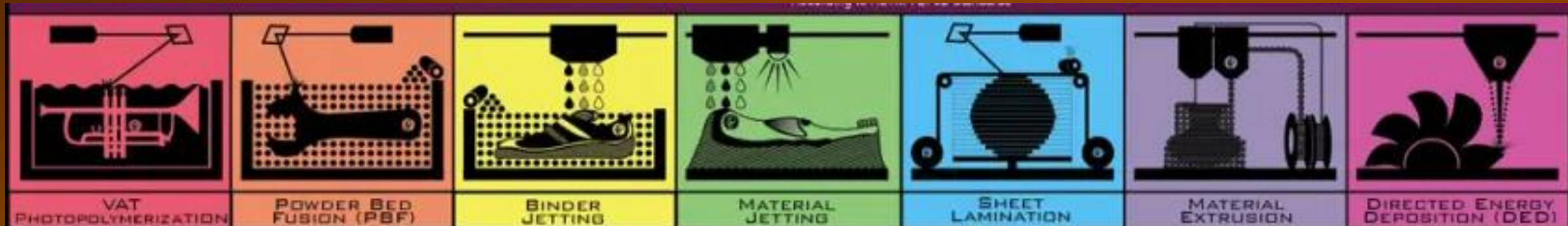


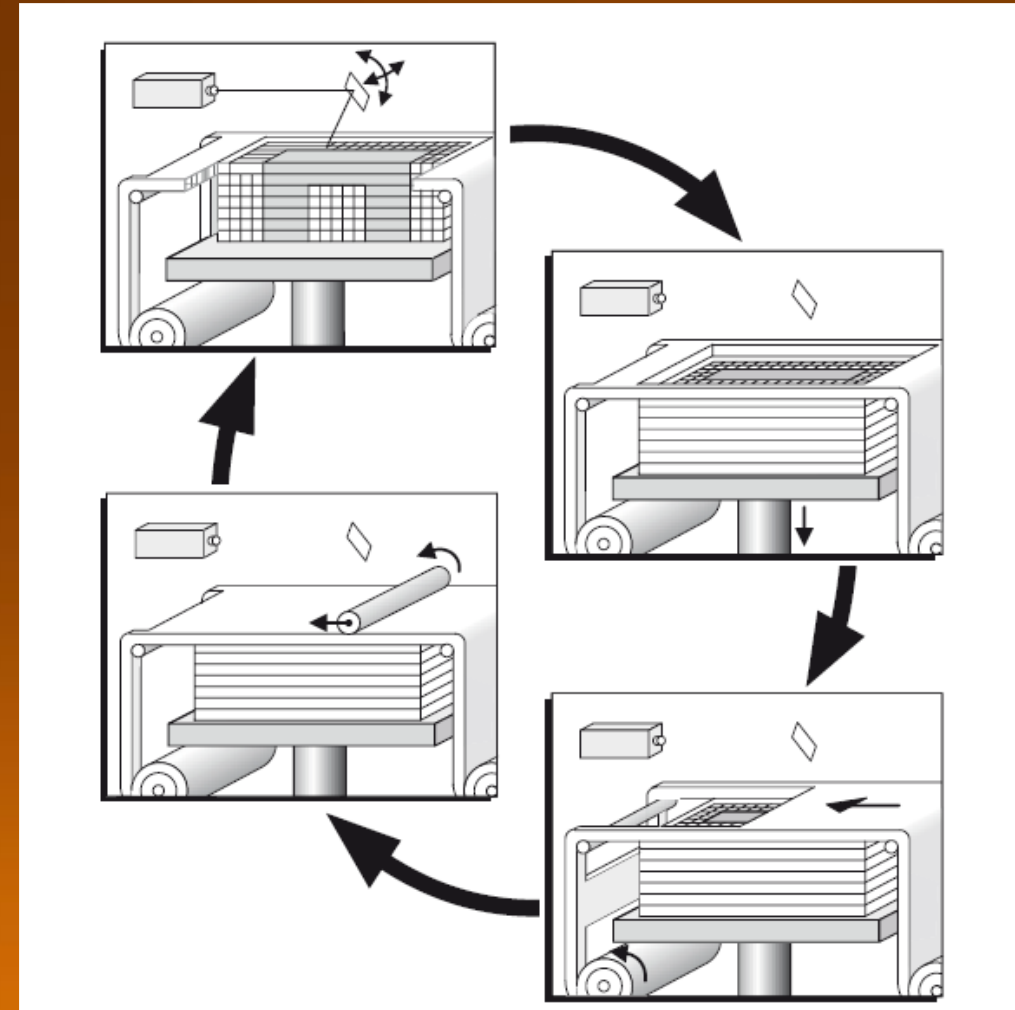
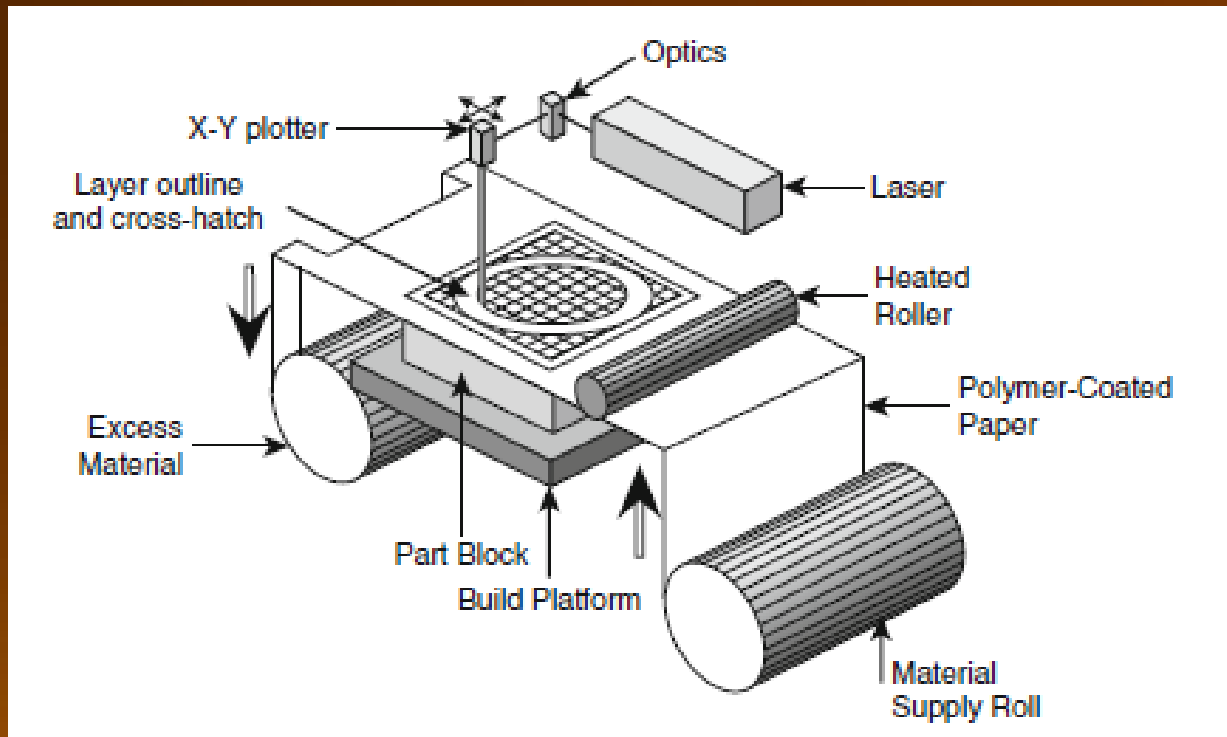


# APRESENTAÇÃO DOS PROCESSOS ADITIVOS





# Layer Laminate Manufacturing, Sheet Lamination Processes, Laminated Object Manufacturing (LOM)





# Laminated Object Manufacturing (LOM)

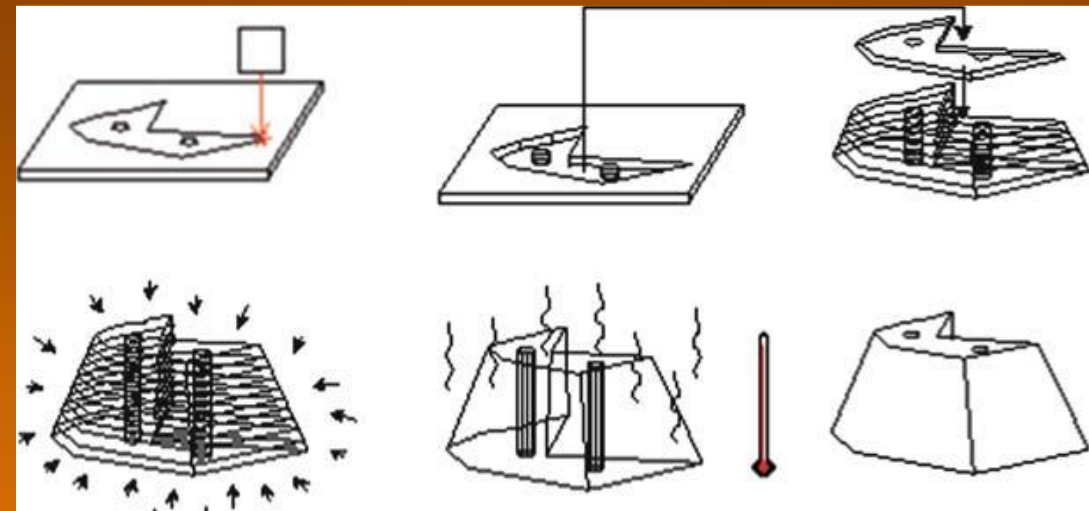
## Bond-then-Form Processes:

- 1 - placing the laminate,
- 2 - bonding it to the substrate,
- 3 - cutting it according to the slice contour.

The original LOM machines used this process with adhesive-backed rolls of material, where a heated roller melted the plastic coating, causing it to adhere to the previous layer. A laser (or a mechanical cutting knife) cut to a depth of one layer thickness.

## Form-then-Bond Processes:

sheet material is cut to shape first and then bonded to the substrate.

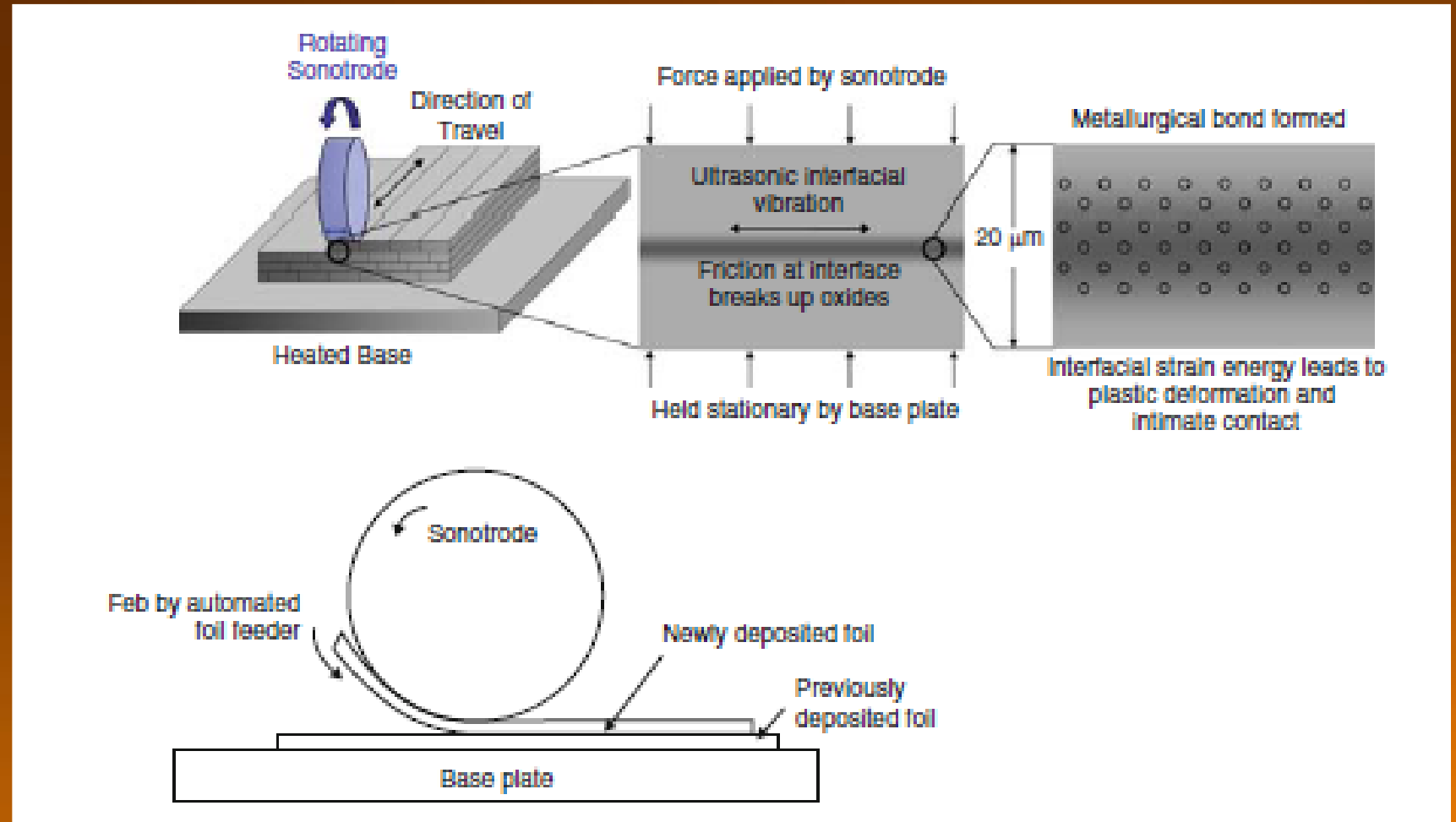




# Laminated Object Manufacturing (LOM)

## Ultrasonic LOM

Hybrid sheet lamination process combining ultrasonic metal seam welding and CNC milling, and commercialized by Solidica Inc., USA in 2000.

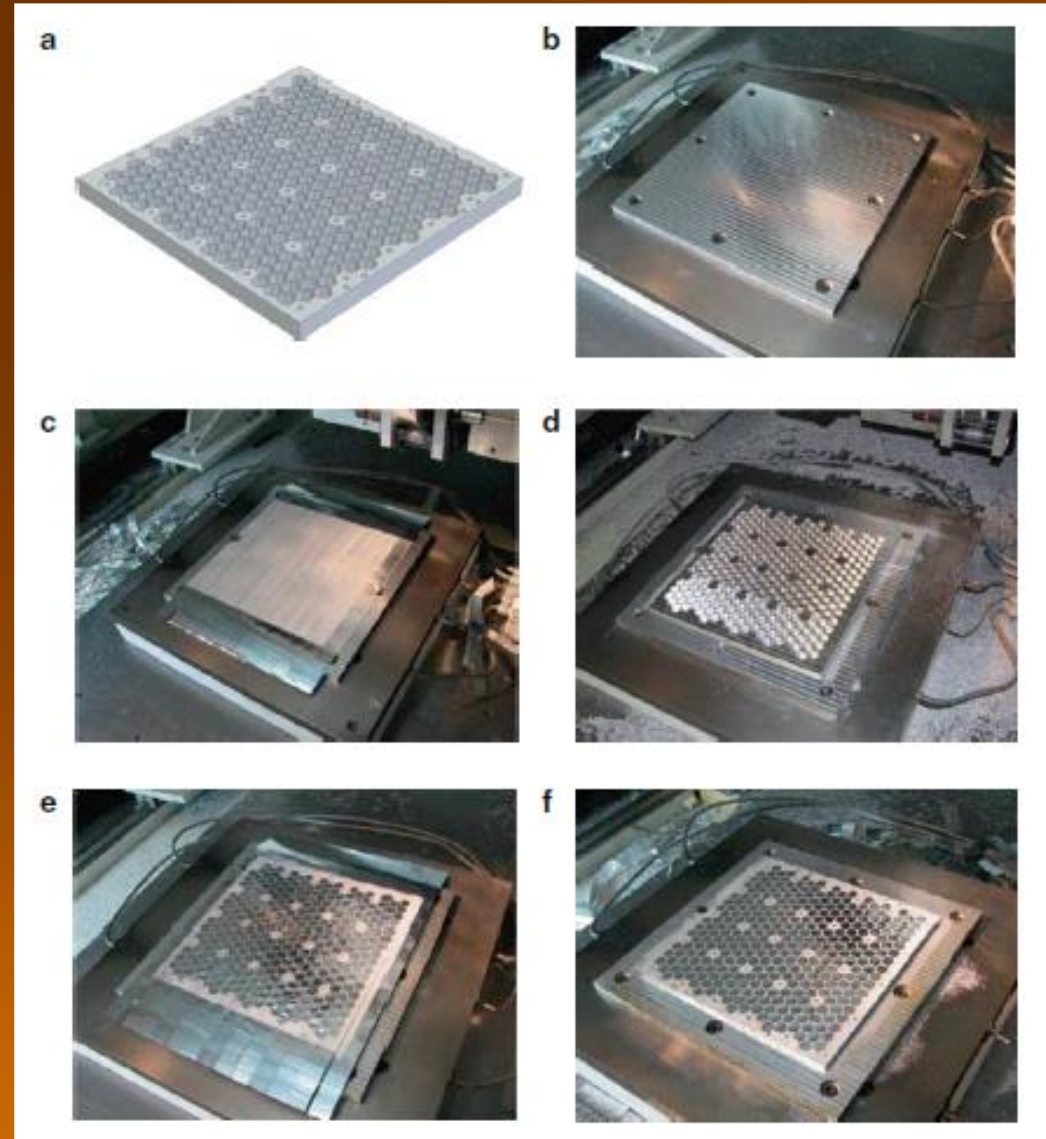




# Laminated Object Manufacturing (LOM)

## Ultrasonic LOM

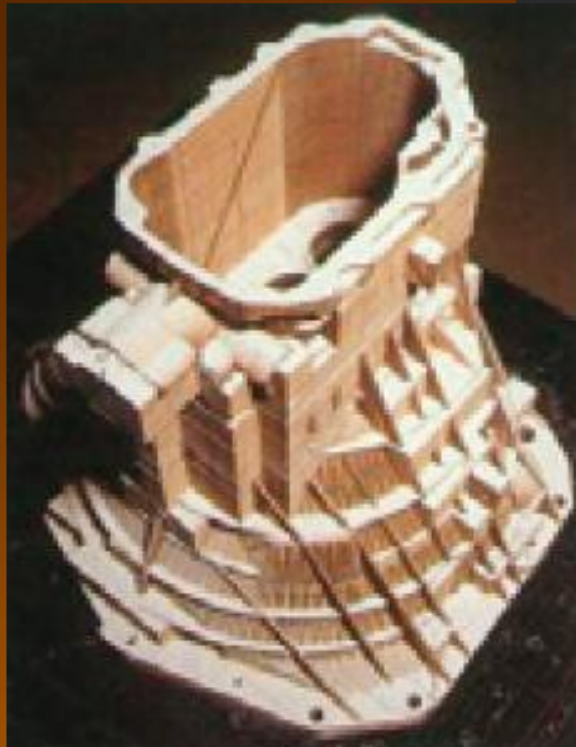
356 mm by 356 mm by  
12.7 mm Al 3003 base  
plate





# Laminated Object Manufacturing (LOM)

papers



plastics

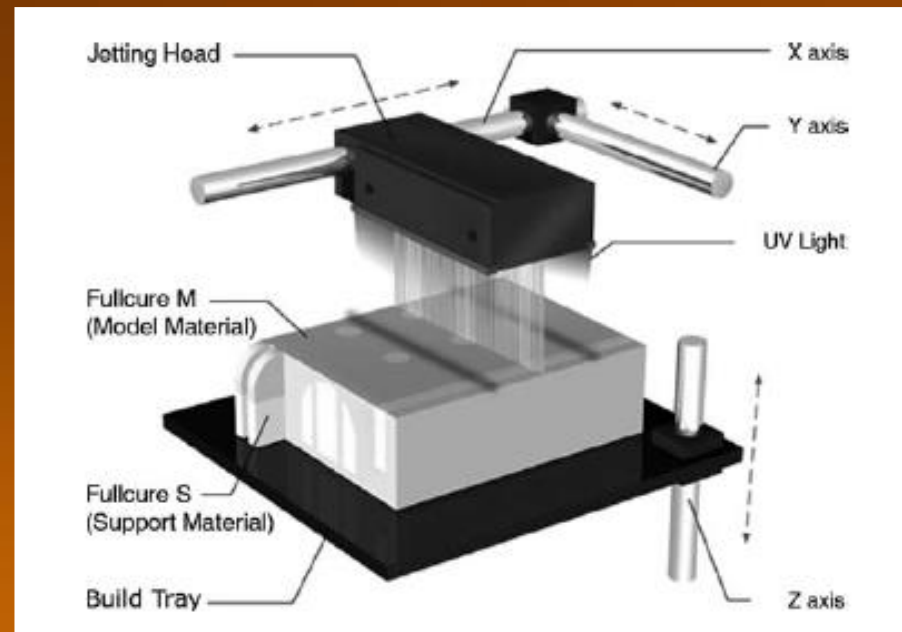


Examples



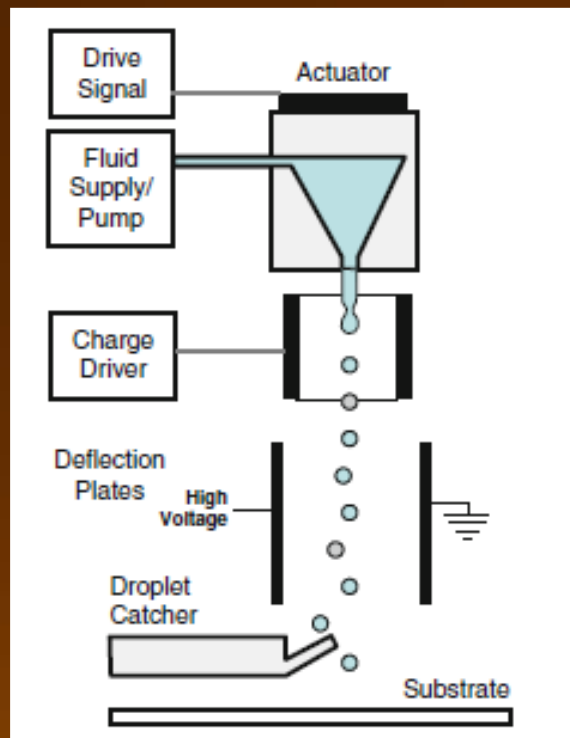
## Printing Processes - History

- Printing as a 3D building method was first demonstrated in the 1980s with patents related to the development of Ballistic Particle Manufacturing, which involved simple deposition of “particles” of material onto an article
- Binder printing methods were developed in the early 1990s, at MIT, in which a binder is printed onto a powder bed to form part cross sections.
- More recently, we have deposition of acrylate photopolymer, wherein droplets of liquid monomer are formed and then exposed to ultraviolet light to promote polymerization.

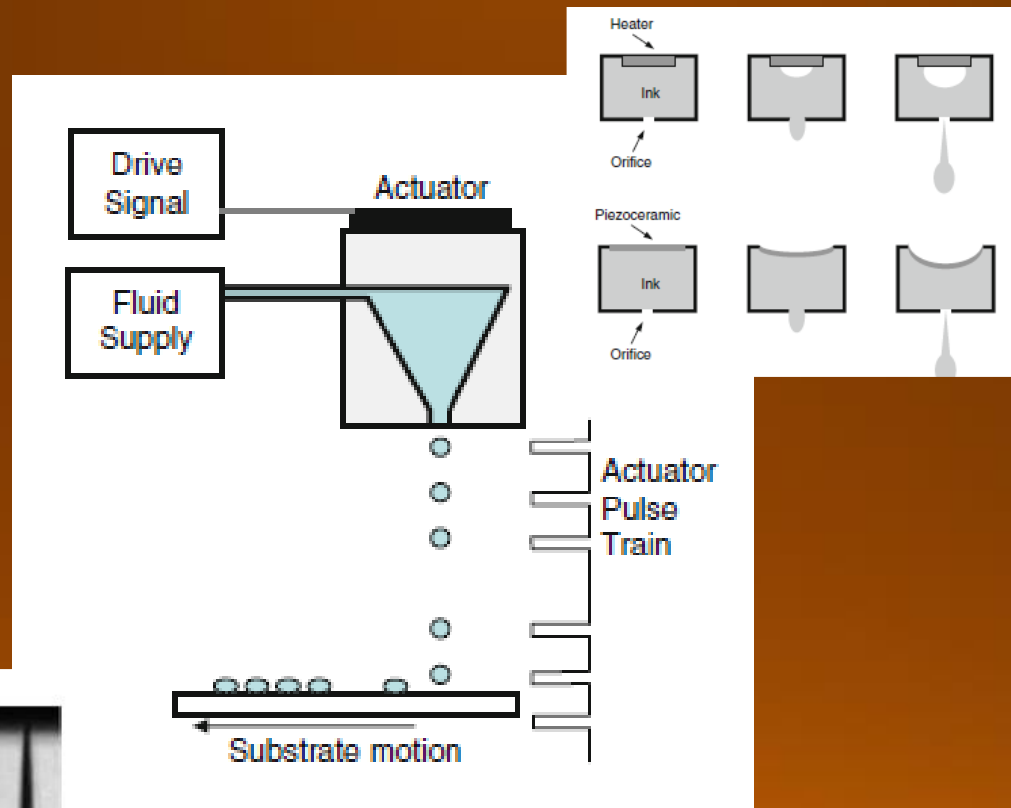
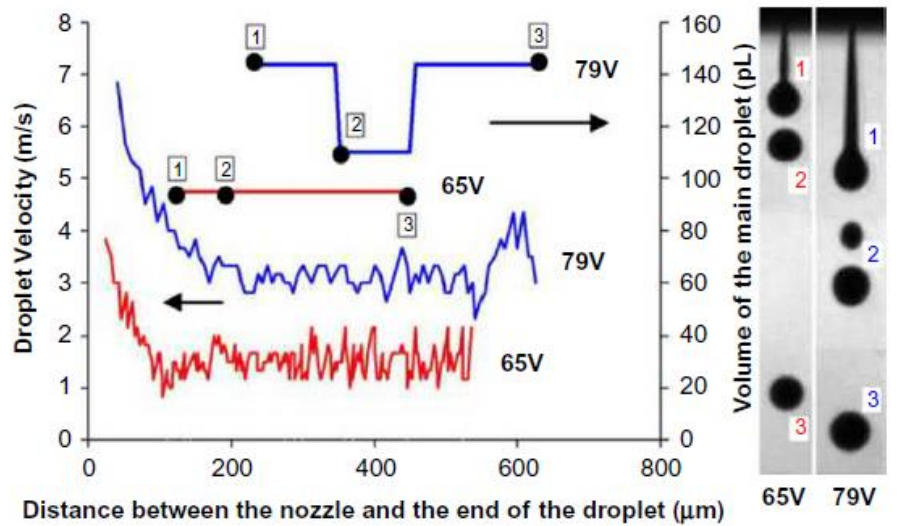




# Printing Processes - Variations



Binary deflection, continuous printing



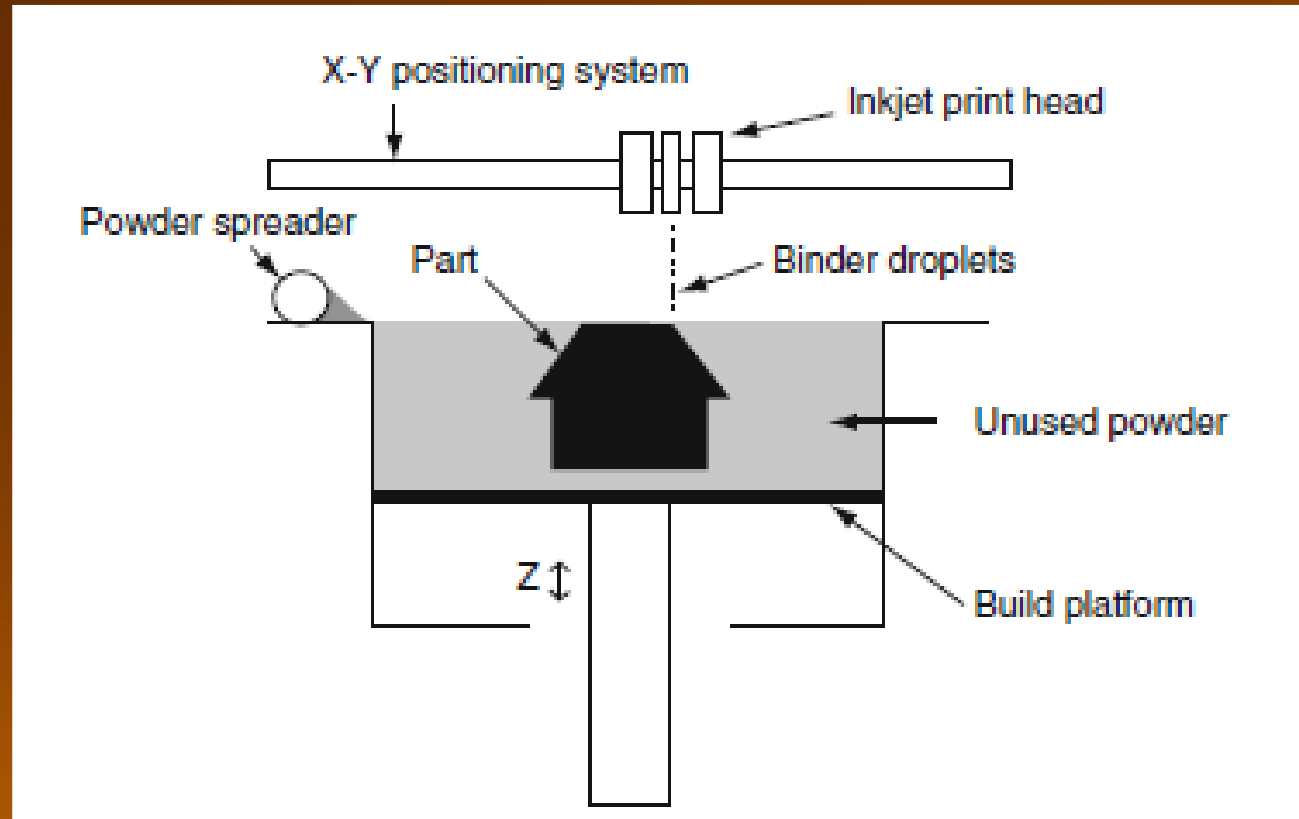
Drop-on-demand printing





# Printing Processes - Variations

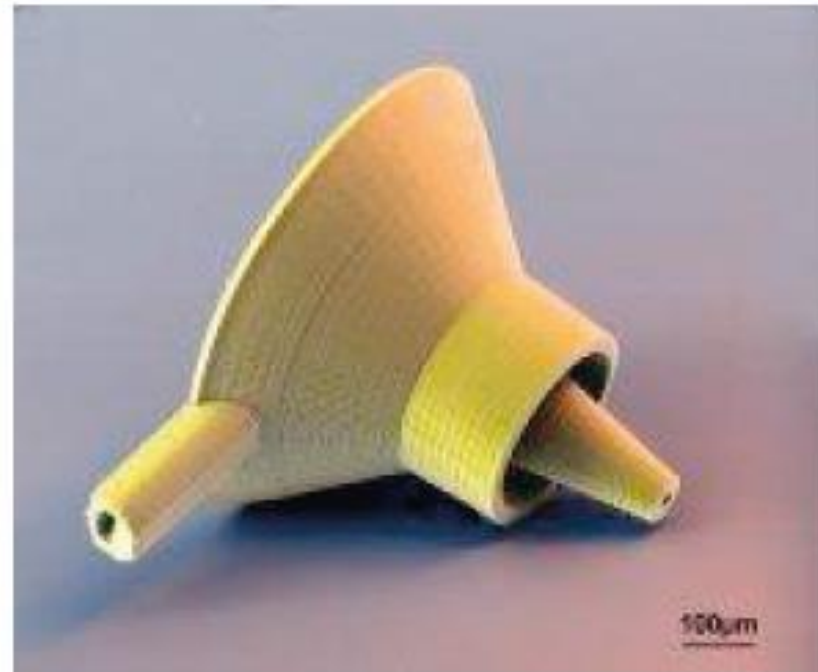
Binder jet printing





# Printing Processes - Variations

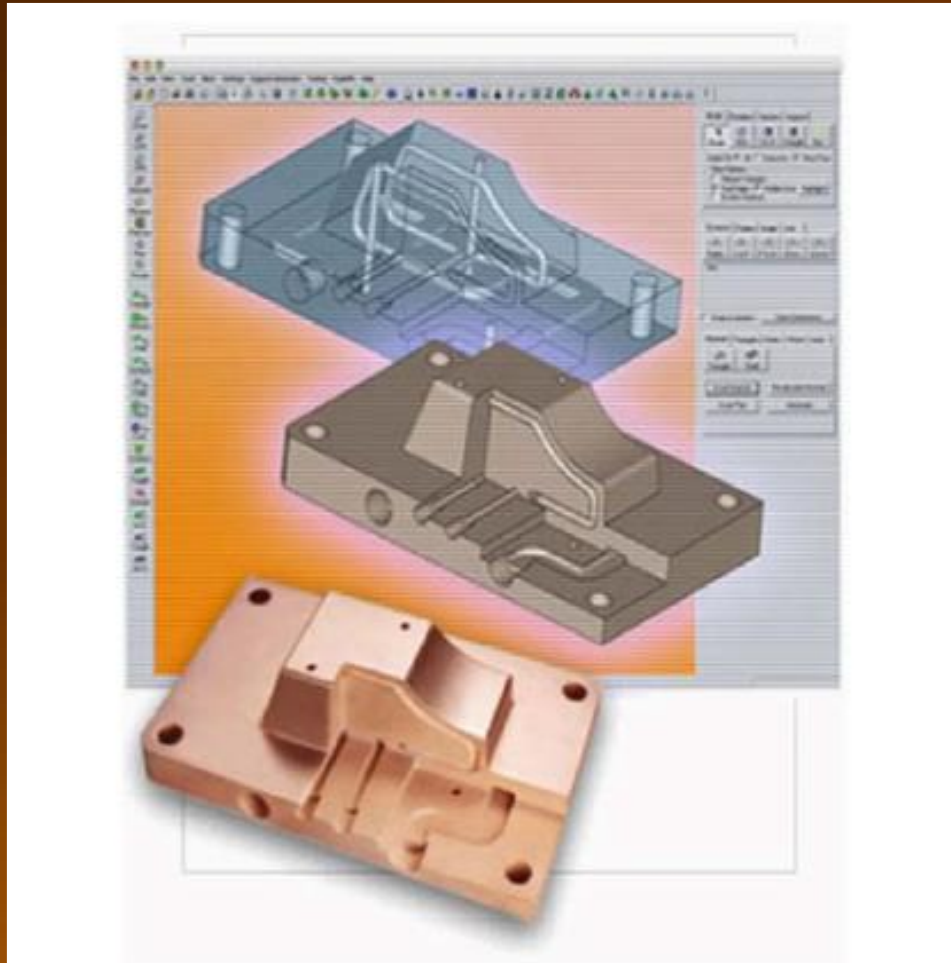
## Micro Stereolithography





# Printing Processes

## Examples





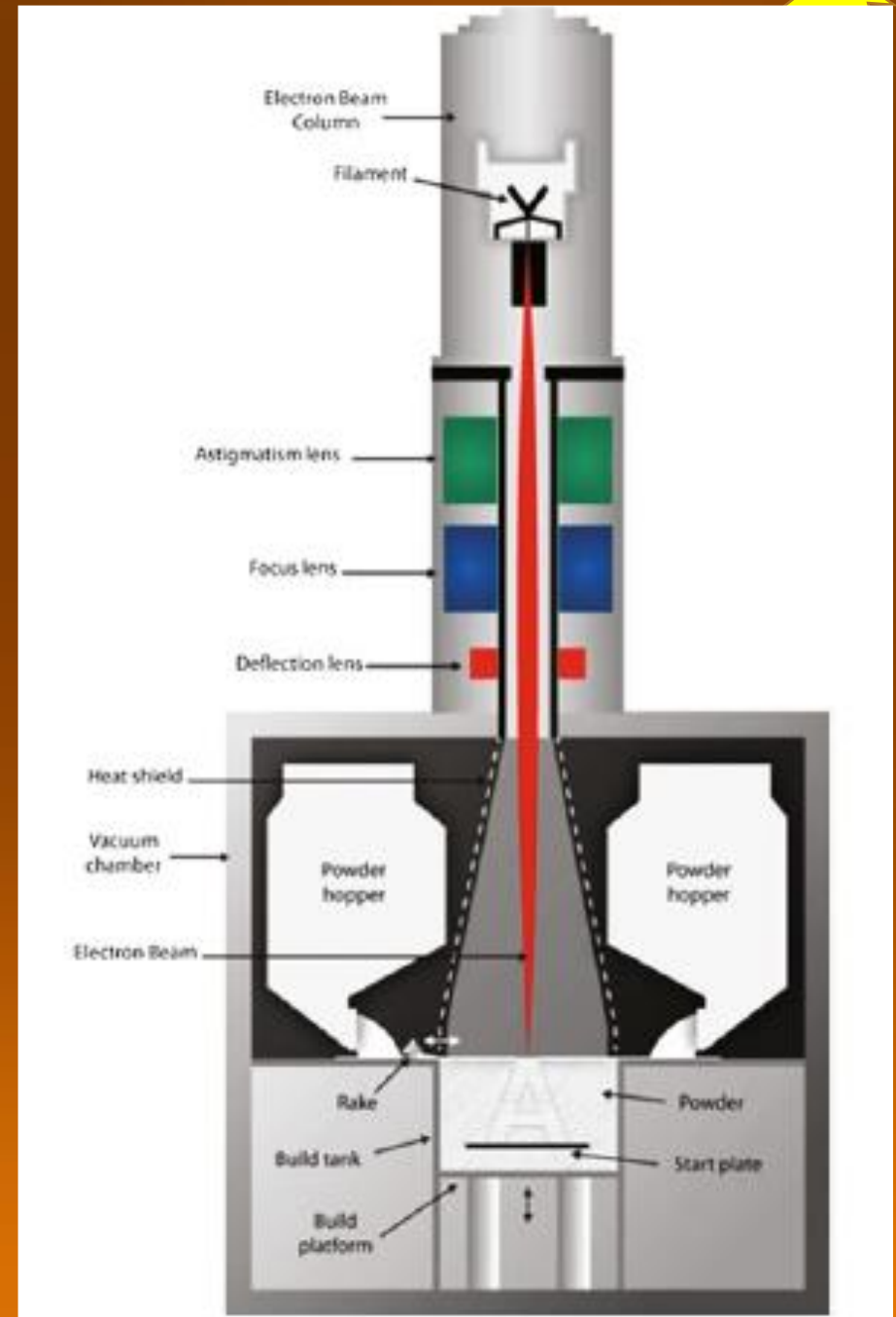
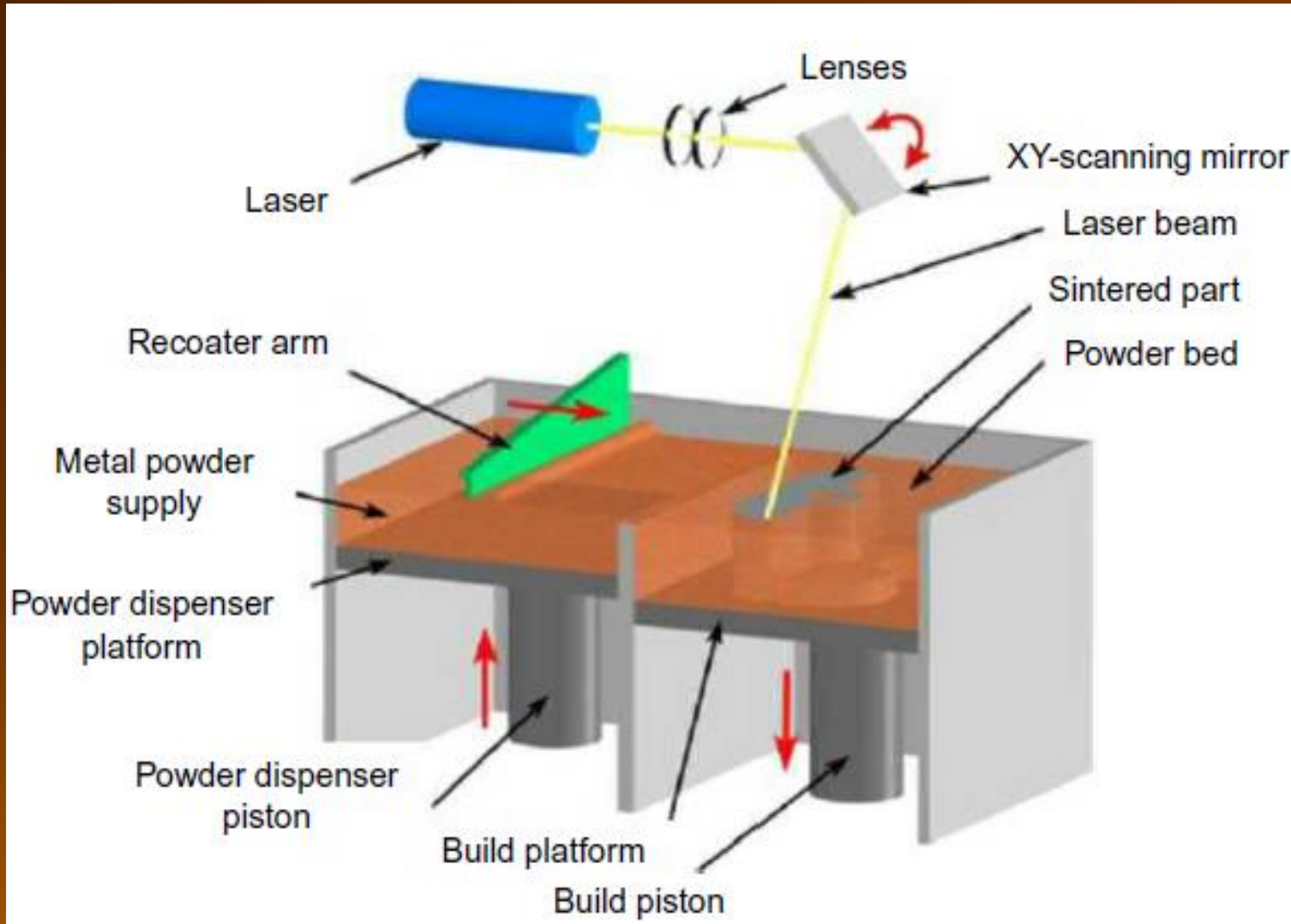
## Powder Bed Fusion - PBF

- Selective laser melting (SLM)
- Direct metal laser sintering (DMLS).

### Energy Sources:

- Laser Beam
- Electron Beam
- Electric Arc (to patent yet)

# Powder Bed Fusion - PBF





# Powder Bed Fusion - PBF

Electric Arc (to patent yet)

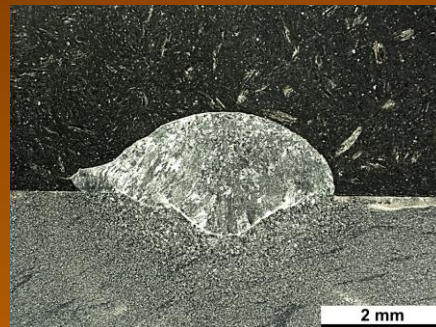
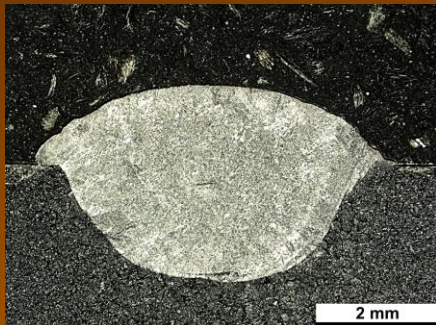
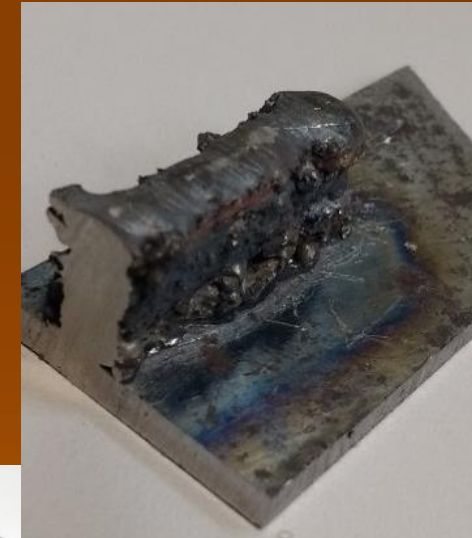


Ceramic Cup

Tungsten electrode

Substrate

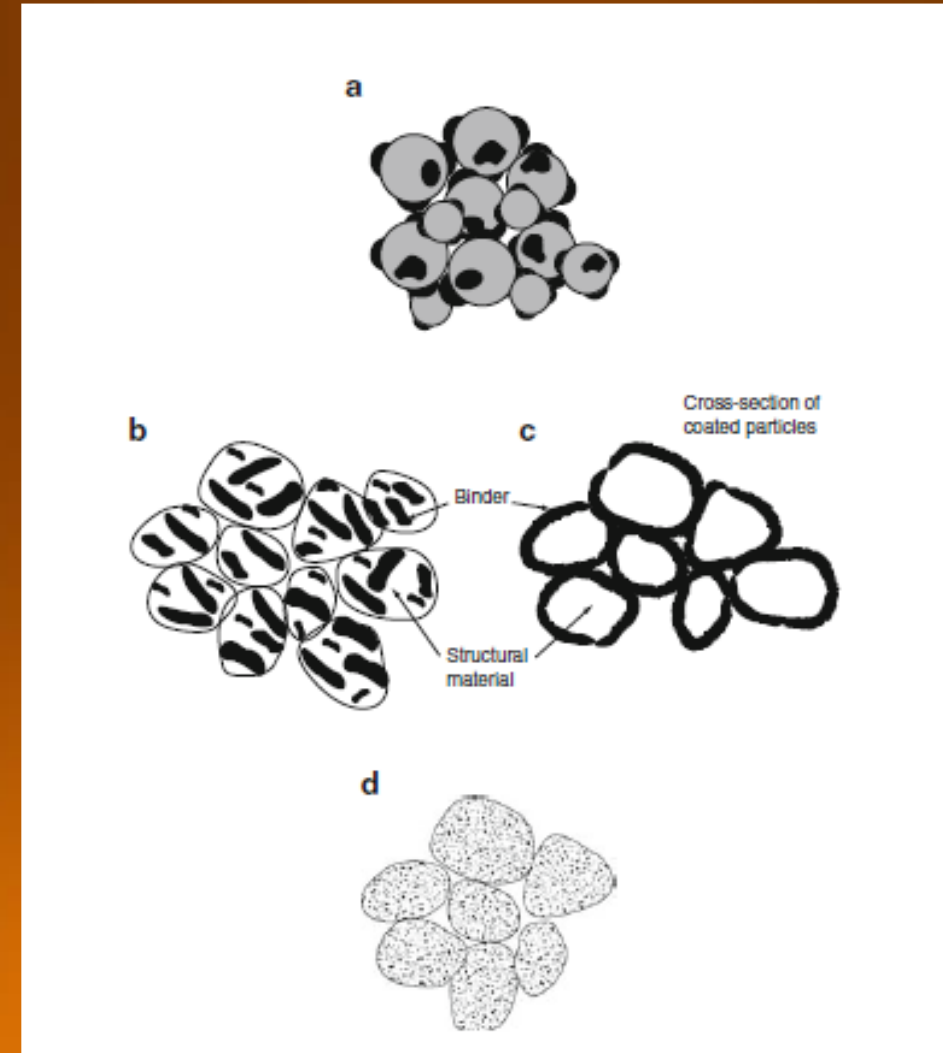
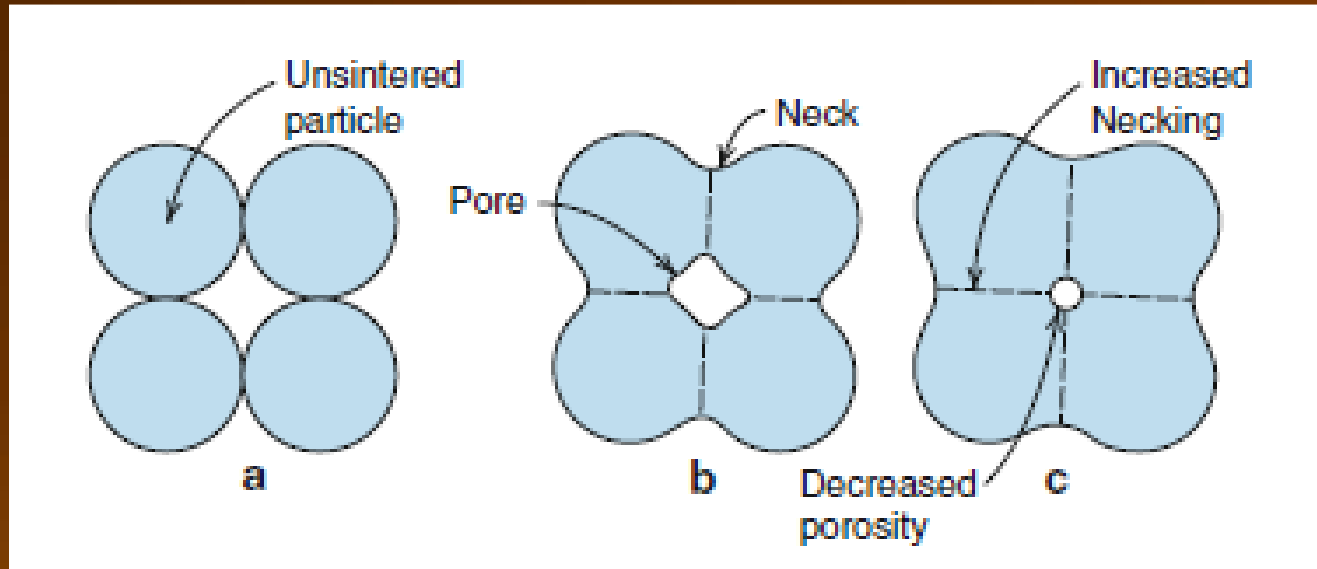
Weld bead





# Powder Bed Fusion - PBF

# Sintering Mechanisms

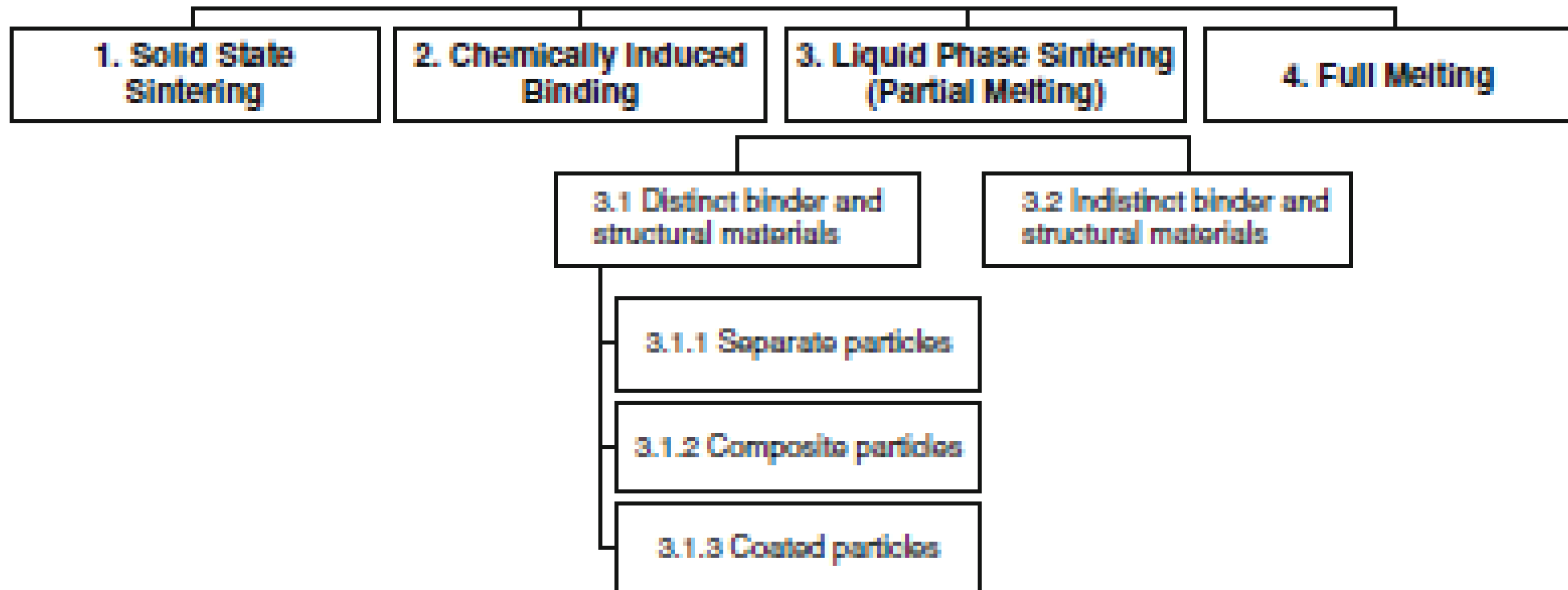




# Powder Bed Fusion - PBF

# Sintering Mechanisms

## Primary Binding Mechanisms in Powder Bed Fusion Processes

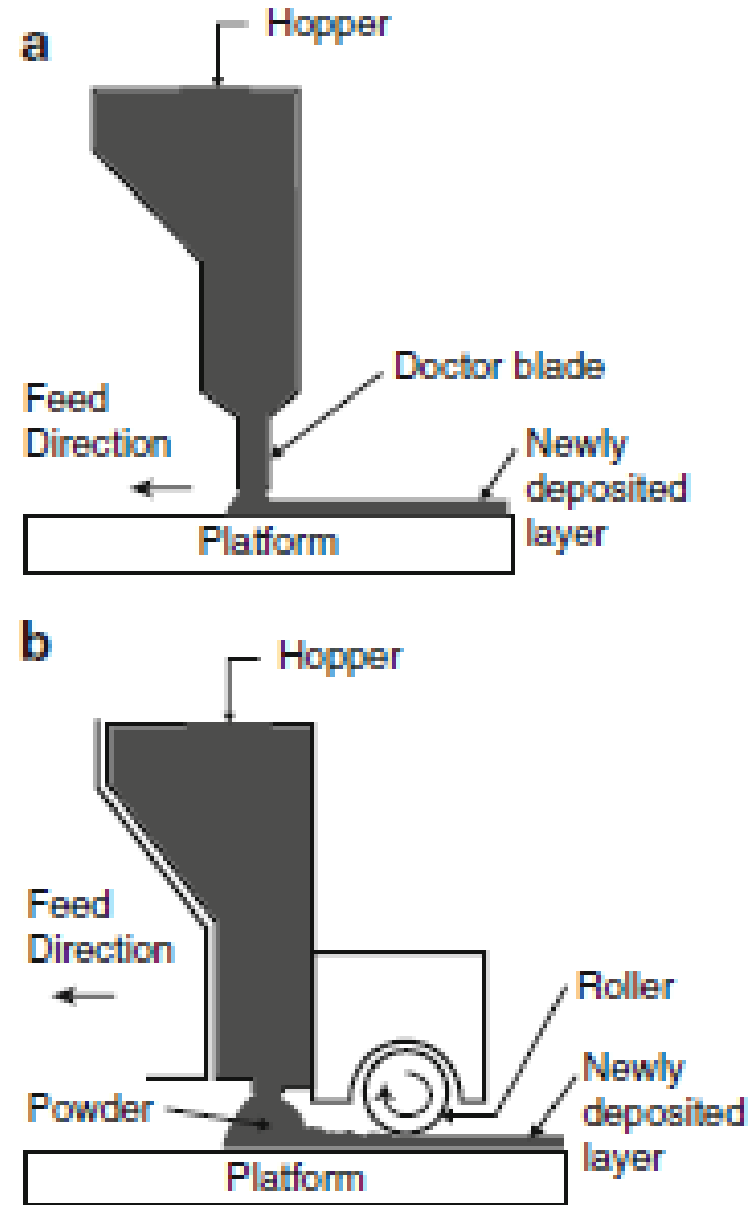






# Powder Bed Fusion - PBF

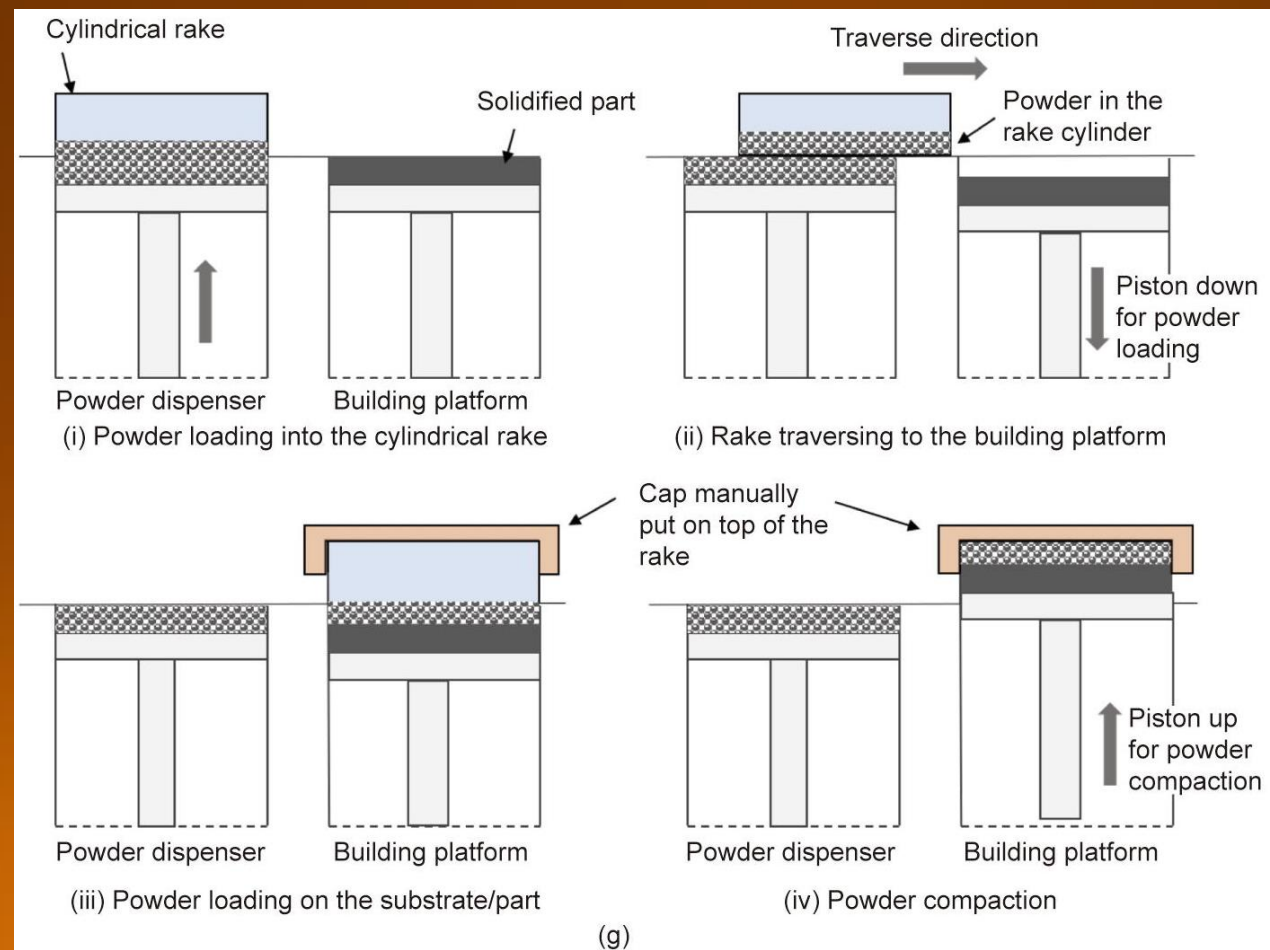
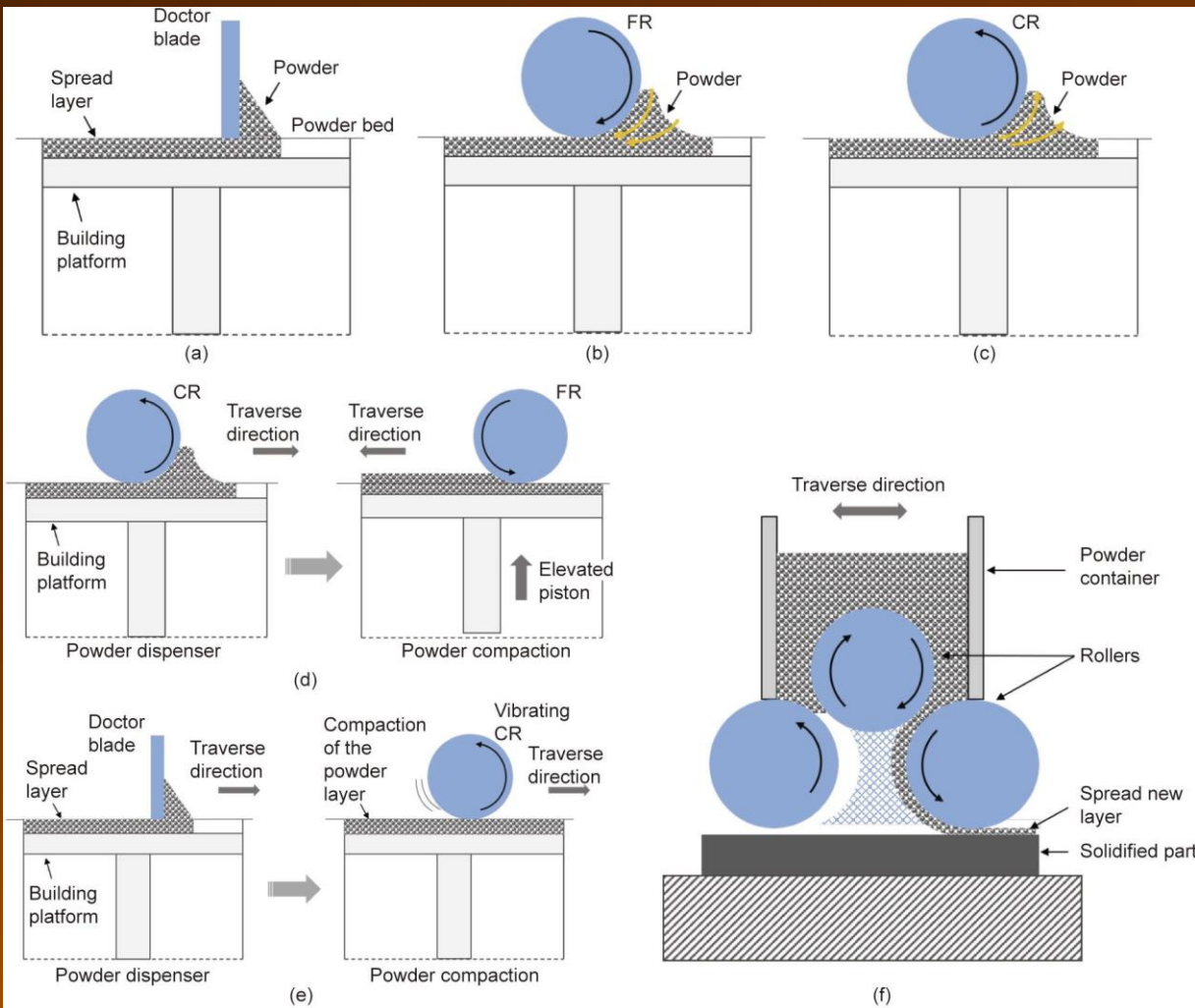
Powder delivery systems





# Powder Bed Fusion - PBF

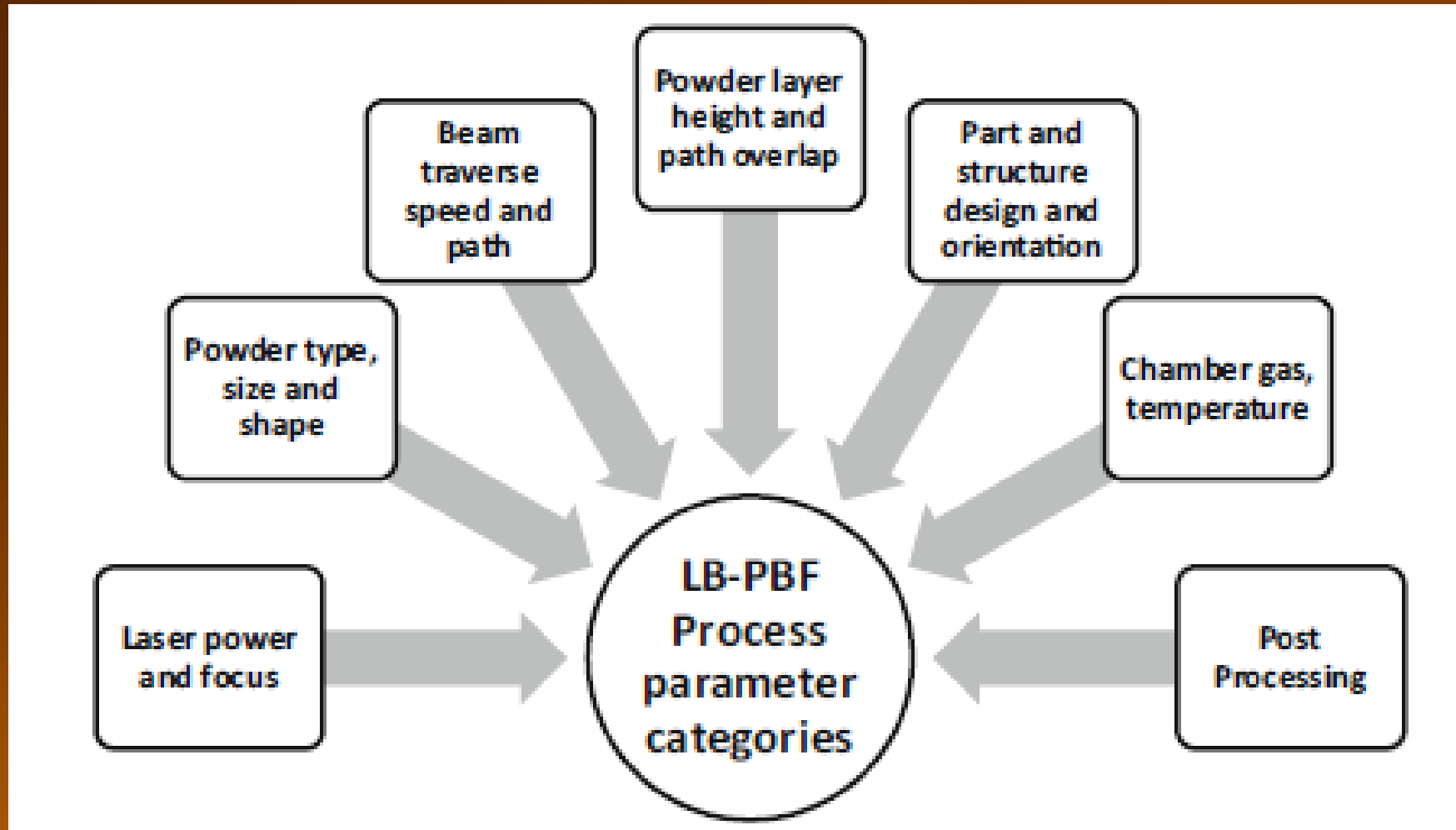
# Powder delivery systems





# Powder Bed Fusion - PBF

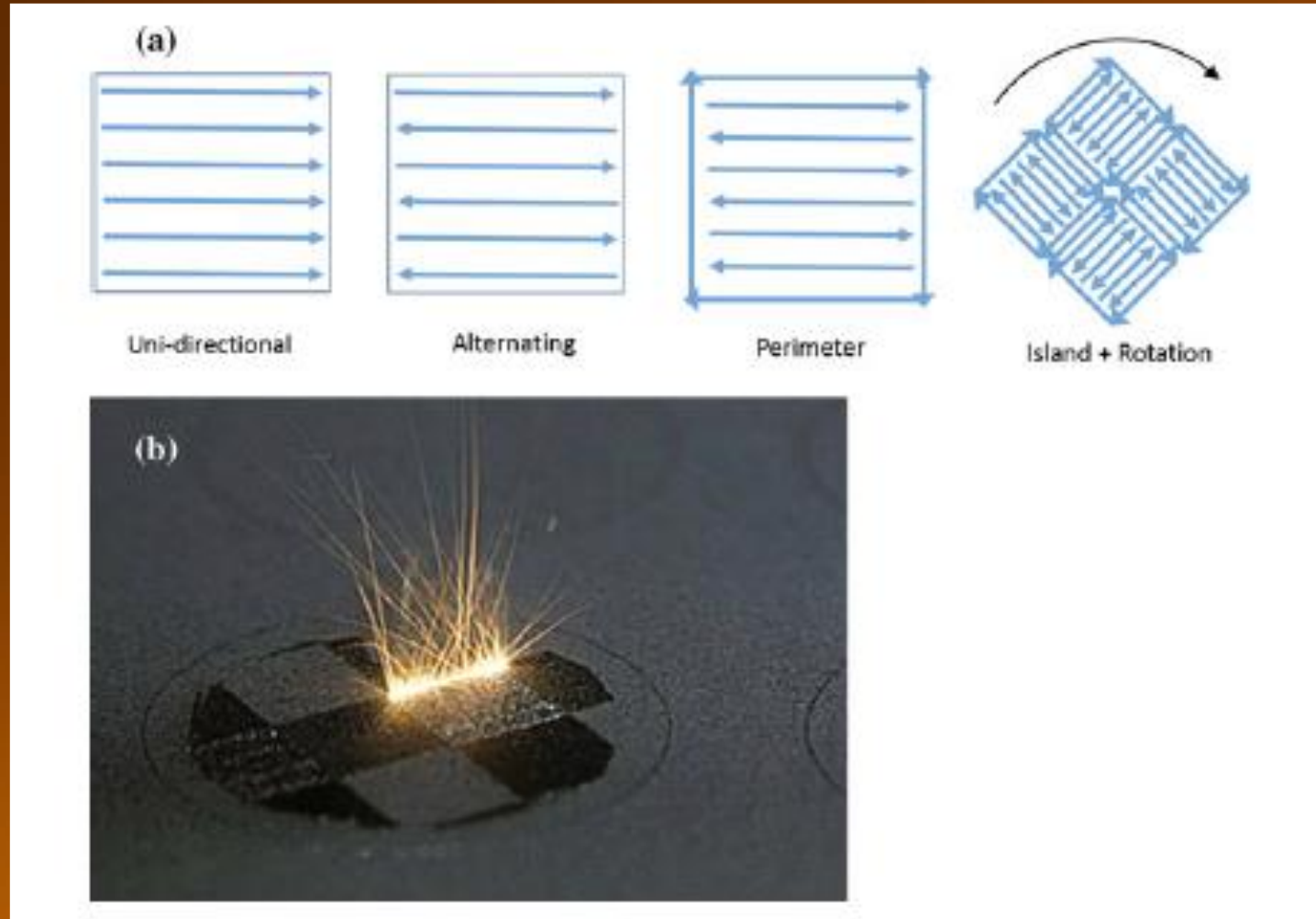
## Parameters selection





# Powder Bed Fusion - PBF

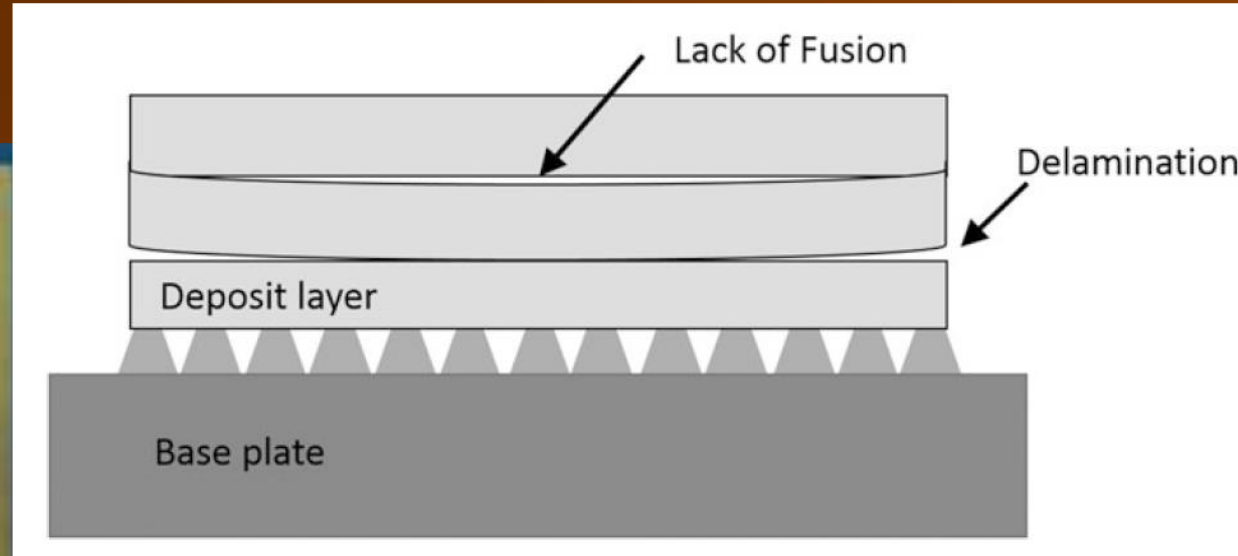
## Path strategy





# Powder Bed Fusion - PBF

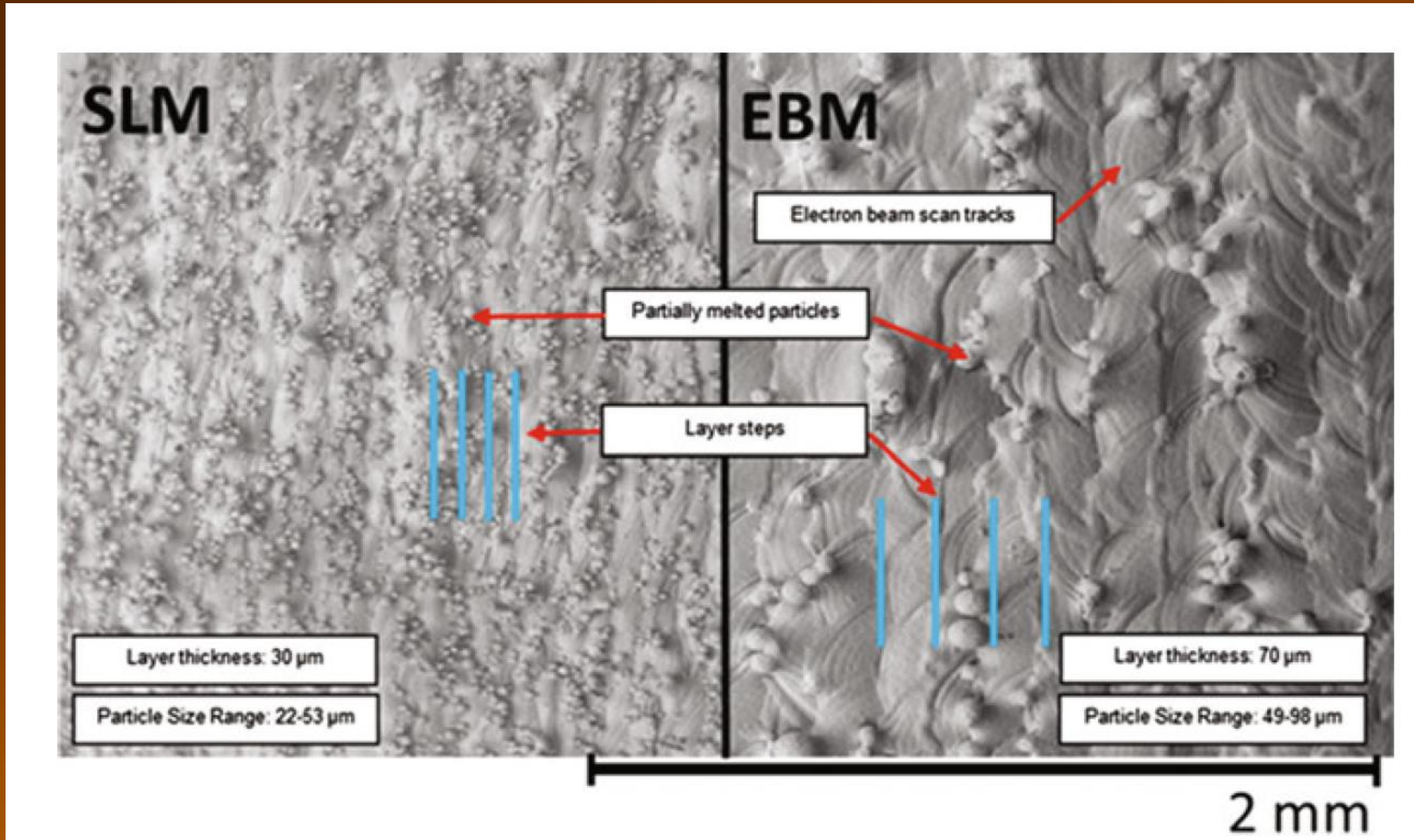
## Residual stresses





# Powder Bed Fusion - PBF

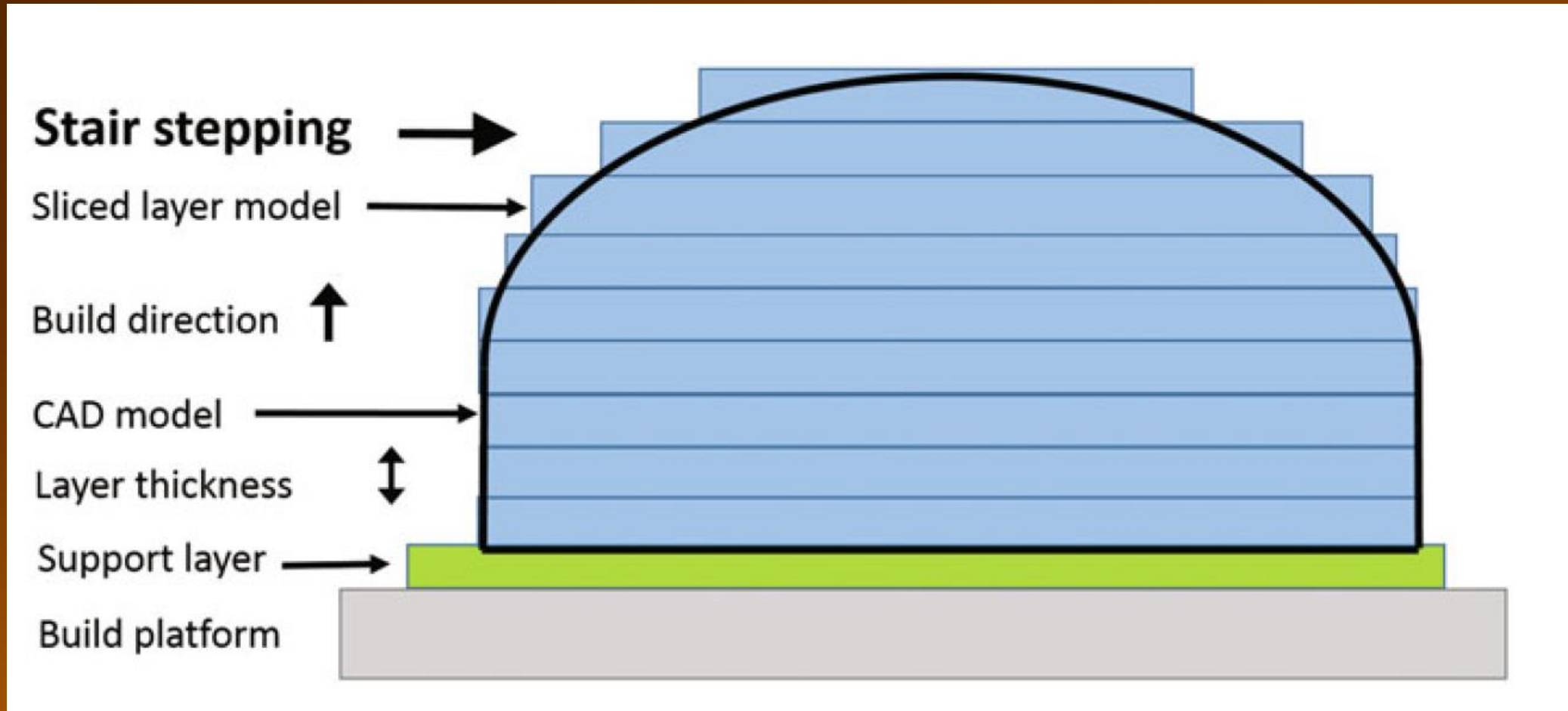
# Microstructure





# Powder Bed Fusion - PBF

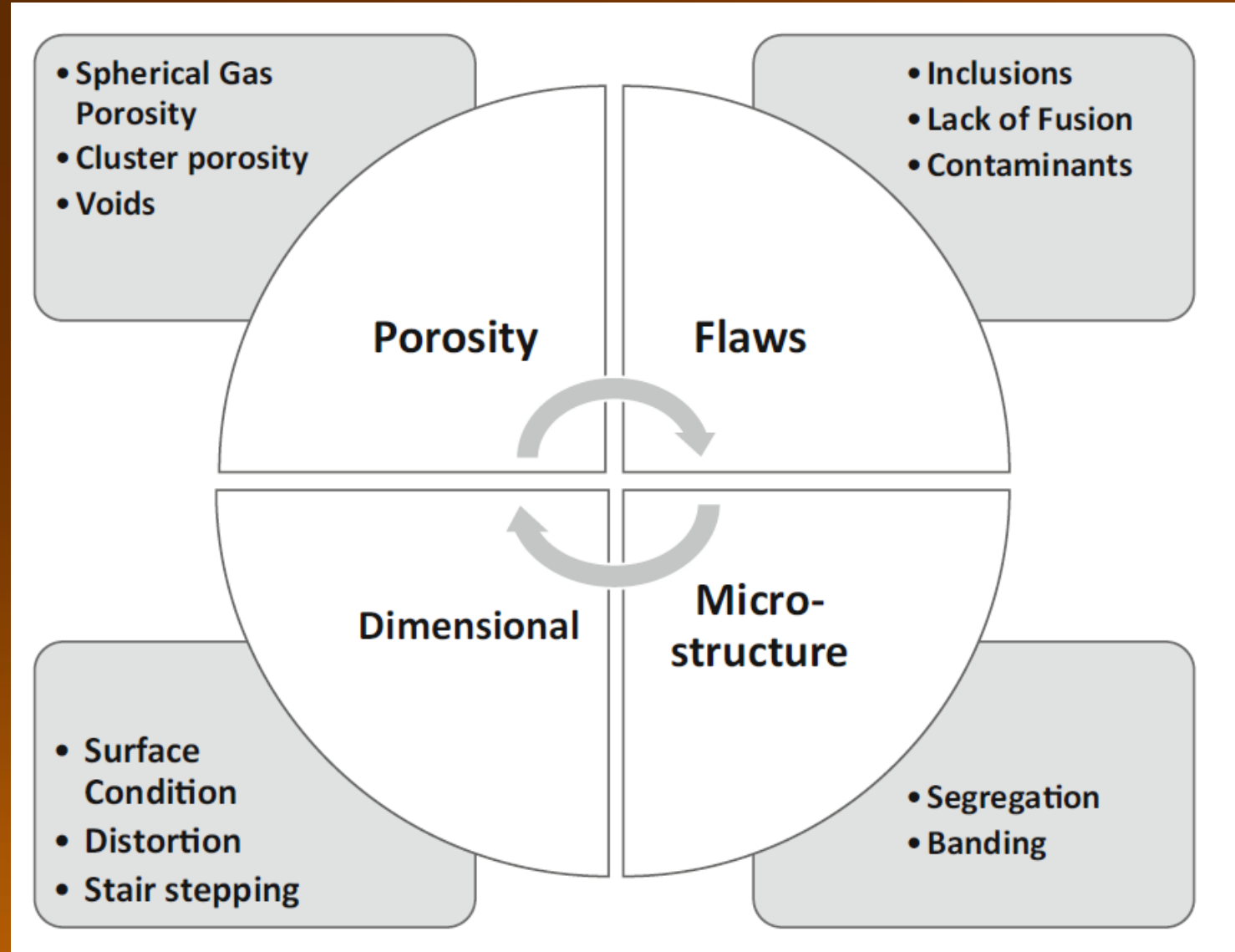
Surface aspect





# Powder Bed Fusion - PBF

## Microstructural flaws

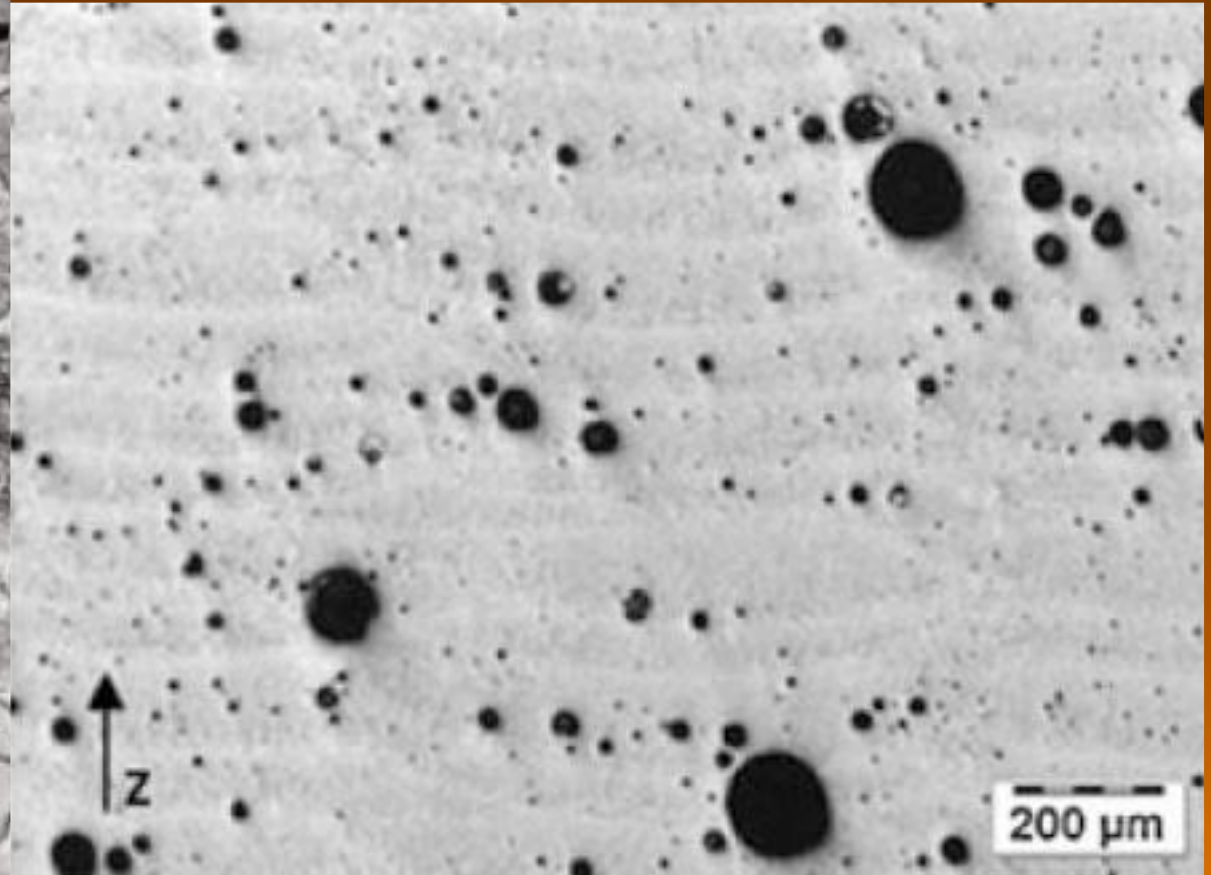
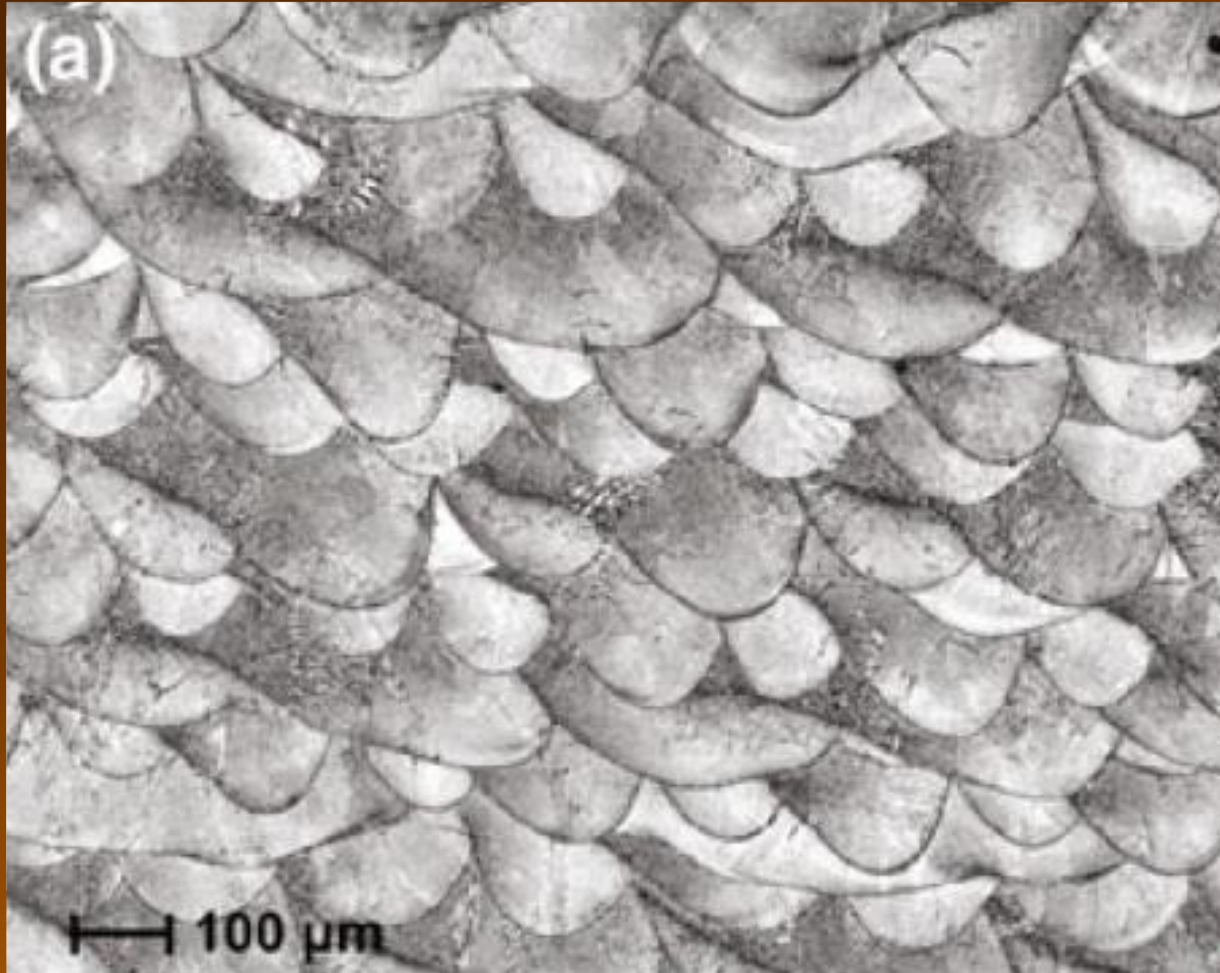






# Powder Bed Fusion - PBF

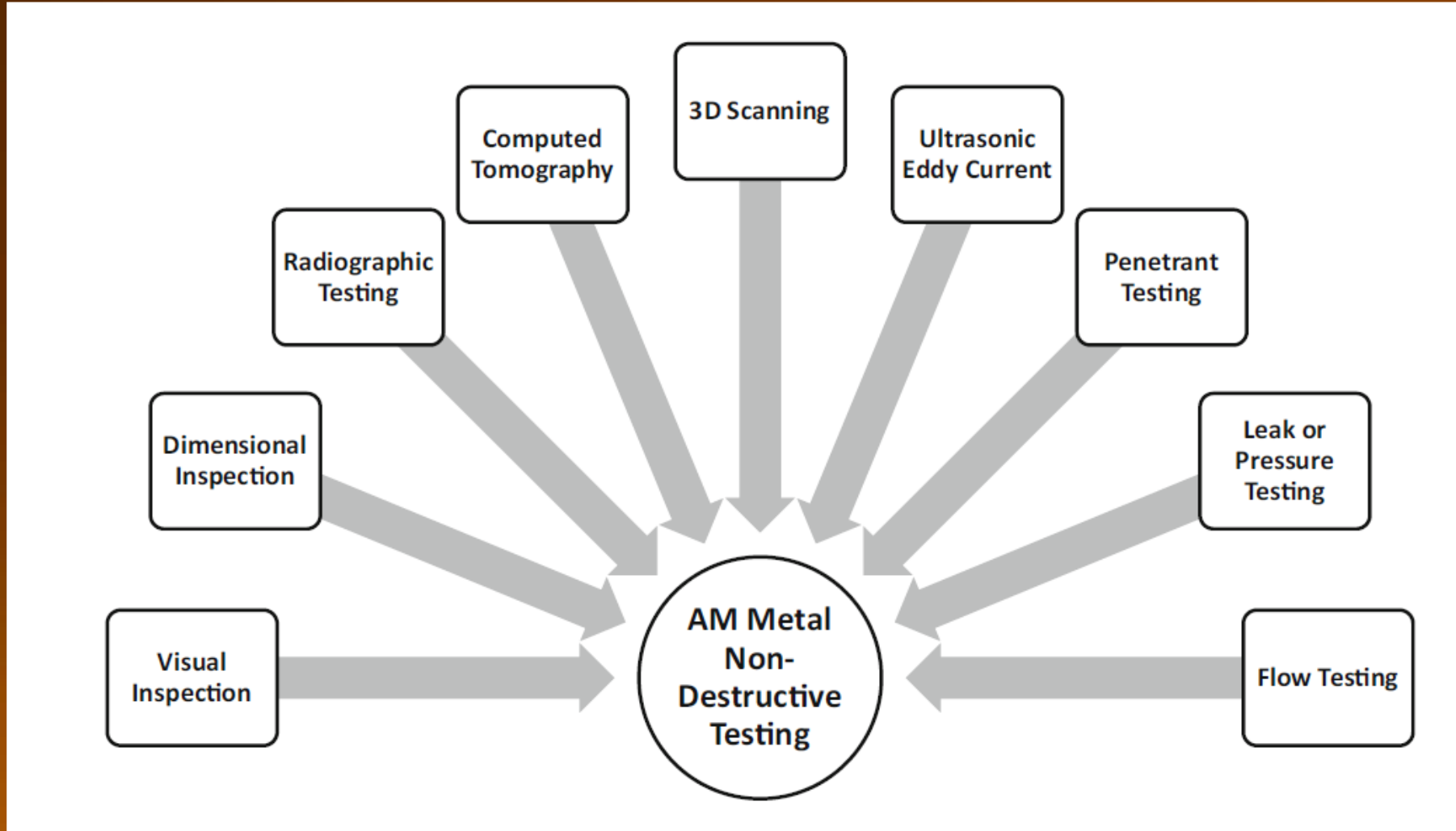
Microstructural flaws





# Powder Bed Fusion - PBF

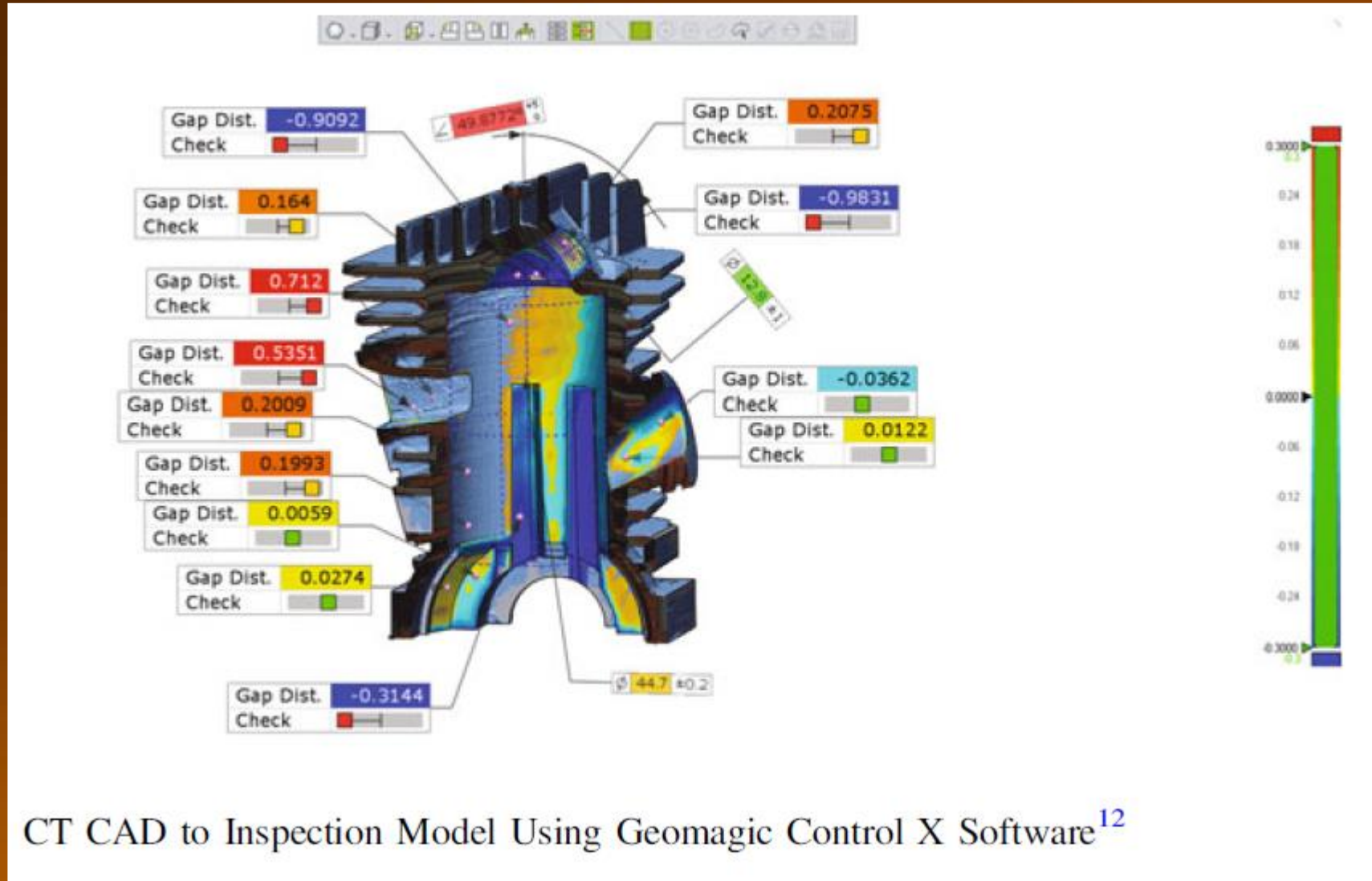
Inspection for quality





# Powder Bed Fusion - PBF

Inspection for quality



CT CAD to Inspection Model Using Geomagic Control X Software<sup>12</sup>



# Powder Bed Fusion - PBF

## Final points

- PBF operations do not require manual intervention or constant supervision. Require expert and specialized personnel
- Post-processing operations, inspection, and quality assurance still needs research and standards.
- Standards are being developed to assist in the certification of critical components.