BIOGRAPHICAL SKETCH

Rumman Ul Ahsan was born in Bangladesh. He received his bachelor's degree in Mechanical Engineering in 2012 from Bangladesh University of Engineering and Technology. He earned his master's degree in Advanced Materials Engineering in 2015 from Dong-Eui University in South Korea. He started his Ph.D. in Engineering with an area of focus in Mechanical Engineering in Spring 2018 at Tennessee Tech University and anticipates graduating in May 2022. His research is focused on welding and additive manufacturing.

EDUCATION

Ph.D. - Engineering
Tennessee Tech University, 2018 - Present

M.Engg. - Advanced materials Engineering
Dong-Eui University, 2015

B.Sc. in Mechanical Engineering
Bangladesh University of Engineering and technology, 2012

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College of Engineering

TENNESSEE TECH

The Department of

Mechanical Engineering

Announces the Dissertation Defense of

Md Rumman Ul Ahsan

In Partial

Fulfillment of the Requirements

For the degree of

Doctor of Philosophy in Engineering

March 28, 2022

9:00 a.m.

Held in

Brown Hall 236

Tennessee Tech University

Teams Link: https://teams.microsoft.com/l/meetup-join/19%3aWnNKvsfYr0FTaoT9NyZ_UZ3fxFEC8WSo1YA3dq3pPD01%40thread.tacv2/1645545182371?context=%7b%22Tid%22%3a%2266fecaf8-3dc0-4d2c-b8b8-eff0ddea46f0%22%2c%22Oid%22%3a%2208d41362-aa56-47e9-9785-1a6e489c7c19%22%7d

FIELD OF STUDY

Mechanical Engineering

DISSERTATION TOPIC

Wire + Arc Additive Manufacturing (WAAM) of Bimetallic Structures and AlCoCrFeNi High Entropy Alloy (HEA)

EXAMINING COMMITTEE

Dr. DuckBong Kim (Co-Chairperson)

Dr. Jiahong Zhu (Co-Chairperson)

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ABSTRACT

Wire + arc additive manufacturing (WAAM) utilizes the existing welding technology to melt and deposit metal in a near-net shape. WAAM is characterized by low material and equipment costs, a high deposition rate, and a wide selection of materials. In this dissertation, a gas metal arc (GMA)-WAAM and a gas tungsten arc (GTA)-WAAM system are used for the fabrication of bimetallic additively manufactured structures (BAMS) and high entropy alloys, respectively.

The first part of this dissertation is about the BAMS fabricated through the sequential deposition of materials using the GMA-WAAM system. The objectives of this part are (1) to achieve a bimetallic interface free of defects, (2) to ensure a smooth compositional gradient at the interface, and (3) to achieve a combination of properties.

BAMS with two different combinations of materials: low carbon steel (LCS) to austenitic stainless steel (SS316L) and SS316L to Inconel625 are fabricated. The bimetallic interfaces were free of voids or cracks for both cases. However, the as-deposited BAMS of LCS and SS316L showed elemental segregation at the interface along with poor ductility. To address these issues, heat treatment was performed over a range of temperatures and hold times to smoothen the interfacial compositional gradient and to achieve a combination of strength and ductility. The BAMS of SS316L and Inconel625 exhibited good strength and ductility. However, to avoid the formation of continuous columnar grains across multiple layers through promoting columnar to equiaxed transition, an interrupted deposition strategy is explored. The effect of microstructural and compositional heterogeneity of the deformation behavior has been investigated through electron back-scattered diffraction (EBSD) and digital image correlation (DIC).

WAAM with pre-alloyed and extruded AlCoCrFeNi high entropy alloy (HEA) wire is investigated in the second part. Based on in-situ process monitoring, bead cross-section measurement, and statistical analysis of single-layer deposits; the process window has been identified and multi-layer thin-walled structures are deposited. With the near-optimal processing condition, the GTA-WAAM HEA has improved mechanical performance compared to cast alloy of the same composition, which is further investigated through tensile interrupted tests and EBSD analysis.

In conclusion, this work contributes to an overall better understanding of the WAAM process, which can provide valuable insights for the future additive manufacturing of multi-material structures and HEAs.