SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
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DEPARTMENT OF AEROSPACE ENGINEERING

19ASZ401 – 3D PRINTING FOR SPACE COMPONENTS
IV YEAR VII SEM
UNIT-III Photo polymerization and Powder Bed Fusion Process
TOPIC: Electron Beam Melting

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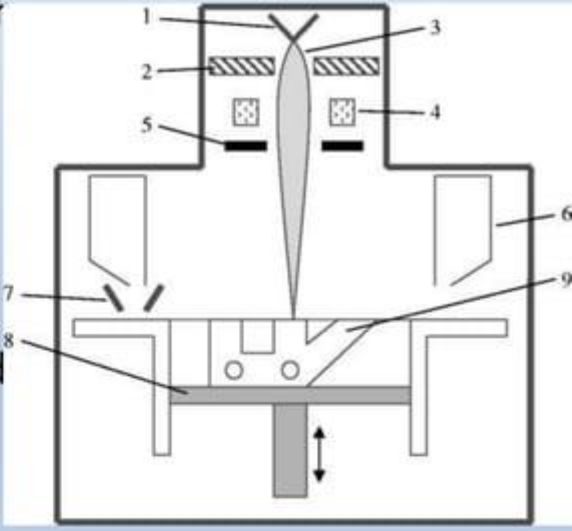
Electron Beam Melting (EBM)

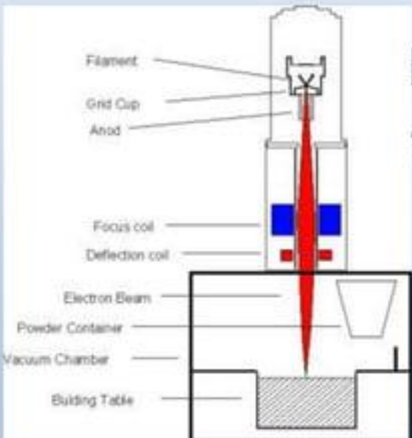
- Electron Beam Melting (EBM) is a type of rapid prototyping for metal parts. The technology manufactures parts by melting metal powder layer per layer with an electron beam in a high vacuum. Unlike some metal sintering techniques, the parts are fully solid, void--free, and extremely strong.
- EBM is also referred to as Electron Beam Machining.
- High speed electrons .5-.8 times the speed of light are bombarded on the surface of the work material generating enough heat to melt the surface of the part and cause the material to locally vaporize.
- EBM does require a vacuum, meaning that the workpiece is limited in size to the vacuum used. The surface finish on the part is much better than that of other manufacturing processes.
- EBM can be used on metals, non--metals, ceramics, and composites.

Electron Beam Melting (EBM)

- Dispensed metal powder in layers
- Cross--section molten in a high vacuum with a focused electron beam
- Process repeated until part is completed
- Stainless steel, Titanium, Tungsten parts
- Ideal for medical implants and injection molds
- Still very expensive process



- **Electron Beam Melting**



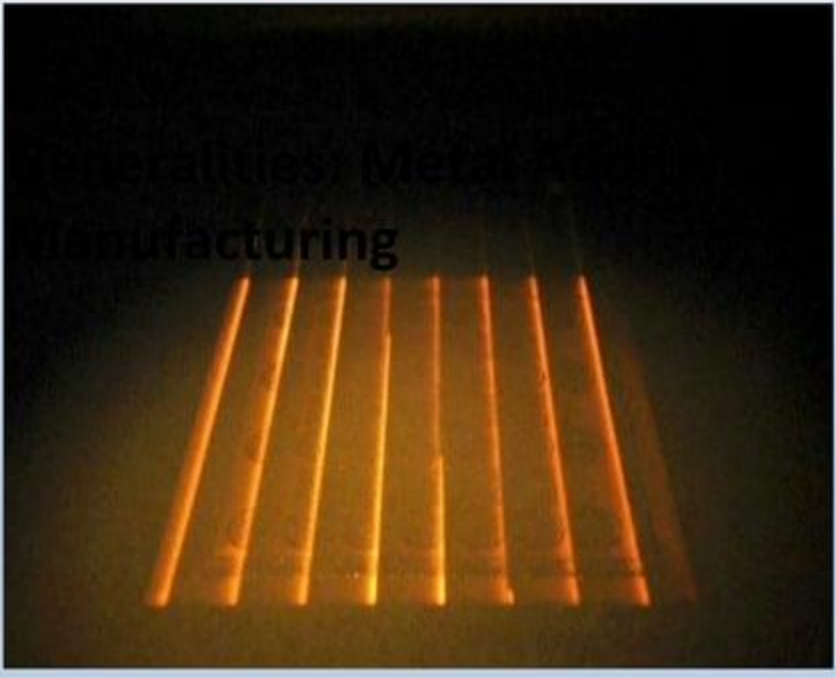
Examples of EBM

ARCAM A2 machine for direct metal deposition

Components made of Ti and Co-Cr alloys

Biomedical components made of Ti alloys

- **Electron Beam Melting**



EMB benefit

- High productivity
- Suitable for very massive parts
- No residual internal stress (constant 680–720°C build temperature)
- Less supports are needed for manufacturing of parts
- Possibility to stack parts on top of each other (mass production)
- Sintered powder = good for thermal conductivity = less supports
- Process under vacuum (no gaz contaminations)
- Very fine microstructures (Ti6Al4V), very good mechanical and fatigue results (Ti6Al4V)

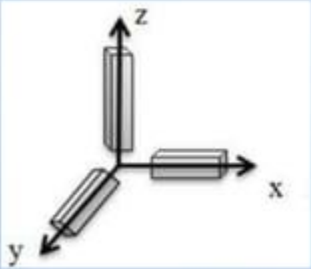
EBM drawbacks

- Powder is sintered ->tricky to remove (e.g. interior channels)
- Long dead time between 2 productions (8 hours for cooling – A2, A2X, A2XX systems)
- Tricky to work with fine powder
- Expensive maintenance contract

Experimental procedures

- Electron Beam Melting (EBM)

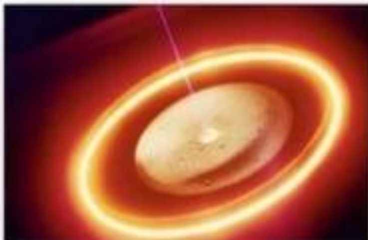
• Random scanning strategy
• Vacuum
•Pre-heating of the subtrate: 680-720°C



Reference axis for EBM and LBM

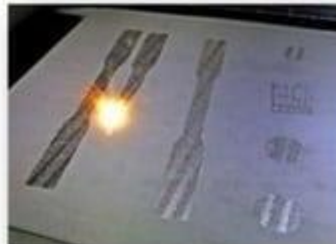
Comparison

- Electron Beam Melting (EBM)



•Metallic powder deposited in a powder bed
• Electron Beam
• Vacuum
• Build temperature: 680-720°C

- Laser Beam Melting (LBM)



•Metallic powder deposited in a powder bed
• Laser Beam
• Argon flow along Ox direction
• Build temperature: 200°C

Comparison

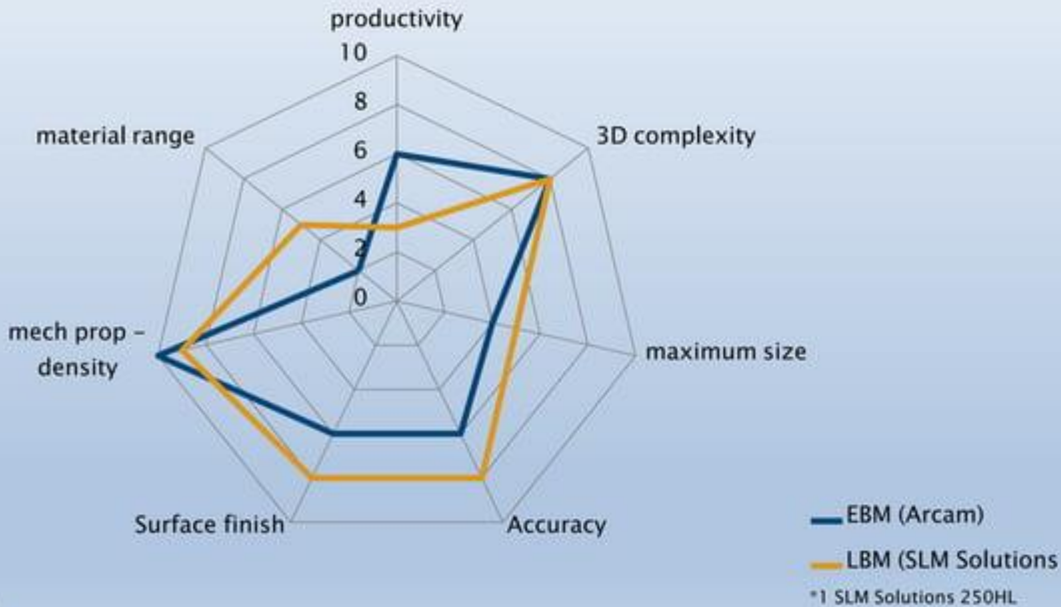
	LBM	EBM
Size (mm)	250 x 250 x 350*1	210 x 210 x 350*2
Layer thickness (μm)	30 – 60	50
Min wall thickness (mm)	0.2	0.6
Accuracy (mm)	+/– 0.1	+/– 0.3
Build rate (cm^3/h)	5 – 20	80
Surface roughness (μm)	5 – 15	20 – 30
Geometry limitations	Supports needed everywhere (thermal, anchorage)	Less supports but powder is sintered
Materials	Stainless steel, tool steel, titanium, aluminum,...	Only conductive materials (Ti6Al4V, CrCo,...)

*1 SLM Solutions 250HL

Comparison

			EOS	SLM	Concept Laser	Renishaw	ARCAM
			M270	250HL	M1	AM250	A1
Gas di processo			Argon o Azoto	Argon o Azoto	Argon o Azoto	Argon o Azoto	
consumo di gas		Lt/h		90	1000	5-30	
Potenza del laser		W	200 - 400	200 - 400	200 - 400	200 - 400	50-3000
Max dimensione		mm	250 x 250 x 215	248 x 248 x 250	250 x250 x250	245 x 245 x 300	200 x 200 x 180
Capacità produttiva		cmc/h	2 - 20	20	2 - 20	5 - 20	55-80
Velocità scansione lase		m/s		20	7	2	8000
Spessore layers		micron	20-60	20 -75	20-80	20 -100	
Formato file			STL	STL	STL	STL	STL
Precisione		mm	+/- 0,05		+/- 0,05		+/- 0,20
Rugosità		micron	4-6	4-6	4-6	4-6	25-35
Principali Materiali	Acciaio inox		17-4 PH1	1.4404 (316L) 1.4542 (17-4 PH)	1.4404	1.4404	
	Acciaio per stampi		Maraging	1.2344 (H13)	1.2709	1.2344	
	Superlega CoCr		CoCr ASTMF75	CoCr ASTMF 75	CoCr (F75), CrCo (dentale)	CoCr ASTMF75	CoCrMo ASTM F75
	Titanio		Ti6A4V	Ti6Al4V, Ti6Al7Nb, Titanio puro	Titanium Grade 5	Ti-6Al-4V e Ti-6Al-7Nb	Ti6Al4V
	Leghe di Nickel		Inconel 625, 718	Inconel 625, 718	Inconel 625	inconel 718 e 625	
	Alluminio		AlSi10Mg	AlSi12	AlSi10Mg, AlSi12	AlSi12	

Comparison


productivity
10
8
6
4
2
0
3D complexity
maximum size
Accuracy
Surface finish
mech prop –
density
material range
EBM (Arcam)
LBM (SLM Solutions
*1 SLM Solutions 250HL