLUSION

- ADAM copper achieves near-MIM densities but exhibits anisotropic pore structures, consistent with filament-based ME processes.
- Mechanical strength is primarily limited by sinter-neck development and any residual carbon.
- ADAM is a viable route for complex copper geometries, especially those requiring internal channels or conformal cooling.