Synopsis Seminar

Seminar Title	: Fabrication of Ceramic Reinforced AISI 434L Steel Composite Structure by TIG aided Powder Bed Fusion Arc Additive Manufacturing (TIG PBF-AAM) Method
Speaker	: M D Aseef Khan (Rollno : 519me1023)
Supervisor	: Prof. Manoj Masanta
Venue	: Mechanical Engg. Seminar Hall (ME001)
Date and Time	: 23 Dec 2024 (4.30 PM)

Abstract

: Arc additive manufacturing (AAM) has gained significant attention because of its potential to rapid production of large-sized metallic components. Complications allied with wire-AAM, i.e., availability of only specific graded wire, requirement of continuous wire feeding, and inability to fabricate composite or functionally graded components, compelled the researchers to explore the feasibility of metal powder in AAM as feedstock material.

In this work, a powder bed fusion (PBF) type AAM setup has been developed, which utilises the tungsten inert gas (TIG) arc as heat source, and employ metal/ceramic-metal powder mixture to fabricate 3-dimensional metal matrix composite (MMC) parts. The developed setup has been used to fabricate thin wall structures of AISI 434L SS, after identifying suitable parameter combination through trail experiments. The fabricated AISI 434L SS thin wall structure exhibited columnar grain structure. In addition, thin wall structures of SiC-AISI 434L and B_4C-AISI 434L SS composite were fabricated using powder blend with variable wt. ratio by the TIG PBF-AAM method. SiC+AISI 434L SS composite exhibited significantly refined cellular and flower-like dendritic grain structure depending on SiC content. The fabricated composite structures exhibited microhardness values up to 626 $HV_{0.05}$ and 1049 $HV_{0.05}$ for the inclusions of SiC and B_4C reinforcement, as compared to pure AISI 434L SS component (186-330 $HV_{0.05}$). Whereas, wear loss (height reduction) was recorded as low as 134 µm and 24 µm respectively, those are much lower than the pure AISI 434L SS part (360 &mum).

Along with &alpha-ferrite and martensite phases of AISI 434L structure, the SiC-AISI 434L SS composite comprises of iron silicate, iron silicon carbide, and unreacted SiC phases. While, B_4C-AISI 434L SS composite contains iron boride, chromium boron carbide, and unreacted B_4C phases. The phase transformations depend on the formation of intermetallic due to dissociation of ceramic particles under intense heat of TIG arc. Also, the B_4C-AISI 434L SS thin wall structures fabricated on AISI 1020 MS and AISI 304 SS substrates demonstrated the influence of substrate material on deposition quality, microstructure evolution, and mechanical properties, with superior results observed with AISI 304 SS substrate.

Finally, B_4C-AISI 434L SS functionally graded (FG) structures have also been fabricated by varying the B_4C percentage along the building direction with different strategies (smooth, moderate, and steep gradient). The fabricated FG parts exhibited graded transition in grain structure, phase composition, microhardness, wear and scratch resistance along the building direction, corresponds to variation in B_4C fraction. The present work established the potential of TIG PBF-AAM method to fabricate ceramic based MMCs and FG parts for advanced tribological applications.