

Technical specifications for Laser Powder Bed Fusion based additive manufacturing system

Required mandatory specifications (all the conditions should be met)

1. Technology requirement

1. Additive manufacturing (AM) system should be based on powder bed fusion (PBF) using laser as a melting heat source.
1. Laser heat source should be capable of completely melt the powder feedstock (raw material) to form a melt pool and create a part/component with density as high as 99.9 %, without any addition of binders.
2. System should be capable of operating on both reactive and non-reactive materials/feedstocks.
3. Equipment should be equipped with a fibre laser heat source of 100 W or higher power.
4. Thinnest possible layer should 30 micrometers or smaller. System should be capable of varying the layer thickness up to 80 micrometers or higher.
5. Minimum feature size should be 150 micrometers or smaller. There must be a provision to extract unmelted powder from a feature of 150 micrometers or smaller.
6. Laser scanning speed should be 7 m/s or faster.
7. System should be capable of building parts with a final dimension of 100 x 100 x 80 mm³ or higher. In other words, the build envelop or powder bed size should be capable of producing parts of 100 x 100 x 80 mm³ or higher.
8. System should be capable of achieving a minimum build rate of 3 cm³/h or higher.
9. System should be capable of operating in nitrogen and argon atmosphere. In other words, there must be a provision to supply nitrogen and argon with controlled flow rate into the build chamber.
10. With the inert atmosphere, the permissible oxygen concentration in the build chamber should be 1000 ppm or lower
11. Gas consumption should be 5 litres per minutes (l/min.) or lower.
12. All the process parameters governing the additive manufacturing process should be open and freely editable to IIT Madras for the Research and Development purpose. A complete list of process parameters for the standard materials should be provided by the manufacturer in their technical bids.
13. A video camera based or any other monitoring system, showing the build operation to the user should be provided and this system should have the capability for closed loop control of the process.

1. Feedstock/powder requirement

1. System should have a capability to use standard and non-standard commercial metals and alloys powders.
2. System should permit the use of feedstock powders with custom designed alloy compositions, designed in IIT Madras or elsewhere.

3. Systems should allow parametric development for custom designed alloy compositions by IIT Madras on their own or with the help of the supplier without any additional charges within and beyond the warranty period.
4. Supplier should help IIT Madras to identify the process parameters to build parts from custom designed alloy powders without any additional charges within and beyond the warranty period.
5. Use of third-party feedstock powders or custom designed powders by IIT Madras should not void the warranty of the equipment.
6. System software should be capable of using any third-party materials with an unlimited possibility to edit the parameters.
7. Minimum powder requirement to print a component should not be more than two times of the build chamber volume.

2. Machine control software requirement

1. Software should have a module for automatic support structure generation capabilities for any given design. Software should also be capable of changing the support structure design as per user requirement.
2. Software should support standard neutral formats such as IGES/STEP/STL. Additionally, it should preferably be capable of supporting AMF format.
3. Software should be capable of correcting errors in the CAD data to heal the geometry and convert into machine readable format.
4. Necessary software for conversion of 3D CAD data (of any readable format) into L-PBF system compatible format to be included.
5. Software should be freely able to communicate with PC/workstation with MS-windows 10 or higher operating system.
6. A free license for the system software should be provided with the equipment
7. Software should be capable of analysing linear and non-linear scaling, translation and rotational displacements.
8. Software should be capable of estimating build time and powder requirement for major engineering metals and alloys.
9. Software should be capable of producing a detailed report, describing part geometry, build process and results.
10. Software should be capable of varying the process parameters (including laser power, focal length and scanning speed) as a function of (x,y) coordinates for a given layer on a build platform.
11. Software should be capable of producing volume and surface lattice designs (including internal light weighting lattices, infills and surface textures).
12. Software should be capable of carrying out lattice advance design (using a finite element analysis-based lattice analysis and optimisation, lattice structure development for smooth and internal shell features).

3. Pre-processing software requirements

1. Pre-processing software should have the capabilities of all the specifications mentioned against machine control software (section 3).
2. Software should provide an automatic pre-processing slicing and capability to generate 3D digital part files.
3. Software should be capable of nesting of parts to optimise powder bed volume and improve build time.

4. Software should be capable of automatically plan the part placement to optimise the build time.

4. Software licenses

1. License for both machine control (item 3) and pre-processing software should be included with the system. Free and perpetual software license for pre and post processing software module should be provided.
2. A free license for pre and post processing software should be provided to install in multiple standalone PCs/workstations or with a floating network licenses.
3. Software license should facilitate to develop/edit the process parameters.

5. Documentation requirement

The following documentations should be provided (one set of each in English)

1. Operation manual
2. Software instruction manual
3. Maintenance, troubleshooting and safety guidelines manuals
4. Manuals to handle accessories and guidelines
5. Process Parameters data for common engineering alloy feedstocks (titanium and its alloys, stainless steels, aluminium and its alloys, cobalt and nickel based alloys) should be given in a CD/flash drive.
6. Occupational Health and Safety (OHS) guidelines and warnings.

6. Warranty and Annual Maintenance Contract requirements

1. A 3-year complete system warranty (including for laser power source) should be provided from the date of installation.
2. Possibility of extending the warranty beyond the mandatory period should be clearly mentioned with the appropriate cost.
3. Bidder should have provision for a continuous Annual Maintenance Contract upon the completion of warranty period.

7. Inspection, installation, commissioning and training

1. All the essential requirements ensuring a ready-to-use set up at IIT Madras should be supplied.
2. Comprehensive training for five research fellows/students should be imparted upon installation.

8. Spares, consumables, mandatory accessories and standard feedstocks

1. Bidder should offer a list of essential spare parts and accessories with their part numbers for a continuous operation for three years. Bidder should also ensure that the spare parts and accessories should be made available to procure for a smooth operation over at least 15 years from the date of installation.
2. However, the consumables and parts required for the installation and standardisation of the system should be given at free of cost.
3. 20 kg of (i) Titanium (preferably, TI-6Al-4V alloy) , (ii) 316L stainless steel and (iii) Aluminium alloy (preferably 4xxx) powders should be supplied with the equipment for the system optimisation during installation and commissioning.
4. A separate build chamber/build platform for titanium, stainless steel and aluminium alloys should be provided.

5. HEPA grade filter as per OEM specification to achieve highest level of safety should be provided. Enough filters should be supplied to ensure smooth operation of the equipment during the warranty period.
6. At least five numbers of ceramic/HSS or suitable recoater blades (suitable for all the feedstocks) should be supplied as a spare.
7. Items in 9.5 and 9.6 should be included in the equipment price.
8. 10 numbers of Nitrogen and Argon cylinders with 99.99 purity should be supplied with the system.
9. Powder sieve station with an ability to sieve both reactive and non-reactive feedstock powders should be supplied.
10. A industry grade dry vacuum cleaner (explosion proof / Atex 22 grade) should be supplied with the equipment.

9. Additional mandatory conditions

1. A continuous operational support to IIT Madras should be provided without any additional cost during the warranty period (at least three years from the date of installation).
2. There should be a minimum of two visits per year by the service engineer and application engineer of the equipment supplier (preferably from OEM).
3. The total cost of the system should be inclusive of these visits.
4. The bidder must either be OEM or legal representatives of the OEM in India. The bidder and the legal representatives should have ISO certification for quality standards (a copy of ISO certification should be attached with the technical bid).
5. The bidder should have supplied at least one L-PBF (Laser powder bed fusion) metal additive manufacturing machine to IITs/NITs/other CFTIs/National laboratories/government organisations.
6. A global reference list as well as user list in India should be enclosed.
7. The operational status of all the equipment in India should be provided.
8. Total weight of the system
9. Personnel safety accessories (goggles, masks etc.)
10. Special design/provision should be made to prevent accidents while in operation.
11. "Emergency Stop" button(s) should be provided at convenient and easily accessible location.
12. Safety manuals and charts should be provided.
13. Supplier should provide safety training at the time of installation.
14. Flow line diagrams and electrical circuit diagrams should be provided.
15. A preinstallation instructions should be provided with the equipment, indicating electrical, space, gas connections and safety protocols should be provided.

10. It is mandatory that equipment supplier should demonstrate the manufacturing capabilities of the equipment upon installation by printing a standard design given by the IIT Madras (with the specifications given in section 1, 2 and 9).

11. A detailed compliance statement, clearly indicating the compliance (or deviation) against each technical specification to above mentioned specifications should be provided along with technical and financial quotes.

12. Financial bids should be provided as a modular bid with a list price for each and individual item. Price should be in CIF Chennai.

13. Optional accessories

1. Band saw with blade size 350 x 29 x 0.9 mm³, drive motor 2 HP
2. Support removal tools and finishing tools.
3. Shot peening machine with a working dimension of 750 x 900 x 900 mm³, blast nozzle, TC 8 mm, compressed air 40 CFM at 80 psi, with manual job handling.

A preheating set-up (preferably based on resistance heating) for preheating the build up to 300 to 400 °C.