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A Study on Manufacturing of an Axial-Flow Impeller with Multi-Material Blades of Inconel 718 and SST 316L by Wire Arc Additive Manufacturing

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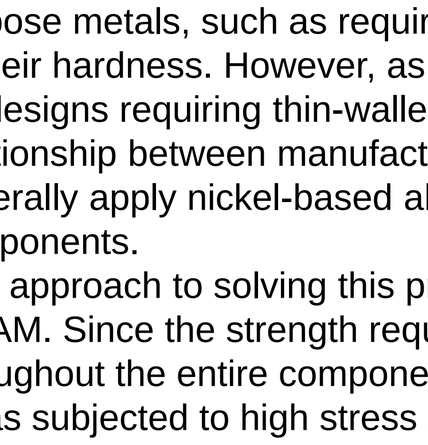
INTRODUCTION & AIM

Nickel-based alloys present processing problems compared to general-purpose metals, such as requiring significantly more machining time due to their hardness. However, as high-strength materials, they are suitable for designs requiring thin-walled components. This conflicting relationship between manufacturing and design makes it difficult to generally apply nickel-based alloys as materials for industrial components.

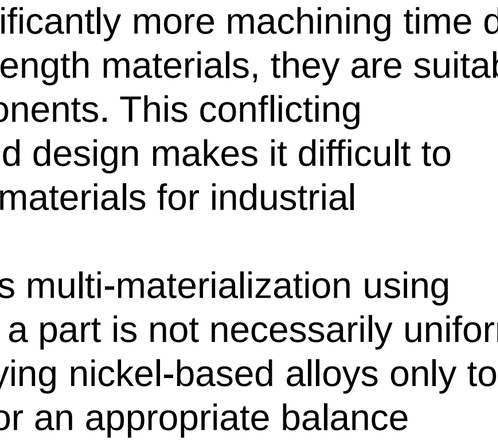
One approach to solving this problem is multi-materialization using WAAM. Since the strength required for a part is not necessarily uniform throughout the entire component, applying nickel-based alloys only to areas subjected to high stress allows for an appropriate balance between manufacturing and design. Several studies have conducted fundamental evaluations, such as mechanical properties, of multi-materialization using WAAM with nickel-based alloys and general-purpose stainless steel. However, research has not yet progressed to the manufacturing study of industrial components multi-materialized using these material combinations. This study conducted an experimental investigation into the fabrication of an axial-flow impeller with multi-material blades using WAAM and machining.

METHOD

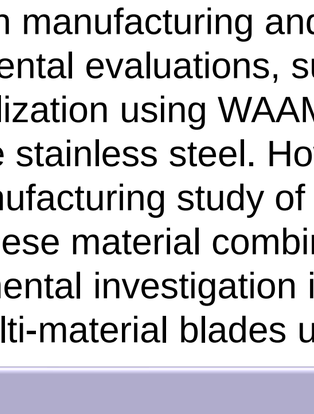
WAAM



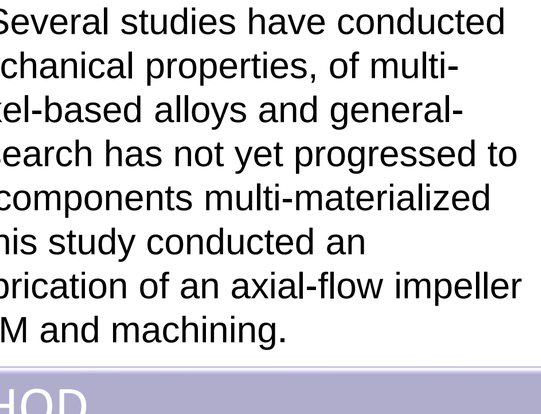
Machining



3D scan



X-ray CT



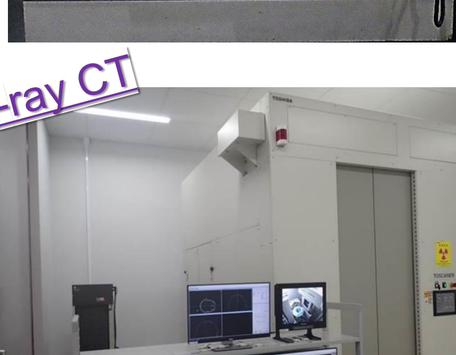
RESULTS & DISCUSSION

Base metal

WAAM

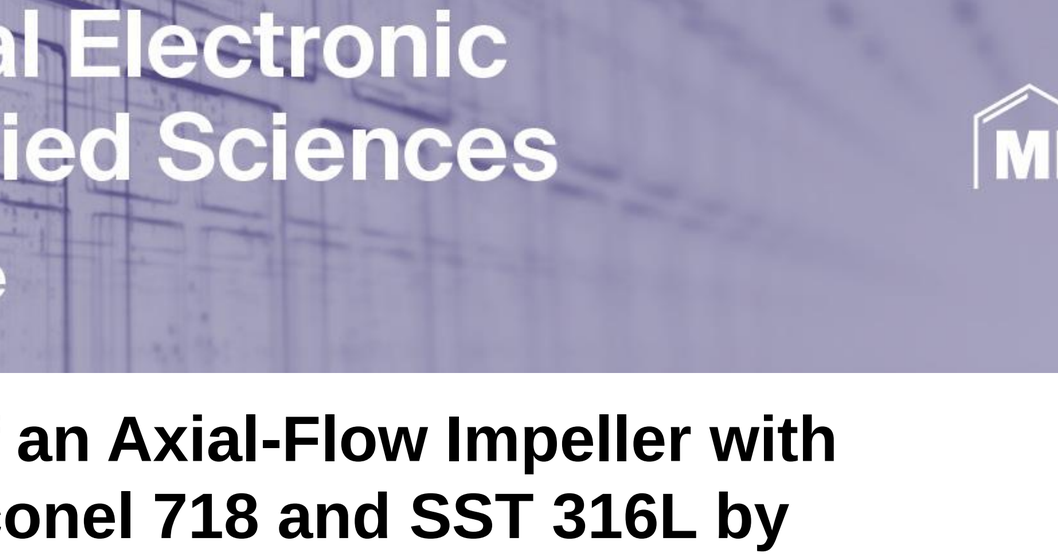
Machining

Finish



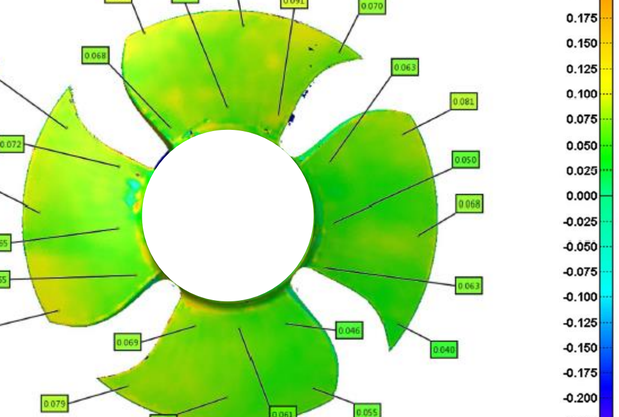
RESULTS & DISCUSSION (cont.)

3D scan



Fabricated to design dimensions

X-ray CT



Several small internal defects detected

Reducing these internal defects remains a future work, but this study experimentally demonstrated the potential for applying WAAM-based multi-material fabrication to the production of industrial components.

CONCLUSION

This study experimentally investigated the fabrication of axial impellers with multi-material blades made of Inconel 718 and SST 316L using WAAM and machining.

1) It was confirmed that it was fabricated to the design dimensions by 3D scanning the axial flow impeller.
2) Observation of the multi-materialized blade using X-ray CT revealed the appearance of small internal defects. Reducing these internal defects is a future work.
3) The potential for applying multi-materialization using WAAM to the manufacturing of industrial components has been experimentally demonstrated.

FUTURE WORK / REFERENCES

- Optimization of WAAM conditions for reducing internal defects
- Investigation using combinations of different materials

[1] S. Ejiri, *International Journal of Fluid Machinery and Systems*, **2025**, 18-2, pp.88-96.