A Literature Review on Wire Arc Additive Manufacturing using CMT

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Abstract **- Wire Arc Additive manufacturing is an upcoming method to replace the normal conventional machining process and also can reduce the wastage and save raw material. This process can be used to produce small to large structure which can be complicated in other conventional machining process. CMT is a modified variant of GMAW which can be suitable for Wire arc additive manufacturing, this paper reviews the technique which can be used in the WAAM and give an information of research paper which are useful for studying wire arc additive manufacturing.**

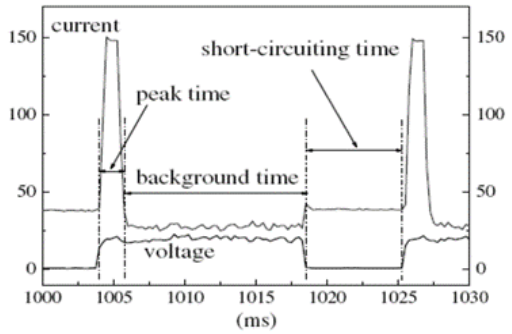
Index Terms **- CMT, GMAW, WAAM, and AM.**

INTRODUCTION

Additive manufacturing is a 3D printing technique quoted for reducing the wastage compared to the normal conventional machining process. This technique has potential to produce a complicate shape and also compromise rising demands of the aircraft industries which are looking for the Buy to fly ratio, and also can play a vital role in automobile, marine time, and defense sectors. It plays a vital role in military aircraft Lockheed SR-71 Blackbird's and also in commercial aircraft Boeing 787 Dreamliner. Although industries using WAAM are in few due to its defect like porosity and residual stress can be high due to it is a welding related process. CMT is suitable process which can be implementing for WAAM.

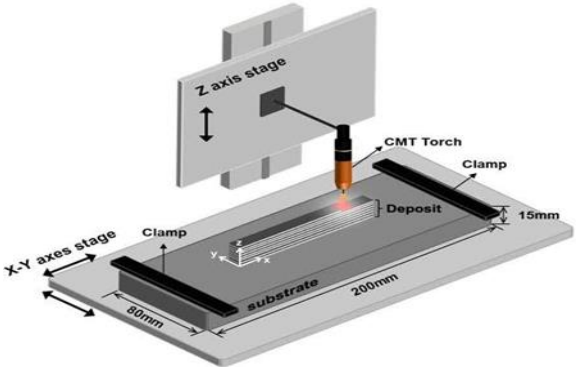
Cold Metal Transfer

CMT process is a modified MIG, it can synergic the current and voltage according to the wire feed rate it can produce spatter free and clear weldments though it is suitable for wire arc additive manufacturing.



Current and Voltage waveforms of CMT process selvi et al., [3]

- The peak current phase: this is often a continuing arc voltage adore a high pulse of current causing the ignition of the welding arc simply and so heats the wire electrode to make drop.
- The background current section: The phase corresponds to a lower current. the current is minimized to stop the globular transfer of the tiny liquid droplet shaped on the wire tip. This section continues till short circuiting happens.
- The short-circuiting section: during this phase, the arc voltage is dropped at zero. At identical time, the return signal is provided to the wire feeder which supplies the wire a back-drawing force. This section assists within the liquid fracture and transfer of material into the welding pool.



Illusion of CMT setup [10]
Above figure show the instrumental setup for CMT torch must have the capacity or the X and Y axis stage can be moved according to the program or machine setup so both the wire arc additive manufacturing can be possible in this method.

Advantage of CMT for WAAM

- High quality weldments with low porosity and surface defects
- Spatter free surface and less chance of thermal deformation.
- Synergic helps in maintaining arc stability and changes operation according to the filler wire.
- Cost friendly compared with powder based additive manufacturing.

During multilayer deposition overflow of weld molten pool can avoided due to its optimized metal transfer which avoid collation during wall formation.

LITERATURE REVIEW

1. Silva et al: Compared CMT and CMT Pulsed mode by depositing 8 multilayers of ER309LSi and analysis the temperature cooling technique for depositing thick and strong tools for heavy applications. Taguchi method was used for DOE, for both methods welding parameter like wire feed rate, torch travel speed, current, voltage and shielding gas flow are optimally selected and Interval time for depositing minimum thickness wall is 9mins and for Maximum thickness is 42mins and the weaving frequency is 1Hz common for both process, Result of the study reveals both CMT and CMT Pulsed produces same high temperature zone and shows the CMT process is energy saving and has 60% smaller for high temperature zone.[4]

2. Gu et al., discussed about the CMT unique specification like low thermal heat input which can produce spatter free an excellent quality weld, metal transfer mode like Dip transfer in CMT pulsed and spray dip transfer in CMT pulsed advanced. ER2319 is deposited in both CMT pulsed and CMT PADV the result show that CMT PADV has more efficient deposition and also eliminate porosity and also has prefect strength and excellent plastic elongation and also suggest interlayer cold rolling can produce a prefect layer and post heat treatment can improve aluminum in WAAM.[5]

3. Shaohua Han et al., The authors investigated the combination of ER408S an alloys wire and MF6–55GP hard facing material which is deposit first four layers are deposit by ER408S and 5-8 layers are deposited by MF6-55GP which is an hard facing material both are deposit in WAAM and their microstructure and mechanical properties are investigated to find out the wear resistant compounded created by using CMT, The result shows positive approach for creating an wear resistant materials can be produced, and also residual stress and defect in surface are present more innovations are need to improve the quality. UTS test shows fractures are occurred in MF6-55GP and also have a high hardness value of 800HV.[6]

4. Savyasachi N et al., studied the literature about wire arc additive manufacturing that is mostly because it uses materials like titanium, which has high BTF (buy-to-fly) ratio. Mentioned about various types of manufacturing and also consolidated the various metals and their microstructure UTS, YS and EL%.[7]

5. Jafari et al., they reviewed the recent development, process planning design and guiding design like patterns with pattern can be used for direct deposition according to the structure which can properly utilized and post treatment guiding, and geometric planning cold rolling methods used to maintain uniform shape and also discussed future needs to improve in WAAM.[8]

6. Seung Hwan Lee et al., studied the deposition of STS316L using numerical method to investigate the heat accumulation between the interlayer pass temperature was captured by high-speed camera. The micro and macro structure are investigated inter pass time set to be varied so 65% IPT the upper layer melts and the conclude that the result the total heat can be calculated accurately by using the equation and mechanical properties such as hardness and yield strength can be anticipated to predict.[9]

7. Seung Hwan Lee et al., used Gaussian process regression (GPR) for WAAM optimization method for improve the quality and productivity of the deposited

shape the following parameters like wire feed and travel speed are finalized for depositing STS316L and deposition angle with set to be at 90˚ and the result shows that the GPR method can be used for finding the optimal parameters for depositing WAAM depending upon the welder experience and by this method it can improve the performance of WAAM involving diverse materials and shapes.[10]

8. Rodrigues et al., in this paper review the current status and improvement in WAAM and Highlighting procedure tendencies and editions to govern the microstructure, mechanical residences, and disorder era within side the as-constructed parts; the maximum applicable engineering substances used; the primary deposition techniques followed to reduce residual stresses and the impact of post-processing warmness remedies to enhance the mechanical residences of the parts. A critical factor that also hinders this era is certification and nondestructive checking out of the parts, and that is discussed. Finally, a standard angle of destiny improvements is presented.[11]

9. J.R. Hönnige et al., studied the effects of inter pass rolling in two methods vertical rolling and post deposition side rolling by depositing 2319 aluminium walls in Wire + Arc Additive Manufacturing. Vertical inter-pass rolling work hardens the fabric and promotes dissolution of copper from the matrix. It is viable that this has facilitated natural ageing of the material, which in aggregate with the work hardening offers progressed yield and tensile strengths. Post-deposition side-rolling may be very effective for controlling residual stresses and distortion in aluminium components manufactured with WAAM and it will increase the hardness through work hardening.[12]

10. Zhong et al., Investigated unique AA2050 wire is used within side the additive production of thin straight wall deposits. Excellent formability is completed via way of means of adjusting the warmth enter the use of a VP-GTAW process. AA2050 Al–Li alloy WAAM components and tested the microstructure and mechanical properties.[13]

11. Chuanchu Su., Experimented torch angle and observed weld molten pool by using high speed camera. The author states the depositing in different angle produces different bead and defects at the angle 10˚ to 20˚ bead quality is good and with less porosity.[14]

12. Thapliyal: The author mentioned the impact of technique parameters at the soundness of constructed and it in addition offers perception into the problems encountered all through the technique and the future attitude of the WAAM constructed aluminum alloys.[15]

13. Rodrigues et al., investigated the high strength low alloys in WAAM which can be suitable in industries and power plant and also experimented the heat input factor which affects the cooling rate interlayer pass and resistance time measured using infrared camera and SEM is reveals the microstructure and electron backscatter.[16]

14. Abdullah Wagiman et al., Author explored the CMT produces a spatter and porosity on the cross section of weld bead they analysised that bead geometric show high heat input makes the bead width larger and smaller bead width on lower heat input. They stated that rapid cooling makes finer grains and slow cooling cause coarse grains.[17]

15. Chakaravarthy et al., studied torch angle influence in orientation of wall formation and topology in multilayer wall formation and also investigated the surface waviness of the SS316L wire by using the cold metal transfer.[18]

CONCLUSION

Wire arc additive manufacturing is a developing technique which can reduce the wastage and increase the production and also cost efficient compared with other AM techniques. WAAM is in under research stage and have a less record in mass production even it has capacity to increase the production rate and has the buy to fly ratio. Application of WAAM it can play a vital role in aviation industry and automobile sectors for products like Ribs for automobile, Impellers for marine time, Fuel nozzles in aircraft and some complicated structure can be design and layered by WAAM. it is some disadvantage like developing a perfectly oriented multilayer wall is unavoidable task in WAAM and having challenge of overflow of weld

pool. Waving patterns and cold rolling on vertical and side of post deposition is a remedy to avoid this kind of problem.

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