Description

Image

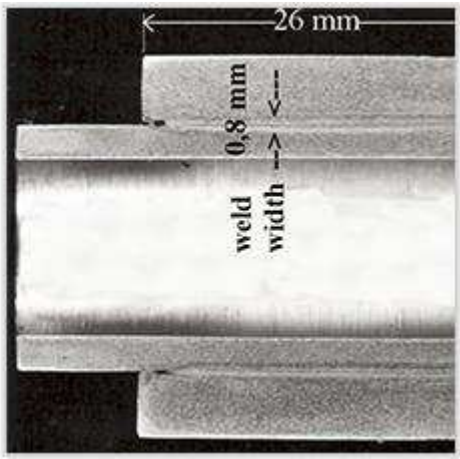


Image caption

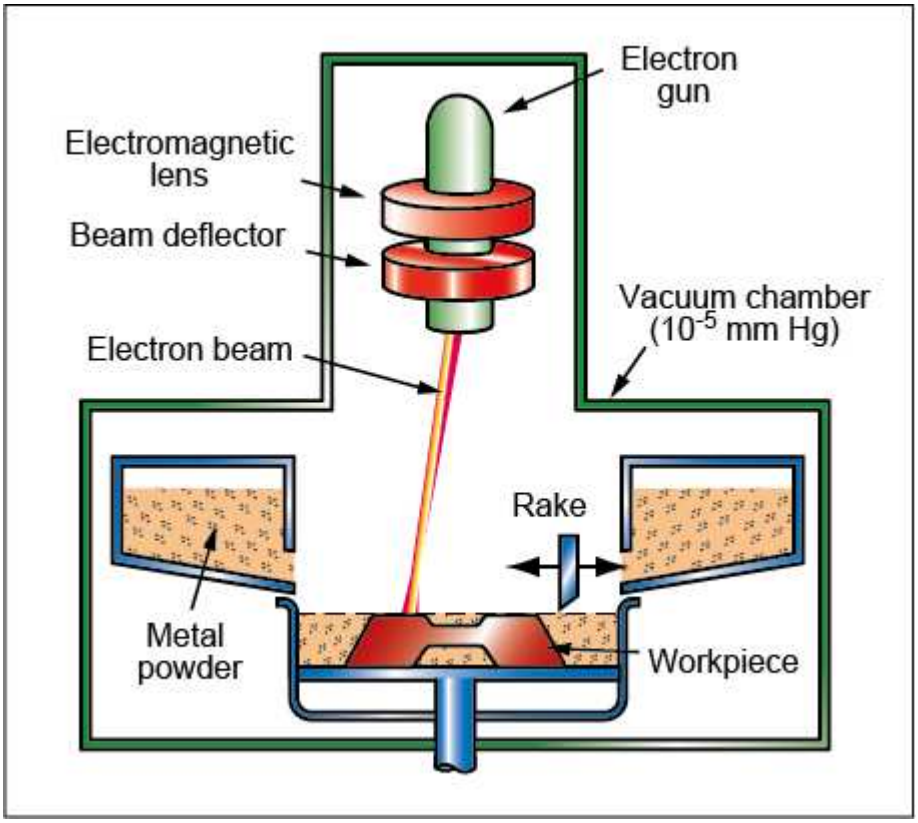
(1) The first model of EBM machine released by Arcam AB © William Sames at Wikimedia Commons (CC BY 4.0) (2) Common EBM machine used in additive manufacturing with cover removed © William Sames at Wikimedia Commons (CC BY 4.0) (3) Deep narow weld © Zobac at Wikimedia Commons [Public domain]

The process

ELECTRON BEAM MELTING (EBM) is a powder bed fusion technique similar to SLM. In this process a high-energy electron beam is scanned across a thin layer of metallic powder, causing local melting and resolidification. A thin layer of powder is then spread on top by a wiper or milling head and the process repeated until the object is complete. To maintain a steady-state uniform temperature throughout the build, the substrate is heated before laying the powder bed. Operating at an elevated temperature results in a grain pattern more similar to cast microstructures. As with other additive manufacturing processes, a CAD solid model of the part is used to create the code to guide the electron beam.

This process is also known as in-situ shelling.

Process schematic



Material compatibility

Metals - ferrous	✓
Metals - non-ferrous	✓

Shape

Circular prismatic	✓
Non-circular prismatic	✓
Flat sheet	✓
Dished sheet	✓
Solid 3-D	✓
Hollow 3-D	✓

Economic compatibility

Economic batch size (units)	1	-	10	

Physical and quality attributes

Mass range	0.11	-	22	lb

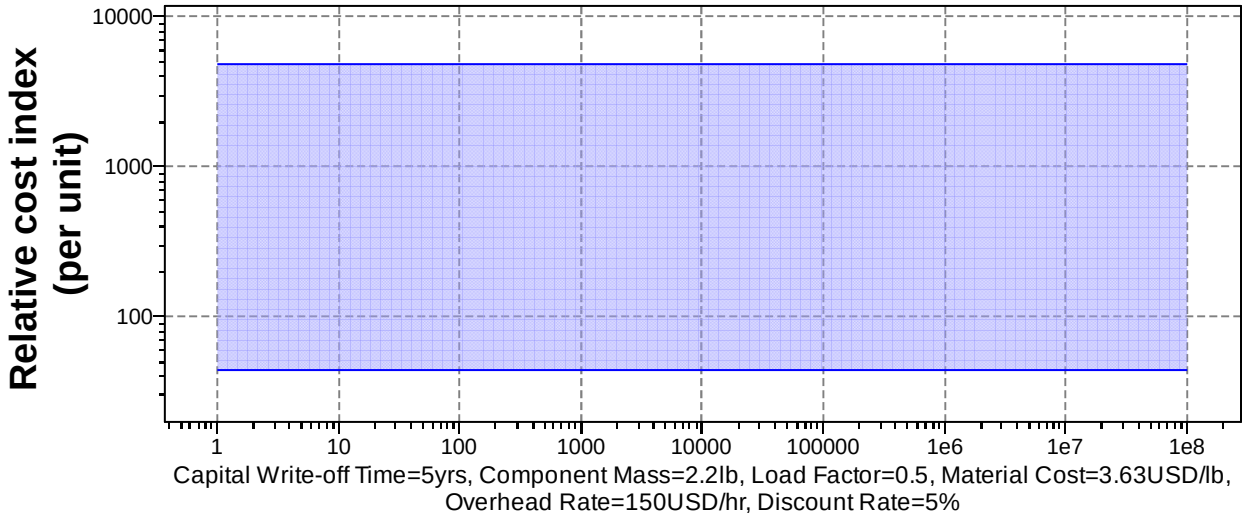
Process characteristics

Primary shaping processes	✓
Discrete	✓
Prototyping	✓

Cost model and defaults

Relative cost index (per unit)	43.4	-	4.78e3	

Parameters: Material Cost = 3.63USD/lb, Component Mass = 2.2lb, Batch Size = 1e3, Overhead Rate = 150USD/hr, Discount Rate = 5%, Capital Write-off Time = 5yrs, Load Factor = 0.5



Capital cost	6e5	-	8e5	USD
Material utilization fraction	0.45	-	0.55	
Production rate (units)	0.04	-	7	/hr
Tooling cost	0	-	0.1	USD
Tool life (units)	1e5	-	1e6	

Supporting information

Design guidelines

Minimum feature size, resolution and surface finish are larger than SLM but this process also produces fully dense parts without infiltration. Requires support structures (which can be removed later) in addition to the main body of the object for overhangs.

Technical notes

The build envelope (L x W x H) ranges from 200 x 200 x 180 mm to 350 x 350 x 350 mm.
Typical layer thickness is 50 - 150 µm.
The object is built up at a rate of around 55 - 80 cubic cm per hour.
The process is limited to conductive materials available in powder form and operates in a low partial pressure vacuum.

Typical uses

Orthopedic implants e.g. acetabular cups; aerospace industry.

The economics

Powder bed fusion is the most expensive type of additive manufacturing due to the inert environment in which it must operate.

The environment

Electron beam generation is more efficient (70 - 80 %) than laser beam generation (10 - 20 %).

Links

MaterialUniverse

Reference