Research Diary

Judicious Additive Manufacturing

Prof Suryakumar S **(L)** & Prof Ventaka Reddy N **(R)**
Department of Mechanical and Aerospace Engineering

KID: 20220110

Additive Manufacturing (AM) is a lot of great things. It is, however, not a complete replacement for traditional manufacturing methods. To make the best use of AM, it must be harmonized with other manufacturing processes. The following snippets of work happening at IITH aim at such judicious use of AM, by hybridizing it with other techniques.

1. Deposition + Deformation for grain refinement and enhanced geometrical complexity

Wire-based Direct Energy Deposition (DED) techniques in Metal Additive Manufacturing (MAM) allow part-fabrication at higher deposition rates and lower costs. Due to the lack of any support mechanism, these processes face challenges in fabricating overhanging features. Inherent overhang capability of weld-beads and higher-order kinematics can help realize certain complex geometries. However, significant challenges like non-uniform slicing, constrained deposition-torch accessibility, etc., limit the efficacy of these approaches. This facet of research at IITH describes a Deformation aided Deposition (DaD) process to overcome some of those limitations and manufacture complex metallic components. It is based on a sequential combination of deposition and bending processes: a shape fabricated through W-DED deposition is bent to realize the required shape. The Deformation- aided- Deposition process consists mainly of two stages. The first stage is meant for deposition in the form of a GMAW welding torch and the second station corresponds to the bending which is to be carried out with a hydraulic press employing customized dies and punches. The component deposited in the first stage can move to the second station to bend the component to a required shape/geometry. After this step, the component can again move back to the deposition stage for further processing. The desired shape can be obtained through this series of activities. **Figure 5** shows a few sets of sample geometries fabricated at IITH using this method. This work is supported by DST under Advanced Manufacturing Technologies (AMT).

2. Deposition + Laser forming for the generative realization of complex geometries

This process is similar to the earlier method, except it uses a Laser instead of a punch and dies for bringing about the necessary shape change. In this two-step process, a component deposited in the first step is subjected to multiple lasers passed in the second step, to obtain a desired angle/shape. This concept has been actualized using a WAAM setup for deposition and a 2kW Yb-YAG fiber laser for the laser forming. **Figure 6** illustrates the steps in this process along with a sample geometry made.

3. Deposition + Electro-pulsing for residual stress reduction

During component fabrication in AM, as the build progresses, the partially build component undergoes complex thermal cycles, including directional heat extraction, varying cooling rates, and repeated re-melting and re-solidification of layers. The consequence of these complex thermal cycles is non-uniform expansions and contractions in the component, thermal strains, and residual stresses. Present work is an attempt to reduce absolute residual stresses developed during additive manufacturing using the electro-pulsing method and comprises of applying controlled electric pulses on a partial and/or complete component fabricated using additive manufacturing. When electric current pulses are applied to a metal, a significant "electron wind" occurs. This decreases inter-granular and macro residual stress. The application of electric pulses disentangles and mobilizes the low angle grain boundaries, indicating a reduction in residual stress. One of the significant advantages of this process is its ability to be applied in an in-situ manner during the build process.

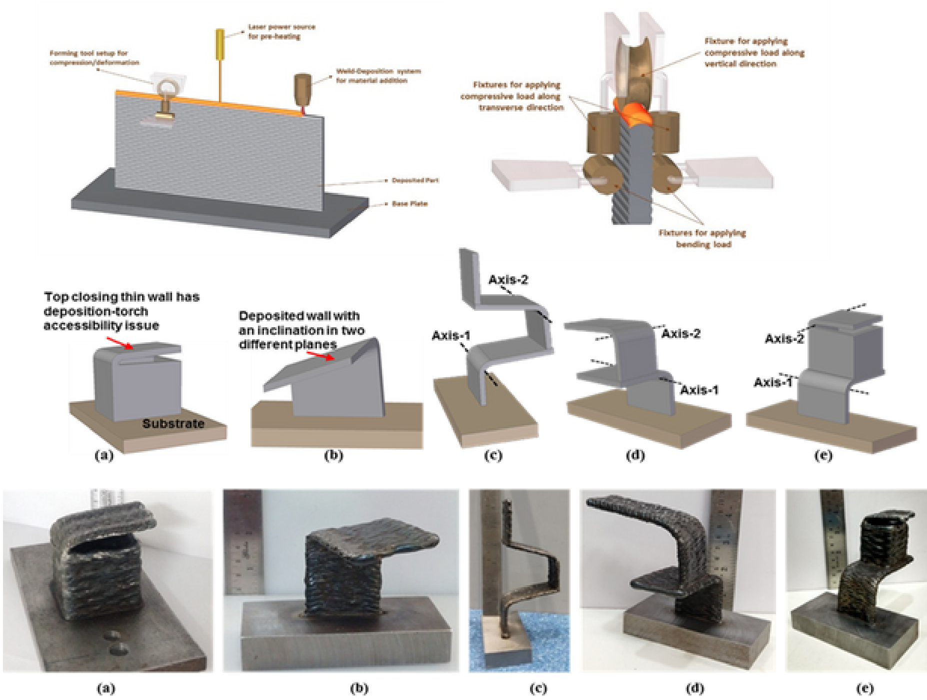

Figure 5: Markforged Mark Two 3D printer

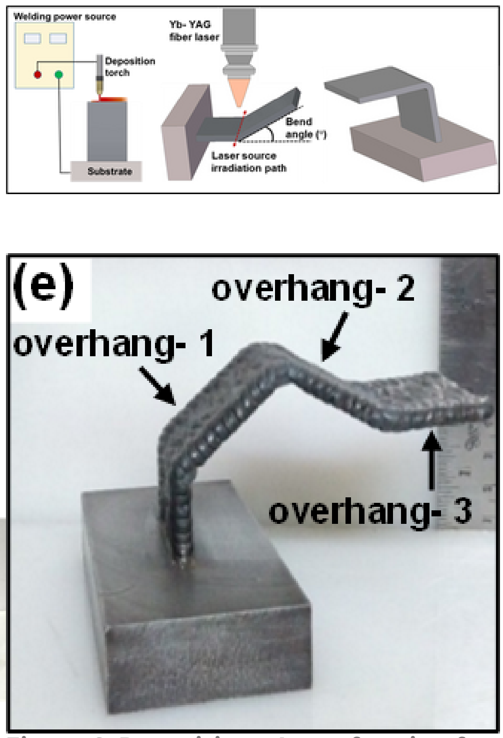

Figure 6: Deposition + Laser forming for the generative realization of complex geometries

4. Wire & Powder deposition for better accuracy and higher deposition rates

Amongst the directed energy deposition-based AM processes, Powder and Wire are different forms of raw material that can be used. Powder-DED comprises a cladding head in which a laser fuses together powder particles sprayed from concentric nozzles. Wire – DED, also known as Wire Arc Additive Manufacturing (WAAM) builds on Arc welding to produce fully dense complex functional metallic objects with wire as feedstock. Amongst the Powder and Wire based processes, the powder offers better accuracy and feature resolution, and wire-based processes are capable of high deposition rates as shown in **Figure 7**. This work aims at developing a Wire & Powder Hybrid Direct Energy Deposition (WP-DED) process bringing together the advantages of a high deposition rate with high accuracy. Apart from the system design, development, and integration, the research also includes studies on:

(a) addressing the distortion and residual stress concerns in the fabrication of large components and,

(b) addressing possible property irregularity arising out of using energy sources with different energy densities.

This work is done together with IIT Dharwad and NITK Suratkal and is supported through the DST-CRG grant.

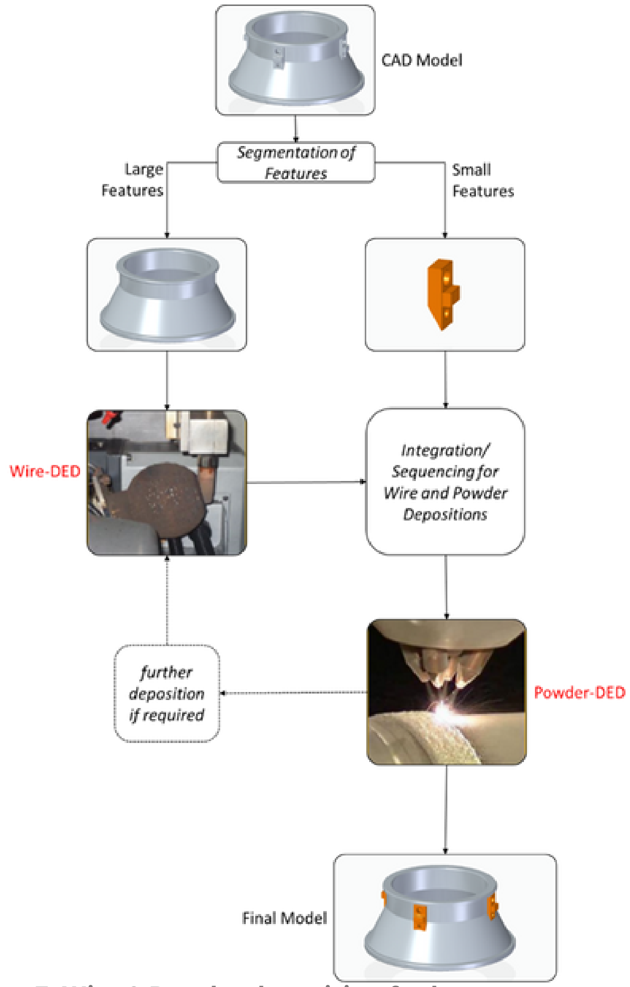

Figure 7: Wire & Powder deposition for better accuracy and higher deposition rates

IITH and WiSig unveil 5G Infra Solutions

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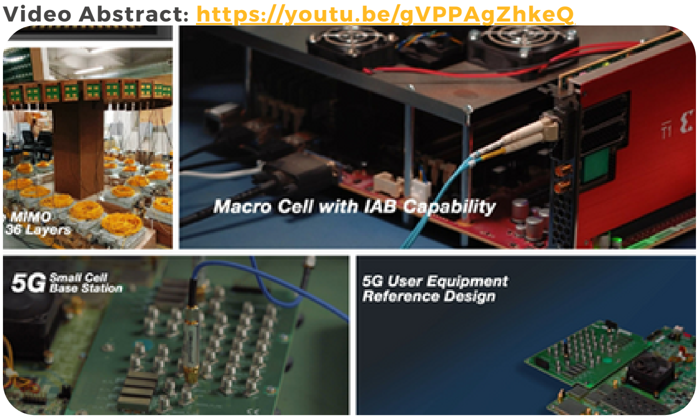
IIT Hyderabad (IITH) and WiSig Networks jointly announced a maiden 5G data call using indigenously developed 5G ORAN technology. The call was made using MIMO capable base station that supports 100MHz bandwidth in the 3.3-3.5 GHz frequency band.

"Inventing and innovating in Technology for Humanity (IITH) is our mantra, and we expect WiSig to make India "Aatma Nirbhar" in the 5G space", **added Prof B S Murty.**

Read More:
https://pcr.iith.ac.in/files/pressrelease/5GIS.pdf
Video Abstract: https://youtu.be/gVPPAgZhkeQ



IITH Research in news - Q1, 2022

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How antioxidants improve the inhibitory nature of Triclosan on Acetylcholinesterase, answers IITH

Can we do something to protect ourselves from the toxic effects of Triclosan? Know from IITH's team. Highlights: 1. Triclosan causes damage to the nervous system at very low concentrations. 2. Triclosan impairs acetylcholinesterase enzyme directly and indirectly (via oxidative stress). 3. Acetylcholinesterase enzyme is a vital cellular component, as it is required for optimal sensory and motor skills. 4. Remarkably, if we improve health with antioxidants, we can also prevent the damage caused by Triclosan.

Read more: https://pcr.iith.ac.in/files/pressrelease/ATL.pdf
Video Abstract: https://youtu.be/npprVSvI53U