L.3: Development of laser additive manufacturing system using powder bed fusion

Laser Additive Manufacturing (LAM) has made its way into mainstream science and technology empowering the designers, manufacturing engineers and users to deliver the product with unlimited complexity and customization. It is not just shapes and designs (could not previously even be conceived of) are now entirely viable, but LAM also could keep the advantages in terms of the structural properties. LAM can build a complete shape in its entirety, by carefully layering and joining materials together to create the desired outcome in single step. The layering of the material in LAM is broadly done either by powder feeding, known as Direct Energy Deposition approach (LAM-DED), or by pre-placed powder bed, known as Powder Bed Fusion (LAM-PBF). A 2 kW fiber laser based LAM-DED system was developed at RRCAT in the year 2011 and since then it is being used for building various engineering components.

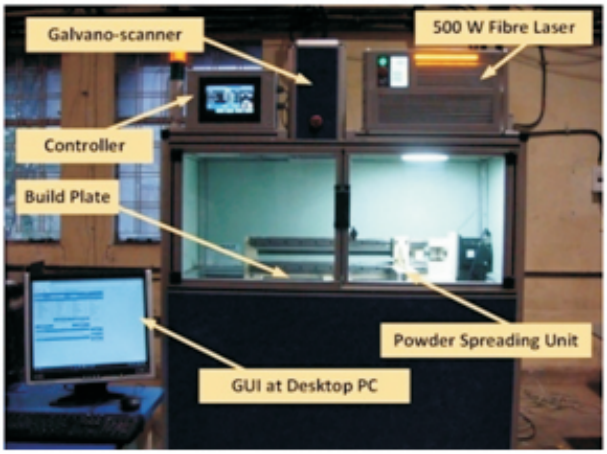

Fig. L.3.1: 500 W fibre laser based LAM-PBF system.

Recently, LAM-PBF system has been conceptualized, designed and developed at LAM Lab, RRCAT using a 500 W fibre laser, galvano-scanner, powder spreading mechanism, built-plate and hopper plate to cater the fabrication need of complex geometries. A solid model of the engineering component to be build is made using computer-aided-design software. The model is sliced into thin layers at various section along the vertical axis and each slice is converted into corresponding file in .dxf format and these files are transferred to desktop computer attached with the system. At deposition station, the powder layer is spread all over build plate and selectively melted as per the section information available in .dxf file by manoeuvring laser beam using galvano-scanner. Subsequently, build plate moves down by pre-defined height (i.e., almost equal to layer thickness) and new layer of powder is spread. Thereafter, this layer is selectively melted as per that section of target geometry (information available in .dxf file). The procedure is repeated until the whole component is built. This whole process is carried out in auto-mode using Mitsubishi's programmable logic controller (PLC) and servo-package. The system has 7–inch HMI for data entry to PLC. Fibre laser, galvano-scanner and servo-package are connected with PLC. Figure L.3.1 shows a photograph of developed LAM-PBF system. The system is capable of fabricating component having size within 250 mm x 250 mm x 200 mm and builds it with slice-layer thickness of 25 microns or more. Figure L.3.2 and Figure L.3.3 presents some of the geometries built using developed LAM-PBF system to demonstrate the system capability.

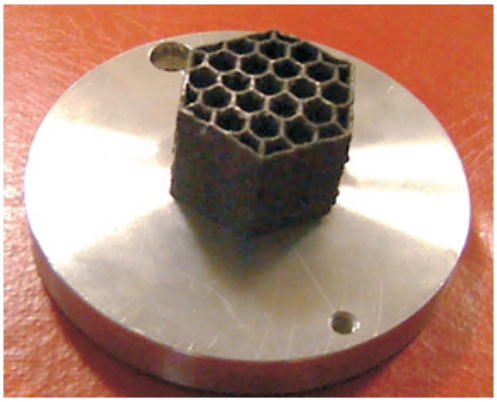

Fig. L.3.2: Hexagon channeled nipple.

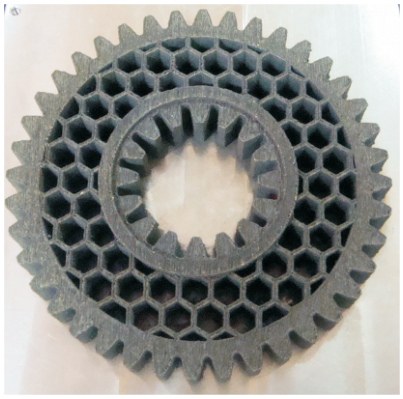

Fig. L.3.3: External and internal geared geometry with honeycomb core.

Presently, the system is being operated in open-air condition for building engineering components of oxidation-resistance alloys. Next step is to upgrade the system to operate it in controlled atmosphere condition to cater other alloys, which will enhance the system capability multifold.

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