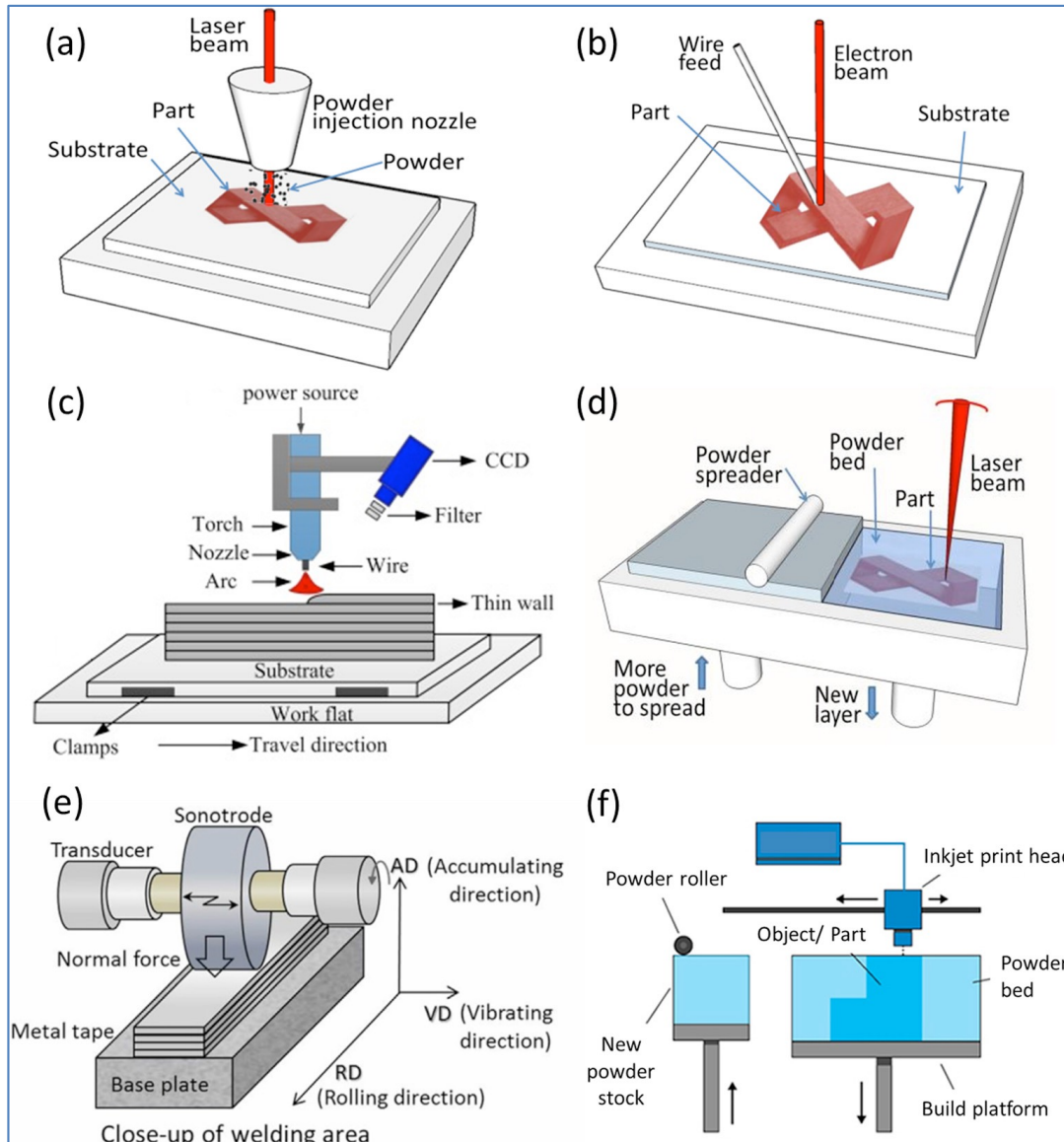




AM of metallic components

AM of metallic components



Schematic diagram of (a) DED-L (b) DED-EB (c) DED-GMA (d) PBF-L (e) ultrasonic additive manufacturing (UAM) process and (f) binder jet process

DED and PBF share :

- high energy density heat sources,
- localized melting and
- microstructural evolution

DED vs PBF

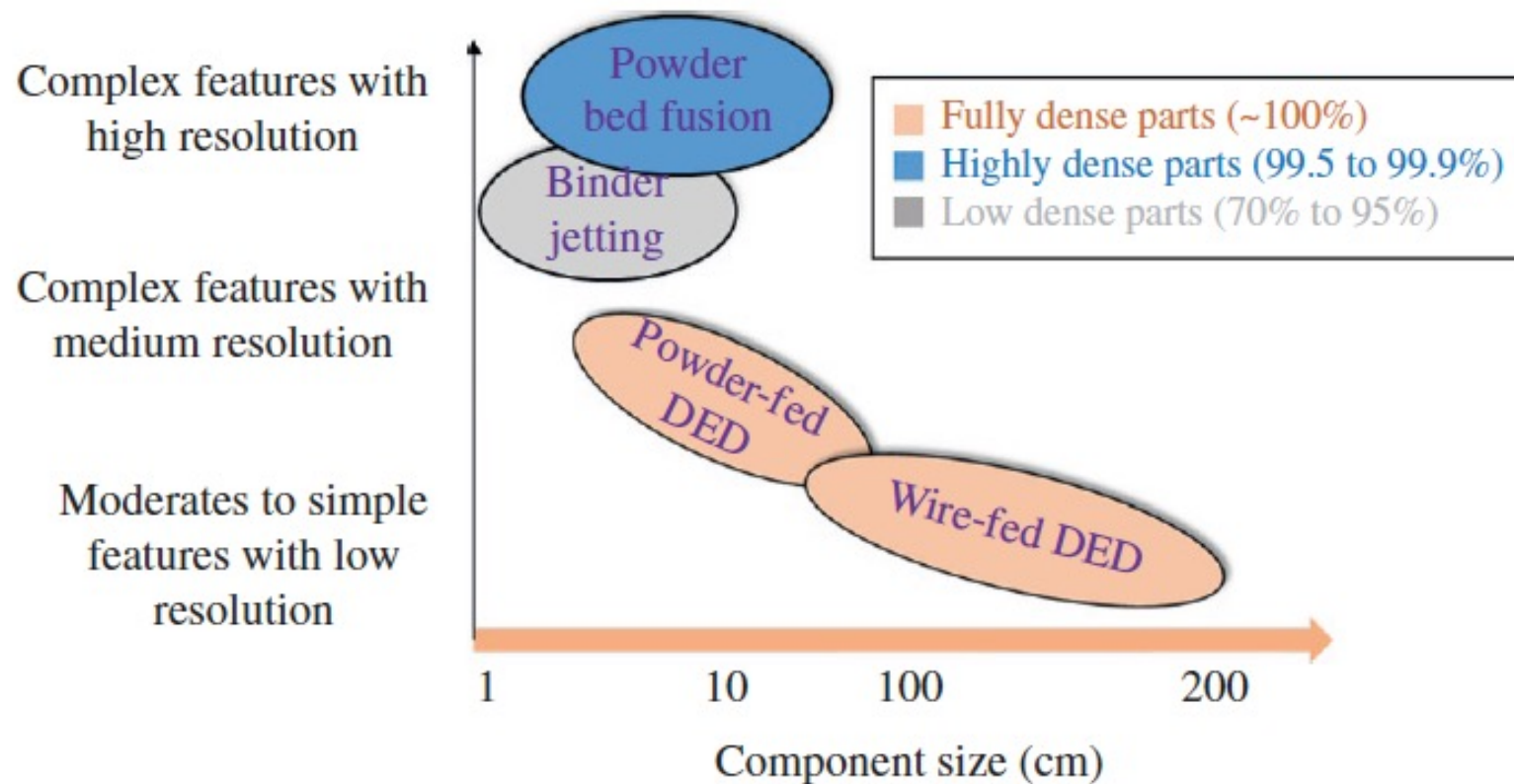


Comparison of two main categories of additive manufacturing processes for metallic components: directed energy deposition (DED) versus powder bed fusion (PBF).

Process	DED			PBF	
Feedstock	Powder	Wire		Powder	
Heat source	Laser	E-beam	Electric arc	Laser	E-beam
Nomenclature	DED-L	DED-EB	DED-PA/DED-GMA	PBF-L	PBF-EB
Power (W)	100–3000	500–2000	1000–3000	50–1000	
Speed (mm/s)	5–20	1–10	5–15	10–1000	
Max. feed rate (g/s)	0.1–1.0	0.1–2.0	0.2–2.8	–	
Max. build size (mm × mm × mm)	2000 × 1500 × 750	2000 × 1500 × 750	5000 × 3000 × 1000	500 × 280 × 320	
Production time	High	Medium	Low	High	
Dimensional accuracy (mm)	0.5–1.0	1.0–1.5	Intricate features are not possible	0.04–0.2	
Surface roughness (μm)	4–10	8–15	Needs machining	7–20	
Post processing	HIP and surface grinding are seldom required	Surface grinding and machining is required to achieve better finish	Machining is essential to produce final parts	HIP is rarely required to reduce porosity	

- Filler wires allow relatively higher mass flow (deposition) rate in wire based processes.
 - Powder based – considered suitable for relatively smaller parts.
 - Wire based – heavier than 10 kg

DED vs PBF



Metal AM – alloys and applications

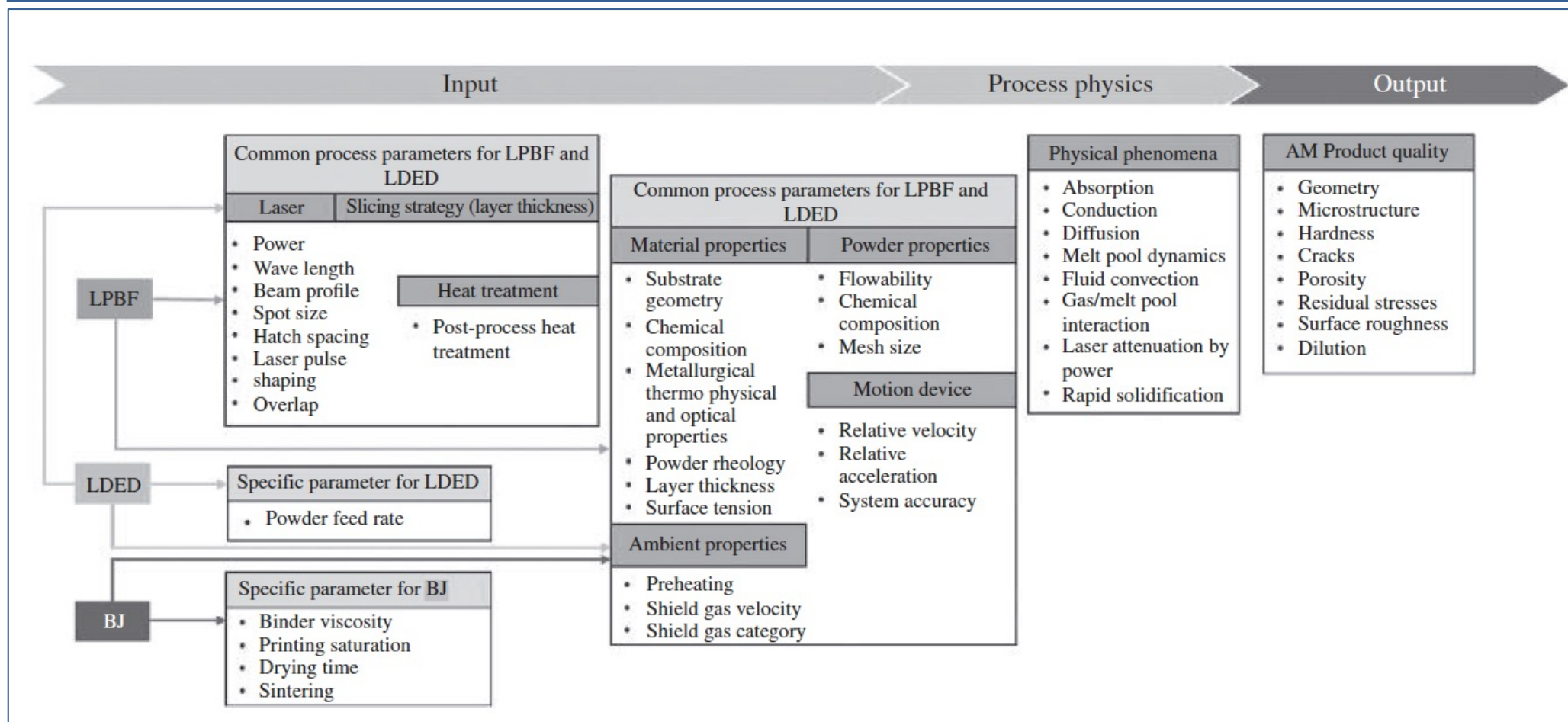
Common additive manufacturing alloys and applications

Alloys ⇒ Applications ↓	Aluminum	Maraging steel	Stainless steel	Titanium	Cobalt chrome	Nickel super alloys	Precious metals
Aerospace	X		X	X	X	X	
Medical			X	X	X		X
Energy, oil and gas			X				
Automotive	X		X	X			
Marine			X	X		X	
Machinability and weldability	X		X	X		X	
Corrosion resistance			X	X	X	X	
High temperature			X	X		X	
Tools and molds		X	X				
Consumer products	X		X				X

AM of a structurally sound, defect free reliable parts requires an understanding of,

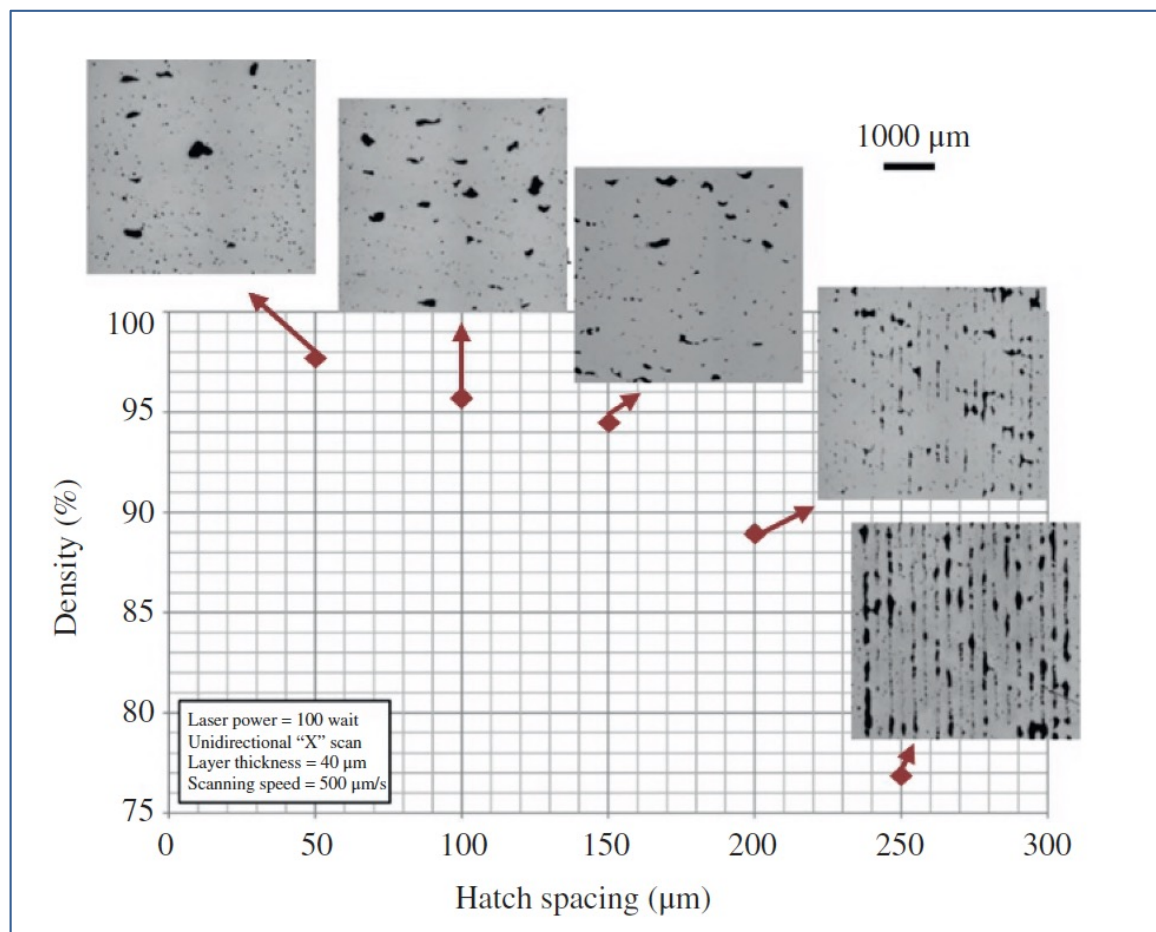
- Available process options,
- Underlying physical processes,
- Feedstock materials,
- Process control methods and
- Common defects and remedies

Process parameters – Metal AM



Process design parameters for LDED, LPBF, and BJ techniques

Process parameters – Metal AM



Porosity of LPBF-made parts from AISi10Mg as a function of hatch distance