



# Additive Manufacture of Multi-Functional, Large-Scale Components

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*Changing the World's Energy Future*

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# Title: Additive Manufacture of Multi-functional, Large-scale Components



PRESENTER:  
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**BACKGROUND:** Extreme environments place more demands on materials. Functionally-grade materials (FGM) can address local operating conditions at reduced cost. However, a cost-effective fabrication method is needed for FGMs.

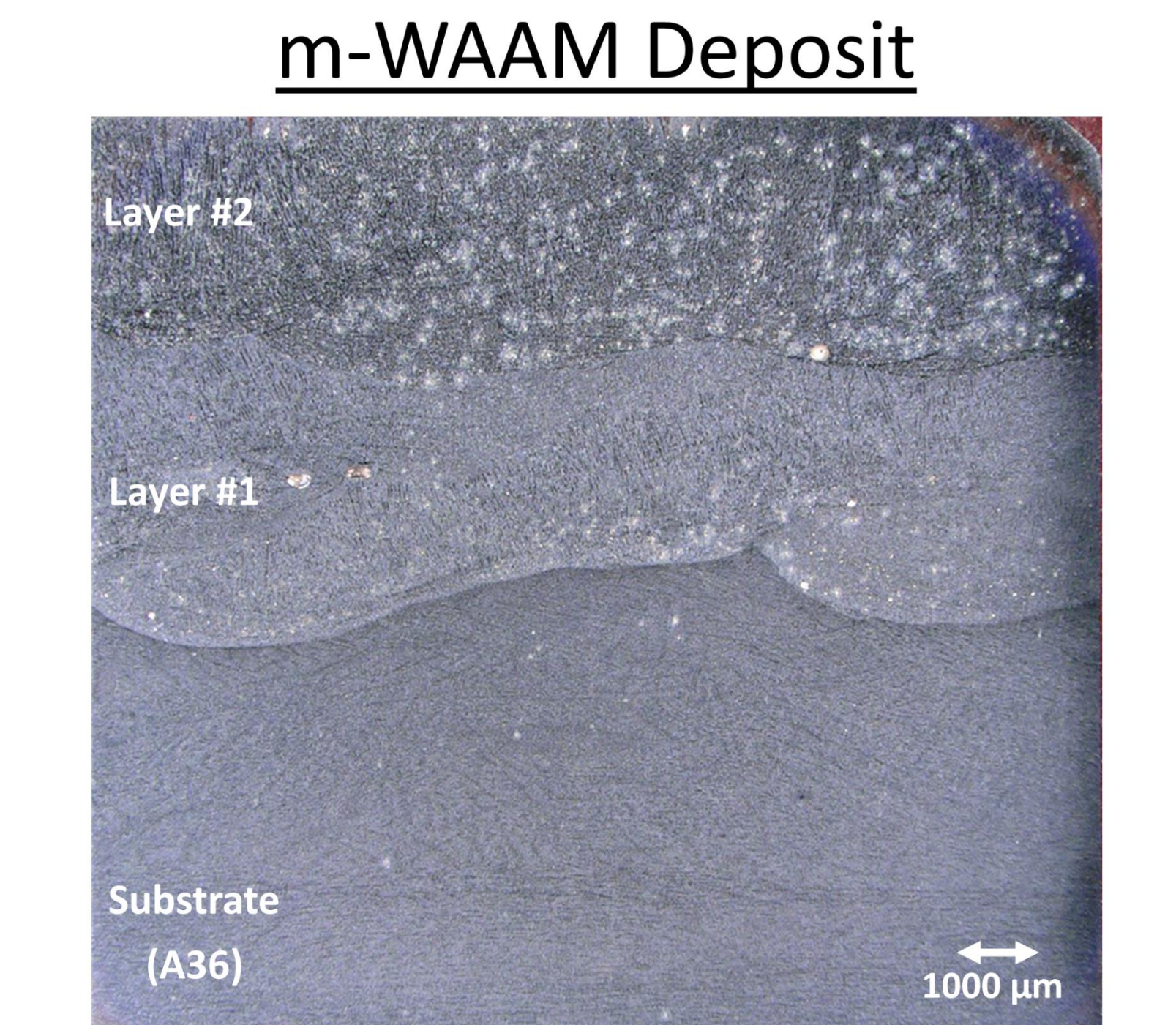
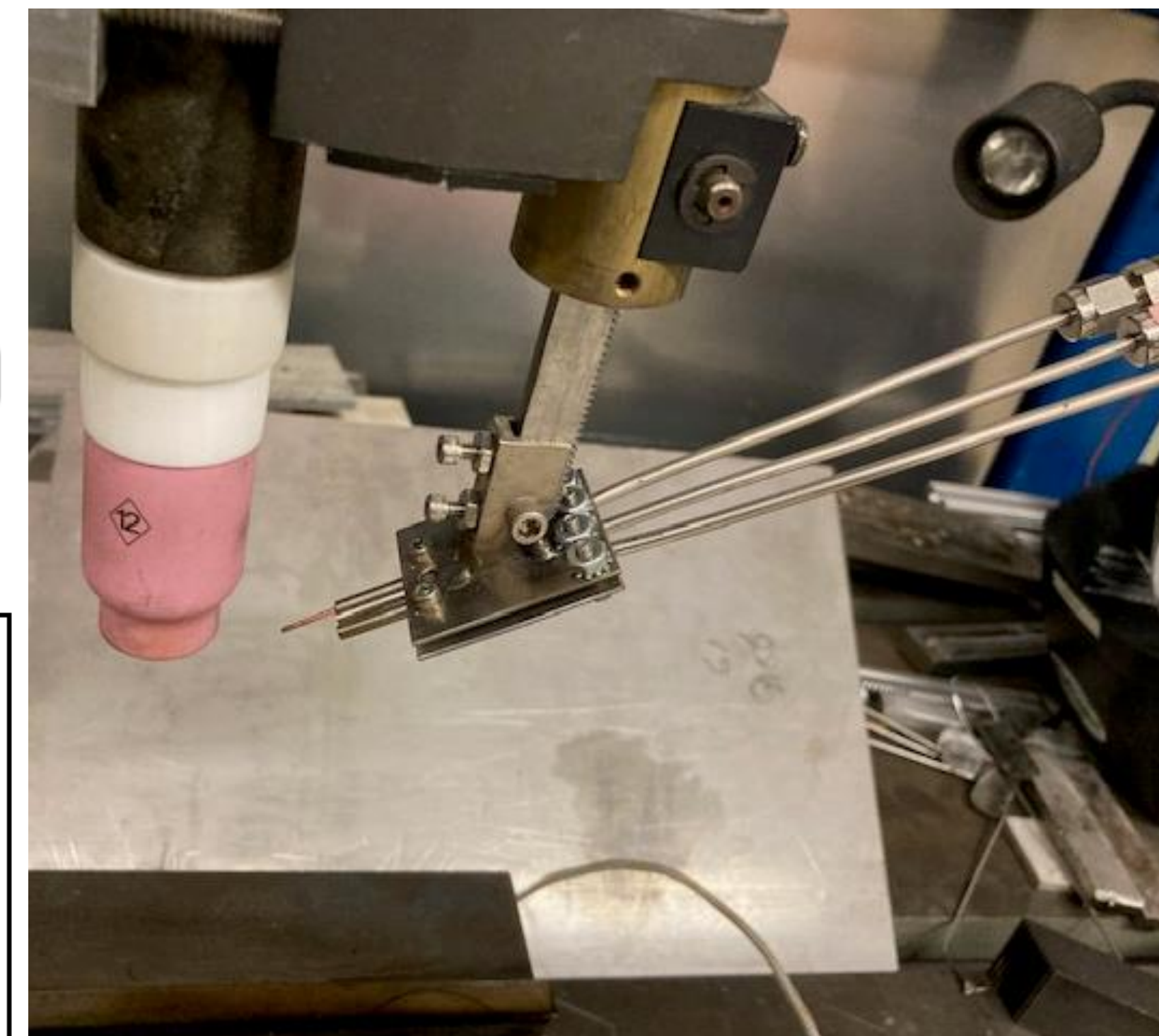
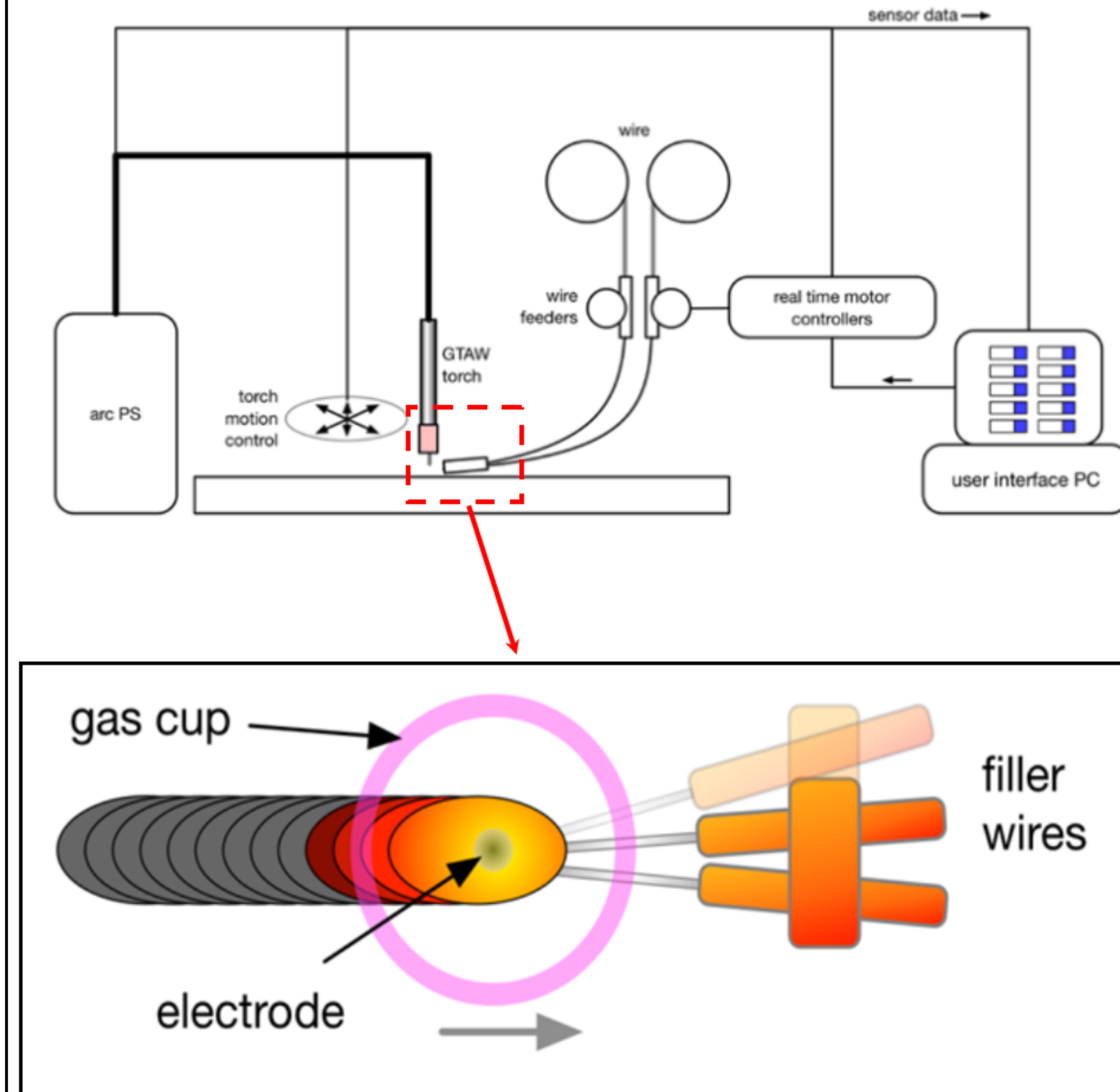
## METHODS

1. Modified standard welding system to deliver up to 3 wires during deposition
2. Explored effect of deposition parameters on resulting composition gradient
3. Combined heat treatments with composition gradient to obtain components with graded microstructure with the potential for improved dynamic impact performance

## RESULTS

- Various graded shapes fabricated
- Deposition parameters influence the resulting composition gradient
- **M-WAAM is viable AM method for FGM fabrication**

# Development of Automated Multi-wire Arc Additive Manufacturing (m-WAAM) For FGMs



## Layer Composition

Element	Weight %
Si K	0.60
Cr K	0.10
Mn K	1.20
Fe K	98.10
Ni K	0.10

Layer 2

## Layer Microstructure

Ferrite =  $51.7 \pm 0.7\%$

100  $\mu\text{m}$

Element	Weight %
Si K	0.47
Cr K	0.10
Mn K	0.90
Fe K	98.43
Ni K	0.20

Layer 1

Ferrite =  $31.3 \pm 1.8\%$

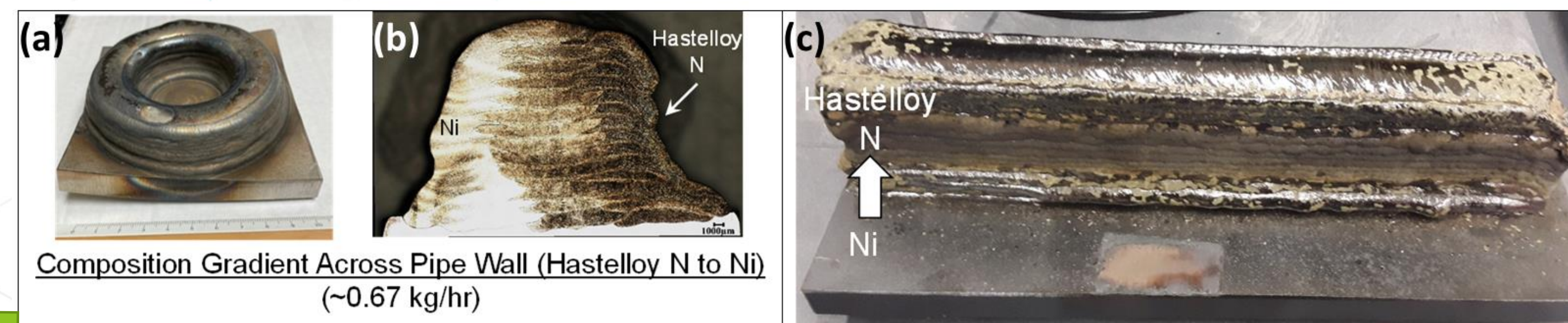
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Element	Weight %
Si K	0.10
Cr K	0.20
Mn K	0.73
Fe K	98.97
Ni K	0.00

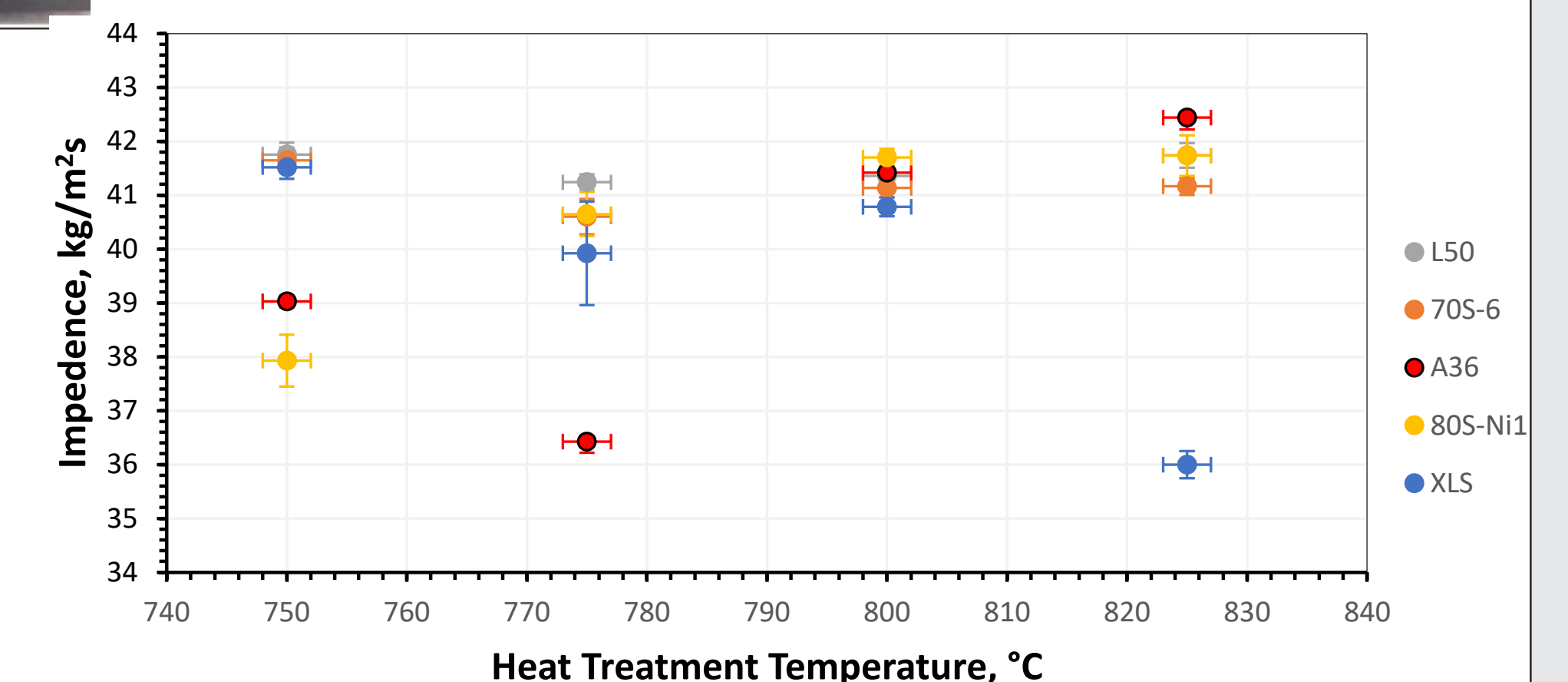
Substrate

Ferrite =  $33.0 \pm 1.1\%$

100  $\mu\text{m}$



## Gradient Microstructures



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