National Institute of Technology Rourkela

Defence 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	: Manoj Masanta
Venue	: Seminar Hall (Room No.- ME001), Department of Mechanical Engineering (Physical Mode)
Date and Time	: 25 Aug 2025 (9.30 AM)
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 powder bed fusion type AAM.

In this work, a tungsten inert gas (TIG) arc based powder bed fusion (PBF) type AAM setup has been developed, and metal/ceramic-metal powder mixture have been utilised 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. 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. 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 composite structures exhibited up to 626 $HV_{0.05}$ and 1049 $HV_{0.05}$ microhardness for inclusions of SiC and B_4C reinforcement whereas, the wear loss (height reduction) was recorded as low as 134 μm and 24 μm respectively, as compared to 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. The 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.