National Institute of Technology Rourkela

Defence Seminar

Seminar Title	: Metal Additive Manufacturing Using Non-transferred and Transferred Type Electric Arc: Microstructural, Mechanical and Biomedical Investigations
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Venue	: ME-001 : Seminar Hall
Date and Time	: 24 Dec 2024 (11.00 AM)

Abstract : Wire arc additive manufacturing (WWAM) with gas metal arc welding (GMAW) system, excels more in the metal additive manufacturing (MAM) field due to coaxial wire feeding mechanism that helps in attaining high deposition rate with improved part density, efficiency, and at a less investment cost. But geometrical undulation, spatter, molten metal overflow, thermal distortions, anisotropy, and wastage of substrate material are the key points to consider during WAAM. Based on these issues, objectives of this experimental investigation are formulated. Initially, non-transferred type electric arc (NTA) has been developed between tungsten and wire electrode, which facilitates deposition even on the non-conductive substrate. The unavailability of arc connection with substrate, makes minimal heat input to the substrate and maximized the developed heat for wire melting. It also minimised the impingement of filler wire and molten droplets into the melt pool, enhancing the deposition efficiency while reducing the spatter.

The geometrical undulations and anisotropy are primarily caused due the improper thermal energy management, as most of the commercially available GMAW machine are existing with current controlled wire feeding mechanism. So adequate control over arc current generation and wire feed speed (WFS) is not achieved. To mitigate such issue, an autonomous wire feeding system (AWFS) has been designed and integrated to the GMAW-WAAM, which independently control the WFS of filler wire irrespective to the welding current values. The availability of fine tuning option for WFS, meticulously control the flow of arc current that in term maintain and manage the thermal energy distributions during the deposition process. The thin-layered structures (using ER70S-6 and 316 and filer wire) fabricated through this approach depicts mechanical anisotropy of <5%, indicating the isotropic nature of deposit. Moreover, the bulk texture evolution depicts similar fiber texture evolutions with limited variations in texture intensity that also highlight the isotropic nature of the deposit. It is also experimentally shown that the WAAMed implant does not shows any acute toxicity in the blood profiles and vital organs like liver and kidney after long-term toxicology analysis in WISTAR rats.