PRAVEGA 2022

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Additive Manufacturing Hackathon

Problem Statements

1. Problem 1: Design F-theta lens system for large area laser beam 2D scanning system
2. Problem 2: Effect of spherical metal powder flowability at high temperature
3. Problem 3: In-situ and Ex-situ defect identification methods using imaging methods in Additive manufacturing.

Explanation of the problem statements is today at 12pm at OPB G20
Students can participate individually or in teams of up to 3 people.
For the prelims, your task is to submit a technical proposal (of around 1 page) outlining you approach to the problem and submit by September 15th
Best submissions move on to the finals where winners will get a sponsored project from Ministry of Heavy Industries
For more details about the problems , please click here.

Society for Innovation & Development
an IISc initiative

Sponsored by SID-IISc

Society for Innovation and Development
Indian Institute of Science
Bangalore 560012

भारी उद्योग मंत्रालय
MINISTRY OF
HEAVY INDUSTRIES
सत्यमेव जयते

Centre of Excellence for Additive Manufacturing, SID-IISc

Funded by Ministry of Heavy Industries, GoI

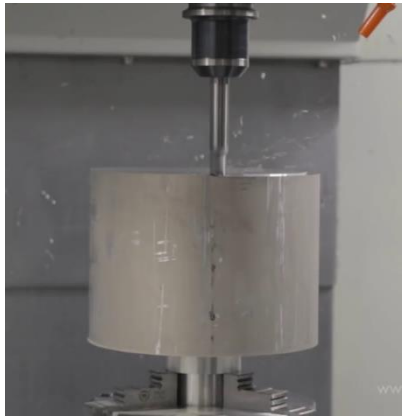
About SID - IISc

- **SID undertakes research and development projects based on individual or joint proposals from the faculty and scientists of IISc in collaboration with industries, business establishments, and national and international organizations.**

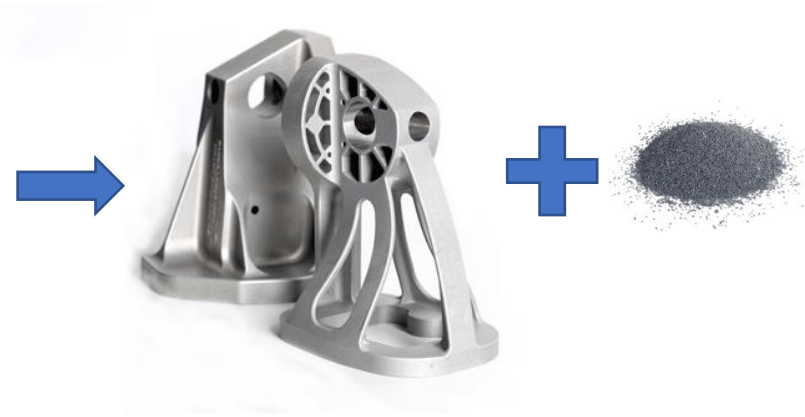
- **Such organizations are welcome to enter into an agreement through SID with an intention to collaborate with IISc Departments to sponsor research projects.**

- **We work with industries like Boeing, Bosh, Microsoft, Accenture, Wipro, Tata Group, GE, and other Industries.**

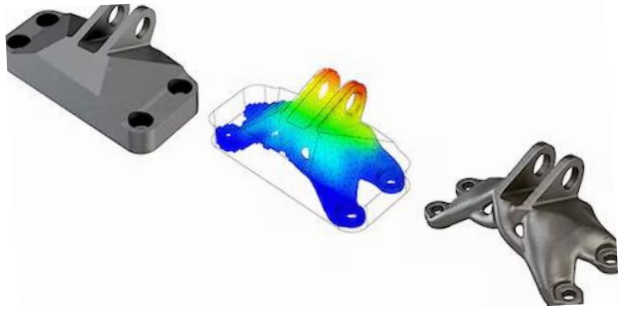
Subtractive Manufacturing




Additive Manufacturing

Advantages of AM

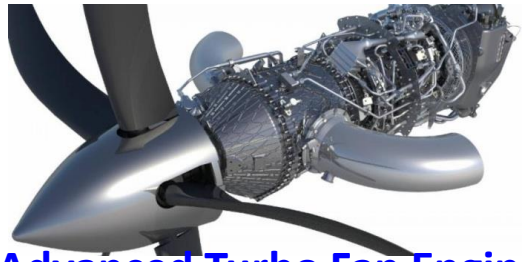


➢Design for additive manufacturing (DfAM)

➢Buy to fly ratio: The Buy-to-Fly ratio is the weight ratio between the raw material used for a component and the weight of the component itself.
(F-22 buy-to-fly ratio is 110K lbs buy to 9Klbs fly(12.2:1),101klbs machined away)

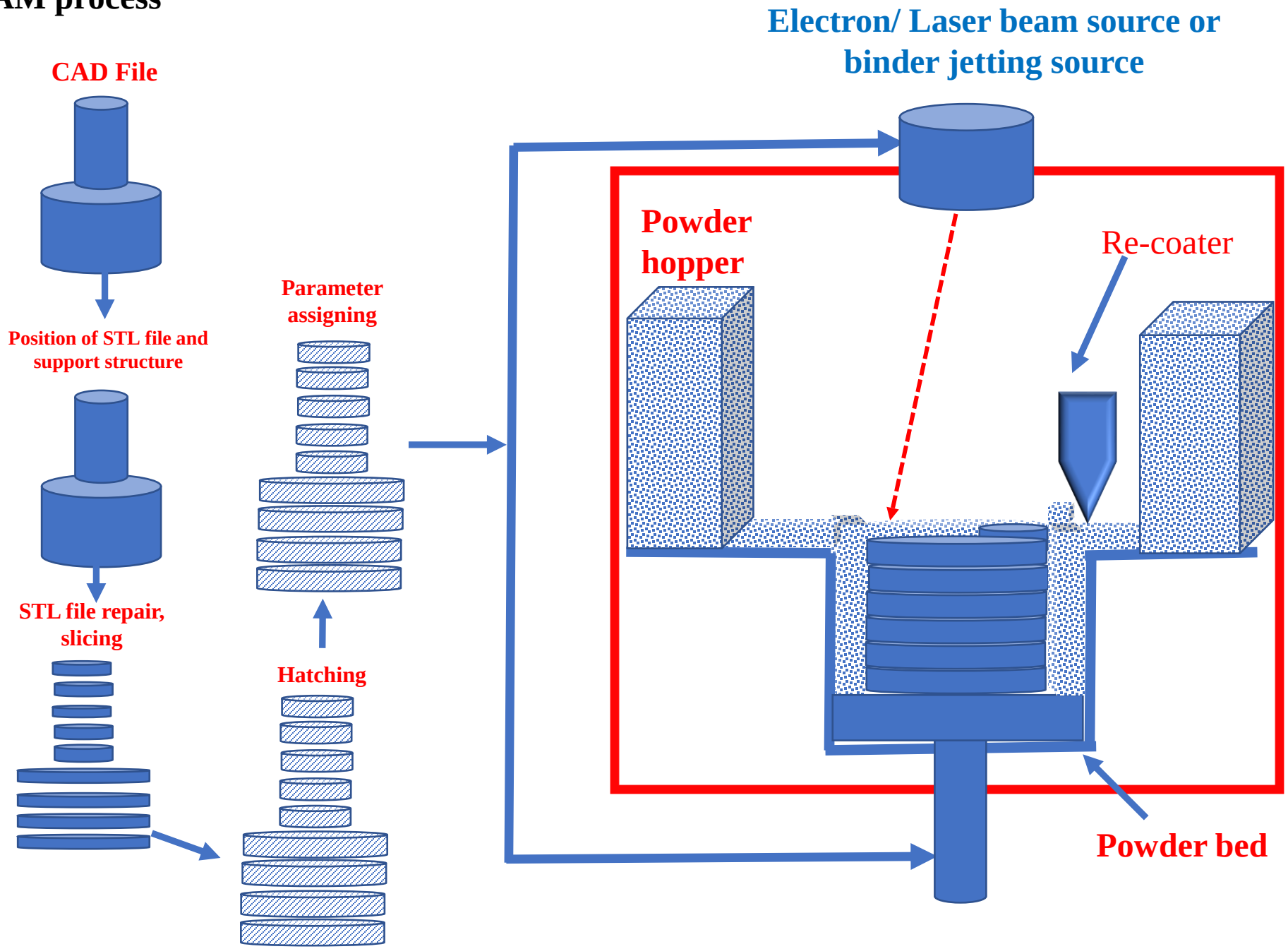
➢ Short lead time and customized building proven for prototyping, aero space and medical implant industry components

➢Reduced efforts for fabrication:
855 separate components into just 12, shave off more than 100 pounds in weight, improve fuel burn by as much as 20 percent, give it 10 percent more power and simplify maintenance.



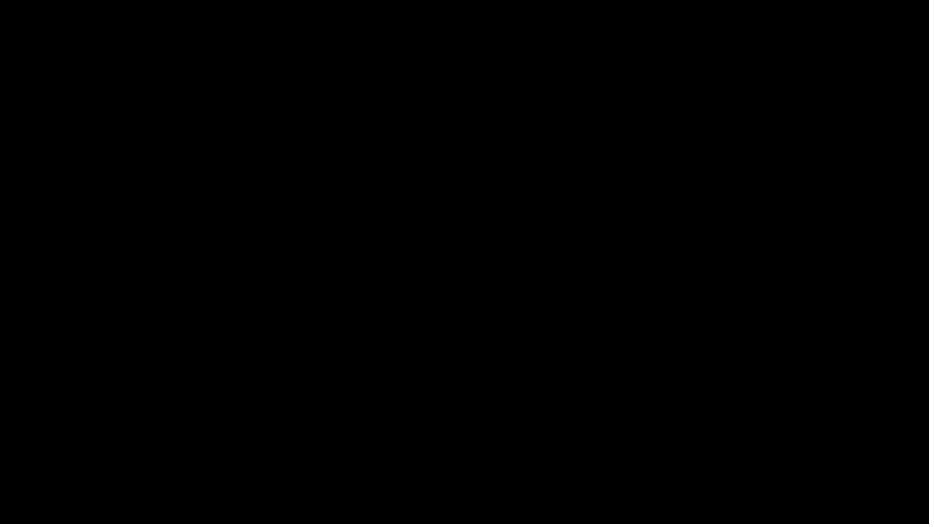
Advanced Turbo Fan Engine

Powder bed AM process



Bio-Medical implant

Patient specific Talus spacer



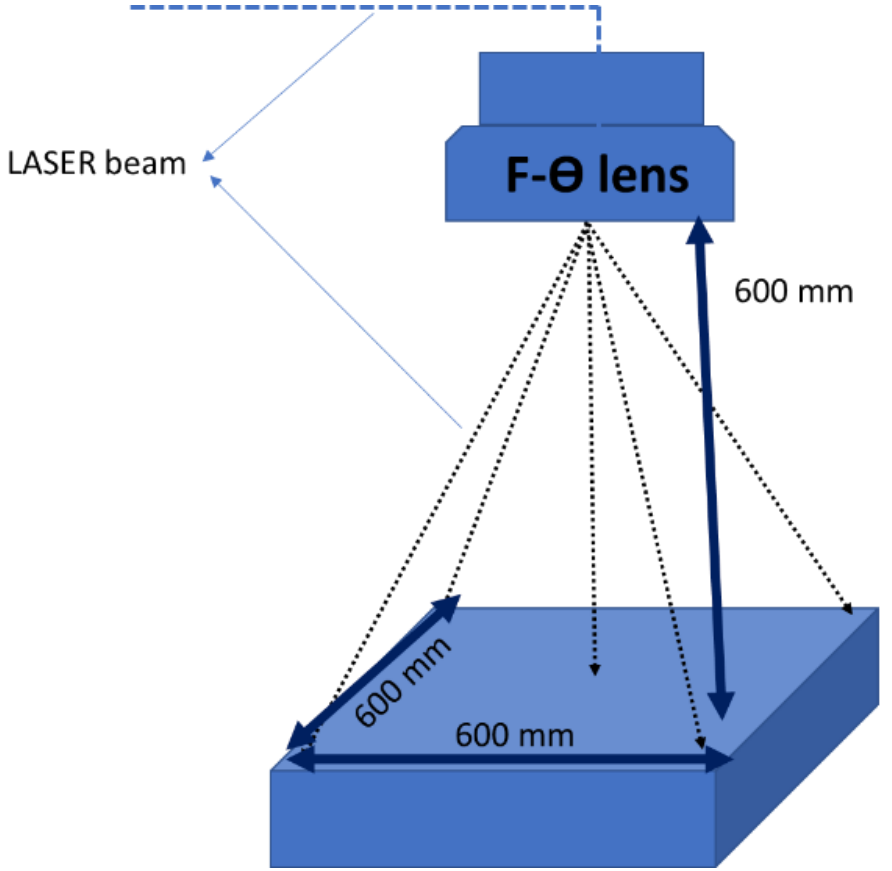
Selective Laser Melting / Sintering

Selective electron Beam Melting powder bed

Binder jetting process

Problem 1: Design F-theta lens system for large area laser beam 2D scanning system

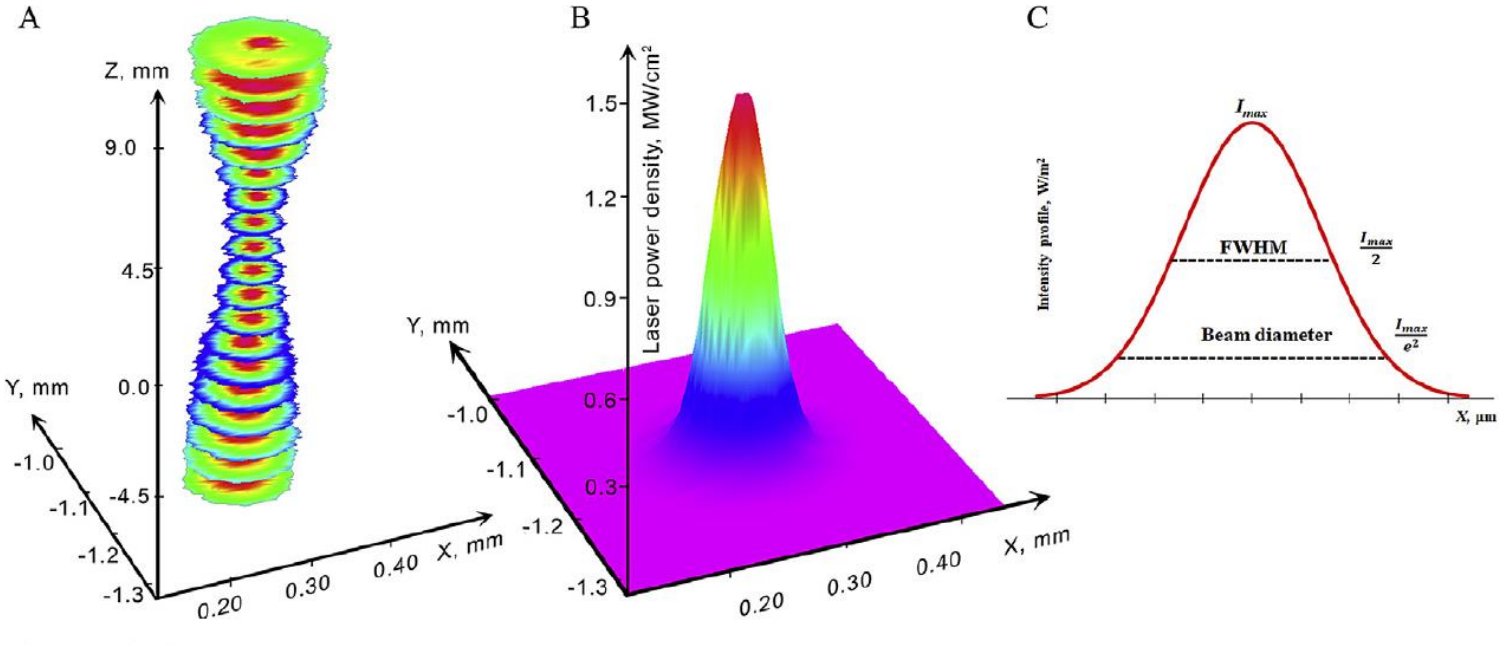
- Laser wavelength of 500nm, 1.067 µm and 10.5 µm.
- Input beam diameter is 1500 µm.
- Expected beam diameter at 600 mm is 100 µm
- Laser beam of circularity(100 µm circular beam) to be maintained over 600X600 mm scanning area at 600mm working distance.



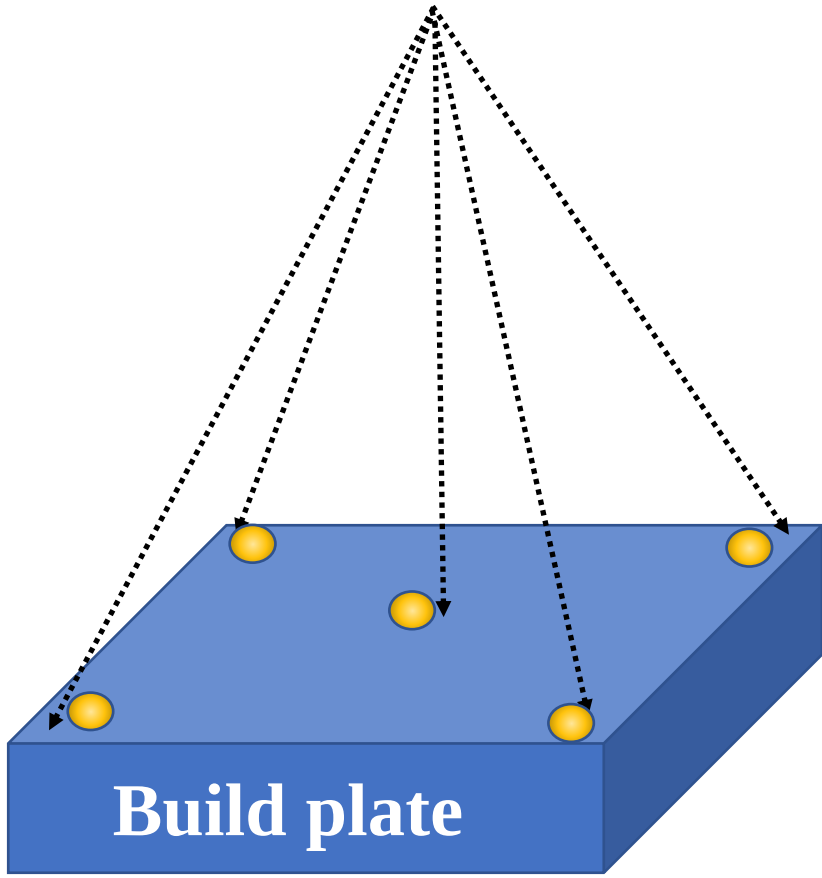
Expected outcome:

- Design with CAD representation of optics system needs to be presented with appropriate mathematical calculation.
- Identification Lens materials needs to be used for the above mentioned wavelength.
- Identification of lens system manufacturing method, integration and testing method needs to identified.
- Lens system should take care of optical errors such as pincushion, astigmatism and other errors.

Energy sources beam profile

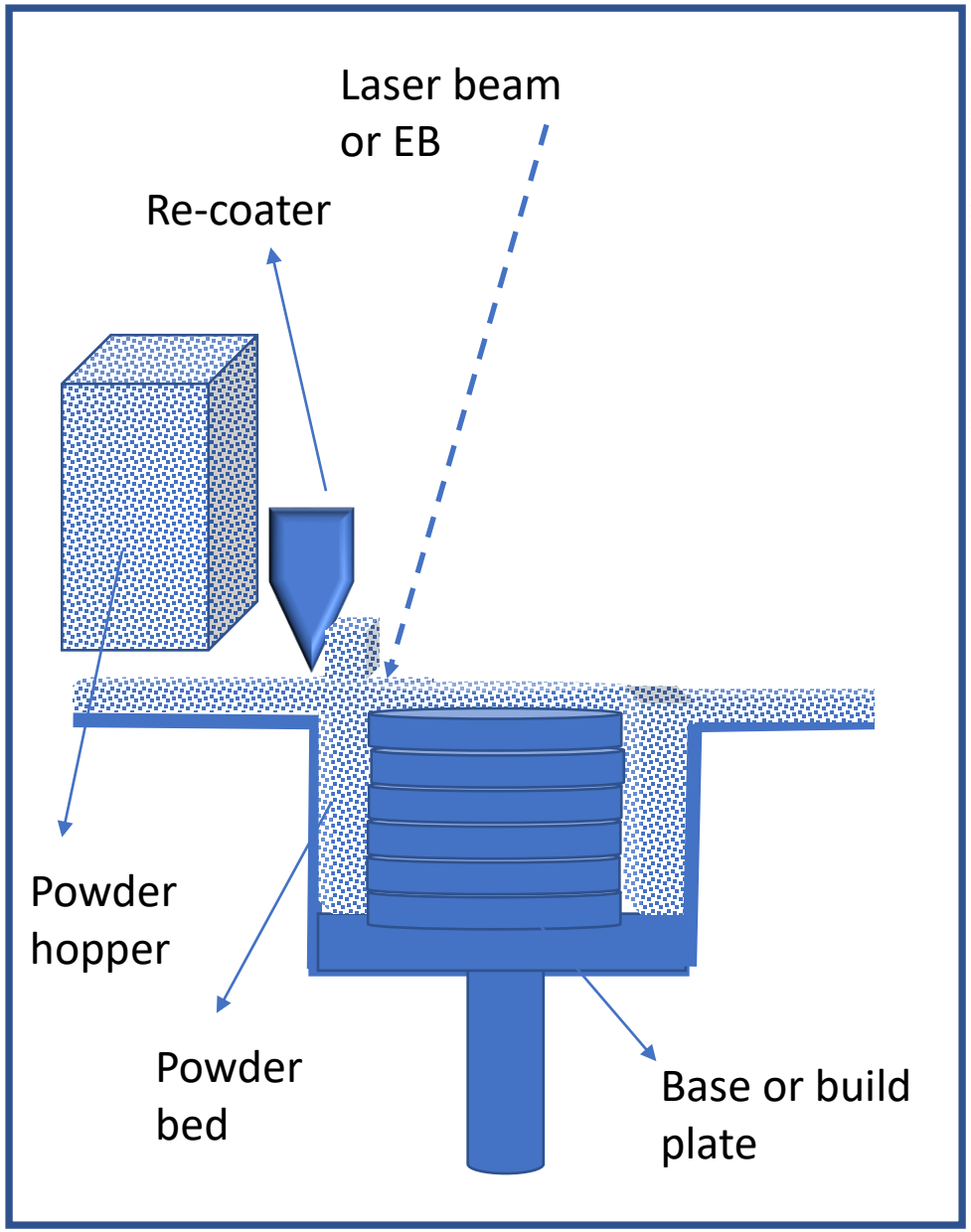


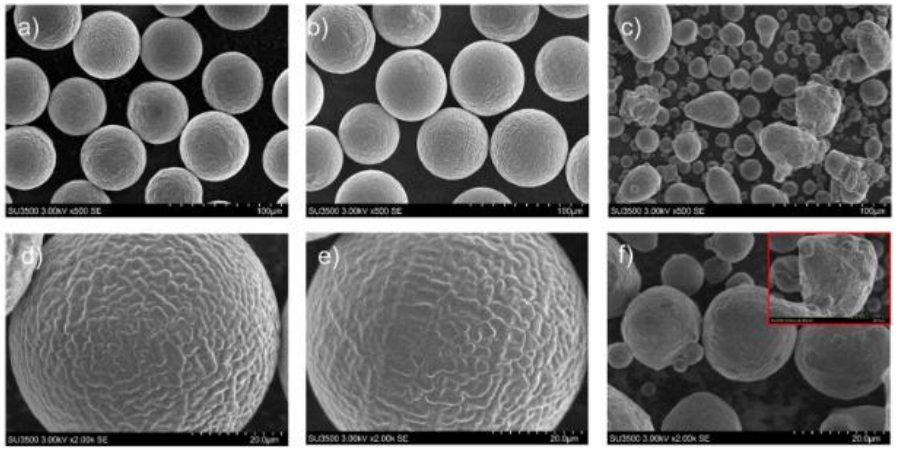
Laser beam spatial profile at different locations along the beam axis (A);
Power density distribution of CW Yb-fiber laser(B)
Gaussian beam diameter definition (C).

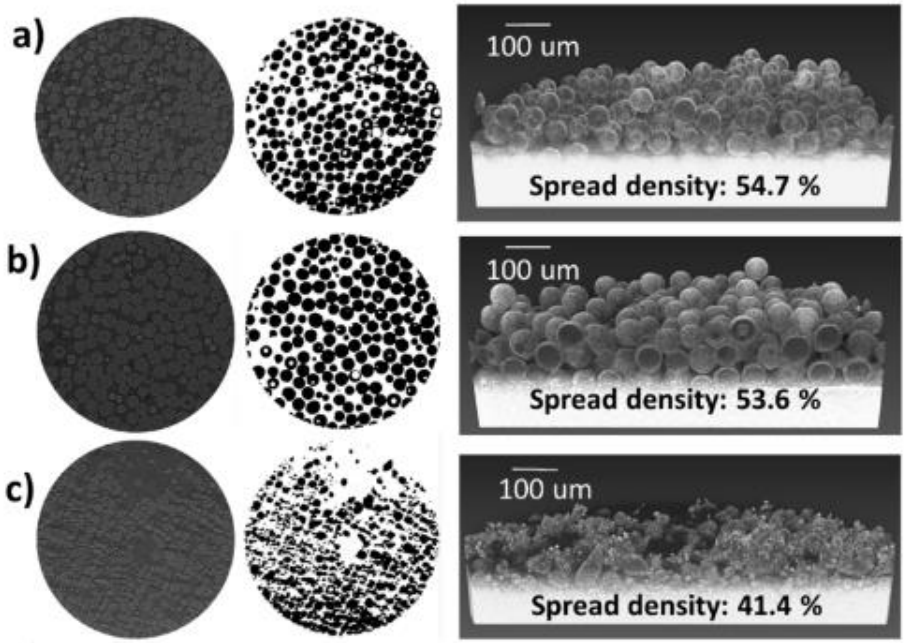


- Uniform energy density

Problem 2: Effect of spherical metal powder flowability at high temperature







- Re-coater(Hard and soft, non-contact)
- Powder hopper with sensors
- Layer thickness
- Re-coating speed
- Recoating count
- Powder wastage
- Powder temperature
- Moisture
- Flowability
- Process atmosphere
- Gas flow
- 15-45 micro meter particles
- Higher could cause large reflections

Materials 2018, 11, 2386; doi:10.3390/ma11122386

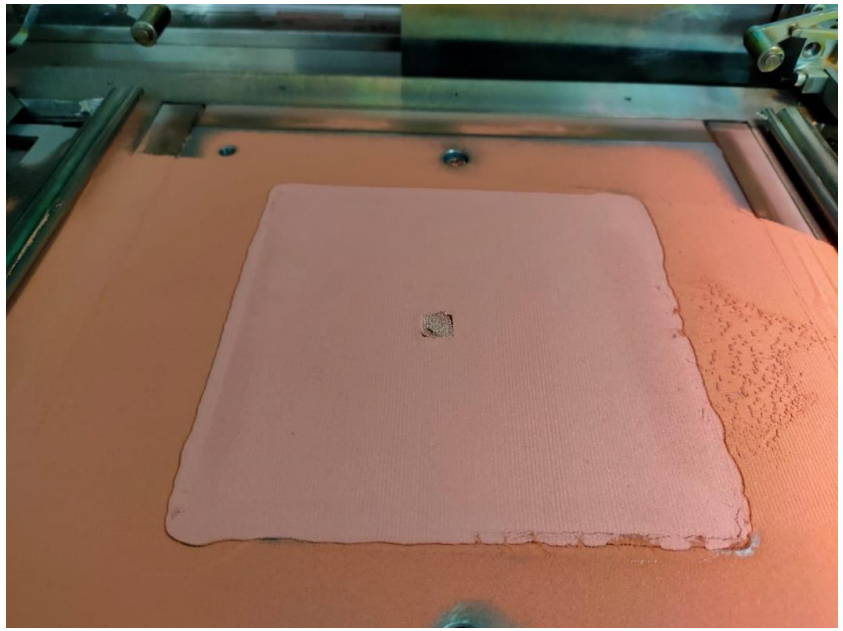
Problem 2: Effect of spherical metal powder flowability at high temperature

Parameter used in the process:

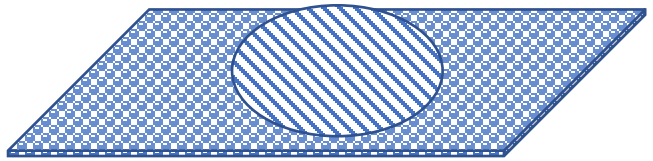
- Powder particle size distribution 45-100 µm
- Temperature during the spreading or re-coating process is 600^{o}C – 1200^{o}C
- Re-coating or blade velocity – 10- 200mm / minute.
- Materials to be considered copper and Titanium Aluminide.

Outcome:

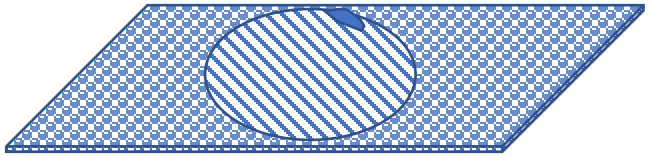
- Powder agglomeration behavior with respect re-coating speed, process temperature and the materials system.
- Threshold temperature at which powder starts giving poor flowability during the re-coating.
- Effect of re-coating density at different temperatures.



Problem 3: In-situ and Ex-situ defect identification methods using imaging methods in Additive manufacturing.



Ideal layer information to be printed



Printed layer with a defect.

Outcome:

- Methodology to be developed for image of capturing and comparing
- The method should be able to identify defects more than 50 µm
- Required instrumentation methodology needs to identified with

Thank you