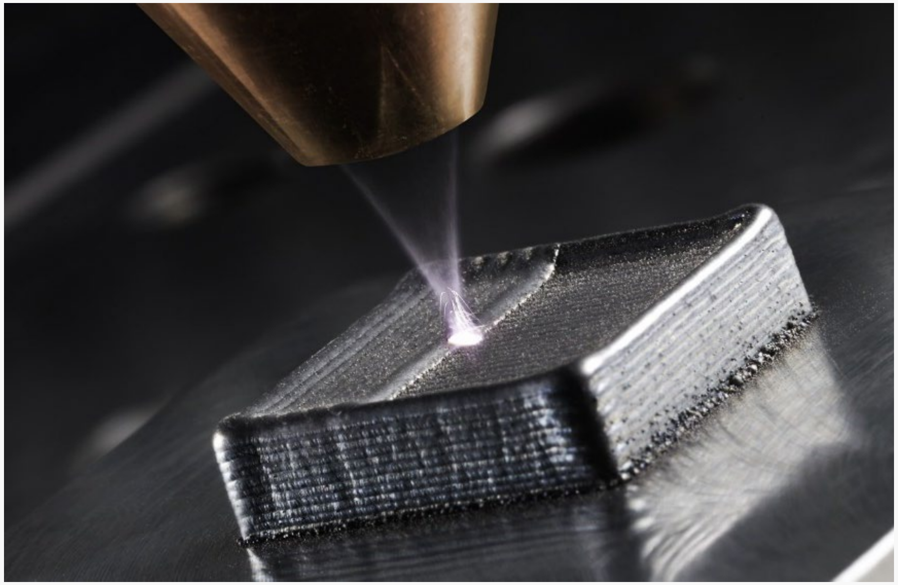
Katmanlı İmalat Yöntemlerinin Sınıflandırılması ve Prensipleri

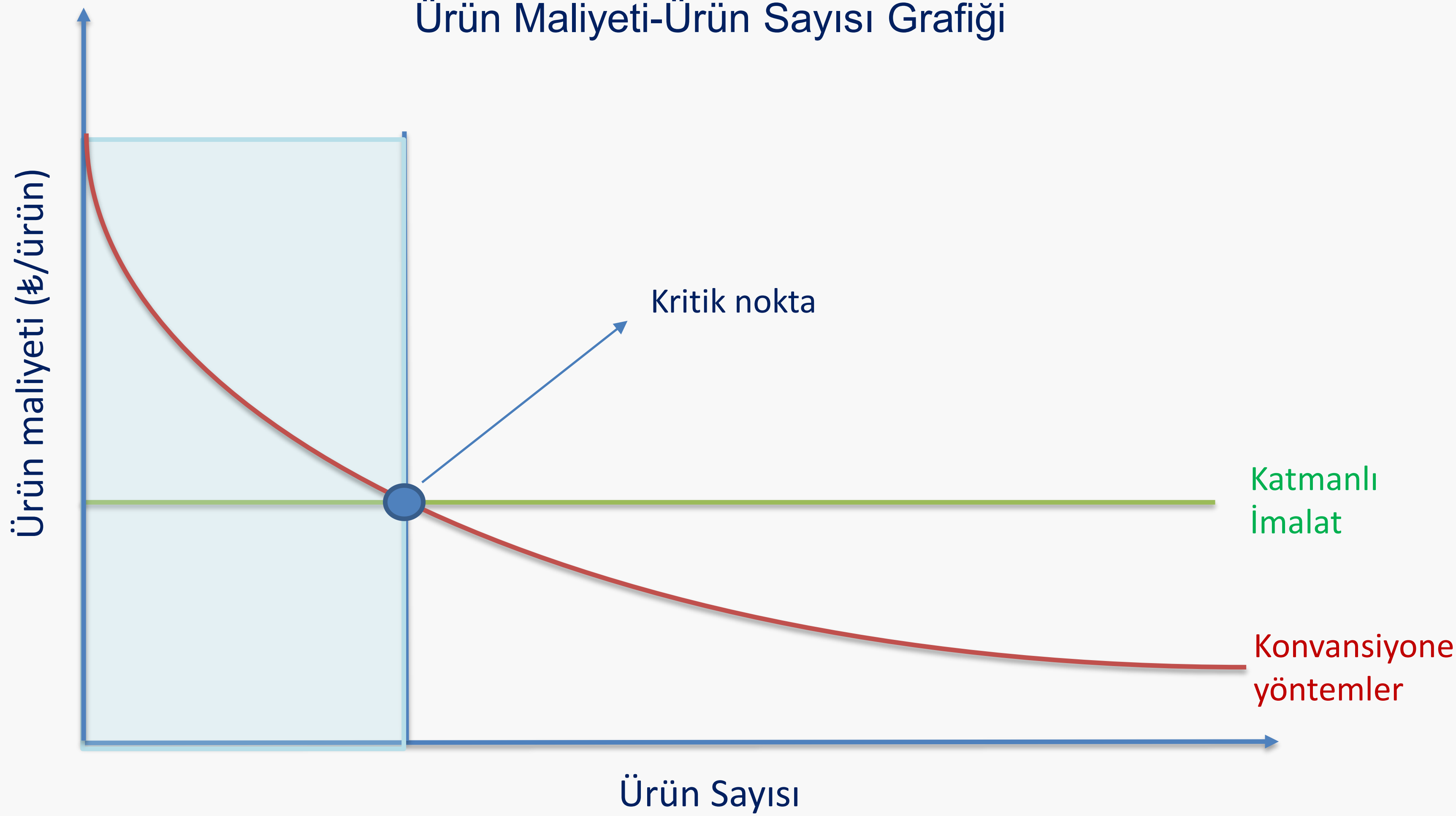


Özgür Uyar

Metalurji ve Malzeme Mühendisi

Uluslararası Kaynak Mühendisi

Katmanlı İmalat ve Konvansiyonel Yöntemler için Ürün Maliyeti-Ürün Sayısı Grafiği



Attaran, M. (2017). Additive Manufacturing: The Most Promising Technology to Alter the Supply Chain and Logistics. *Journal of Service Science and Management*,

İçerik

- Üretim yöntemlerinin sınıflandırılması

- Katmanlı imalat yöntemlerinin
- Genel özellikleri
- Kullanım alanları

- Katmanlı imalat yöntemlerinin sınıflandırılması
- Elektron ışını
- Laser ışını
- Ark

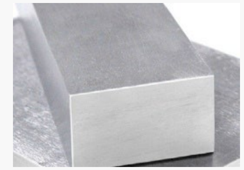
- Özet

- Kaynakça

Üretim Yöntemlerinin Sınıflandırılması

GSI SLV

Ham madde



Birincil işlemler

- **Döküm Yöntemleri** - kum, savurmalı
- **Kalıplama Yöntemleri** - Enjeksiyonlu, basınçlı
- **Deformasyon Yöntemleri** - Haddeleme, tel çekme
- **Toz Yöntemleri** - Sinterleme
- **Kompozit Oluşturma** - Elle yatıma, Filament sargısı
- **Özel Yöntemler,** **- Hızlı prototipleme**, elektroform

İkincil işlemler

- **İşleme** - kesme,delme, zımparalama
- **Isıl İşlem** - Su verme, temperleme, yaşlandırma

Birleştirme İşlemleri

- Perçinleme
- Kaynak
- Esneyerek kilitleme
- Yapıştırma

Yüzey İşlemleri

- Parlatma, zımparalama
- Metal ile yüzey kaplama
- Anodizasyon
- Boyama

Tamamlanmış ürün

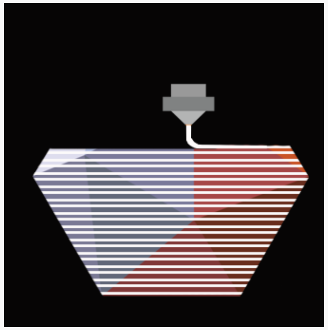
Ashby, M. F. (1999). *Materials selection in mechanical design*. Butterworth-Heinemann.

Katmanlı İmalat yöntemleri

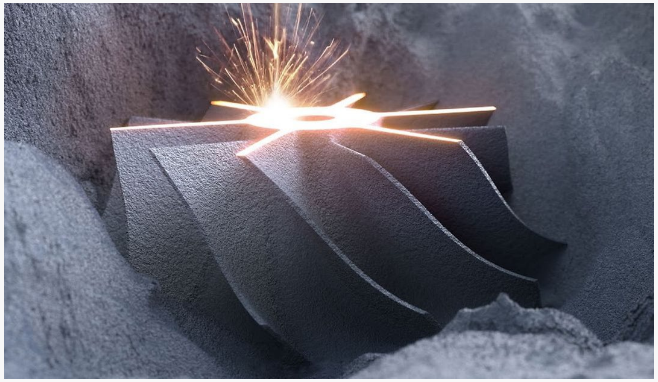
1. CAD model

2. Katmanlara bölme

3. Üretim



liveroomlk.medium.com



dmgmori.com

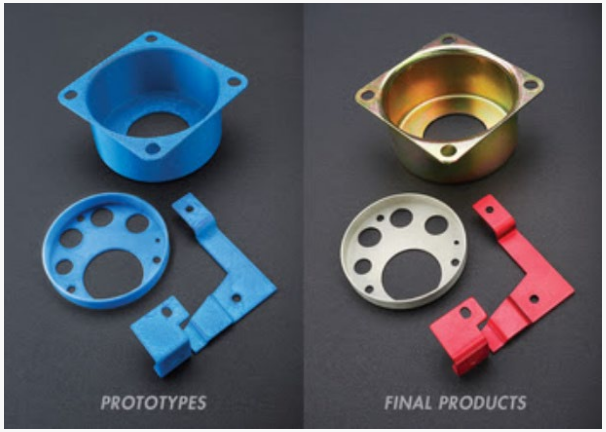
(+) Net şekil
(+) Karmaşık tasarımlar
(+) Etkili malzeme kullanımı
(+) Çevre dostu
(+) Metal, polimer, kompozit ve seramik malzemeler

(-) Üretim hızı
(-) Ürün boyut sınırı
(-) İkincil bir işlem gerekliliği

Lelaporte, P., & Allonce, A. (2016). [INVITED] Laser-induced forward transfer: A high resolution additive manufacturing technology. *Optics & Laser Technology*

Katmanlı İmalat yöntemlerinin uygulama alanları

1. Prototip yapımı



2. Medikal, otomotiv, uzay ve havacılık

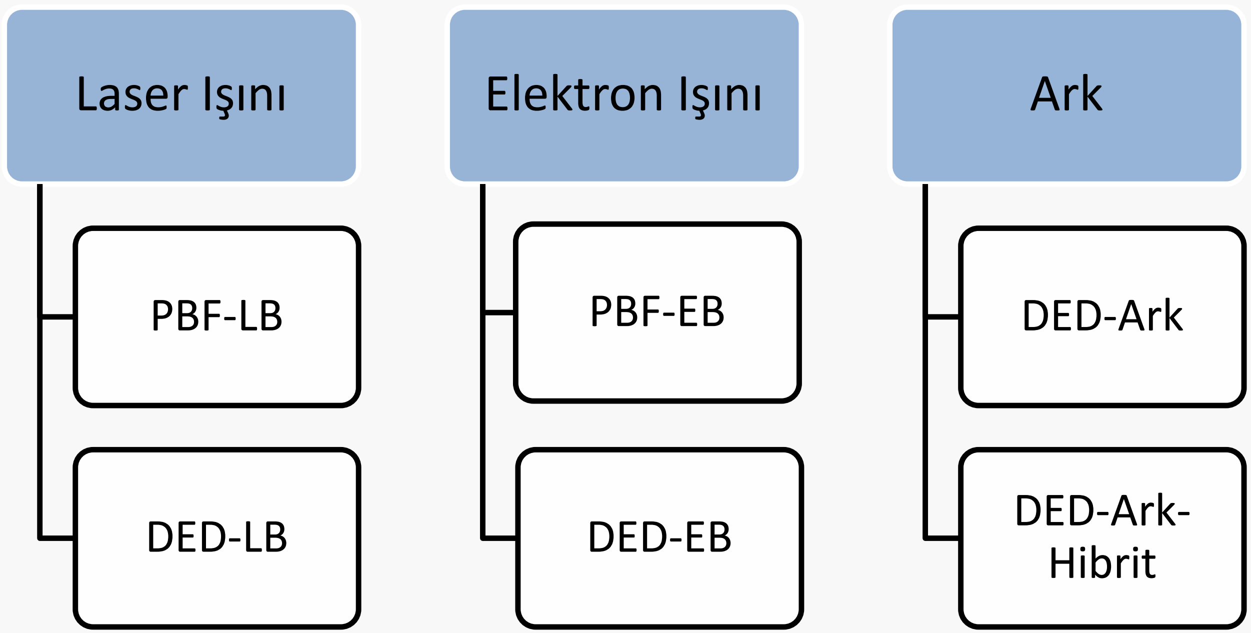
3. Adet sayısı az olan ürünler

4. Alternatif yöntemlere uyun olmayan tasarımlar

metal-am.com/introduction-to-metal-additive-manufacturing-and-3d-printing/applications-for-additive-manufacturing-technology

Katmanlı İmalat Yöntemlerinin Sınıflandırılması

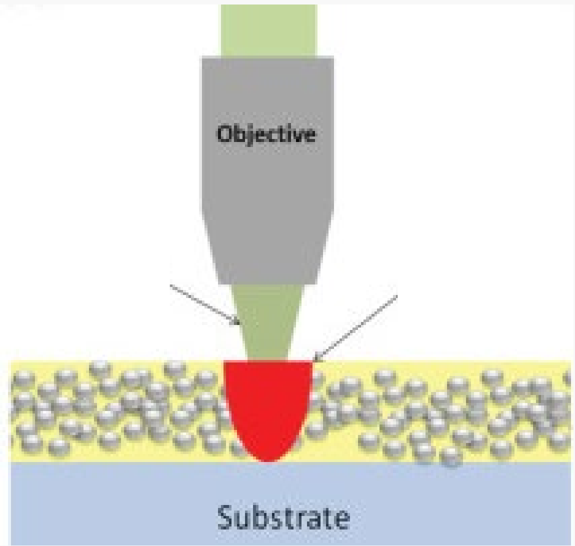
IAMQS



IAMQS (Katmanlı İmalat Vasıflandırma Kataloğu, Versiyon 1.3)

International Additive Manufacturing Qualification System, “Additive Manufacturing Qualifications,” IAMQS, 2019. www.ewf.be/additive-manufacturing.

Laser Işını / PBF-LB



Katman kalınlığı: 120 µm – 150 µm

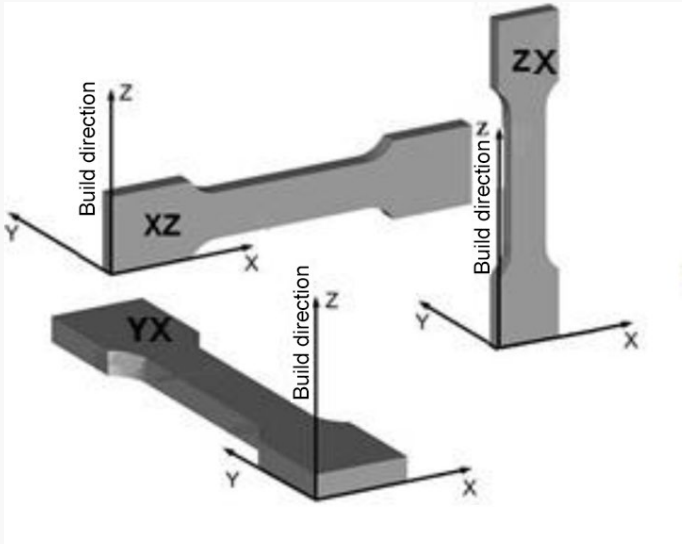
Laser tipleri: Nd-YAG Laser
Fiber Optic Laser
CO_2 Laser
Excimer Laser

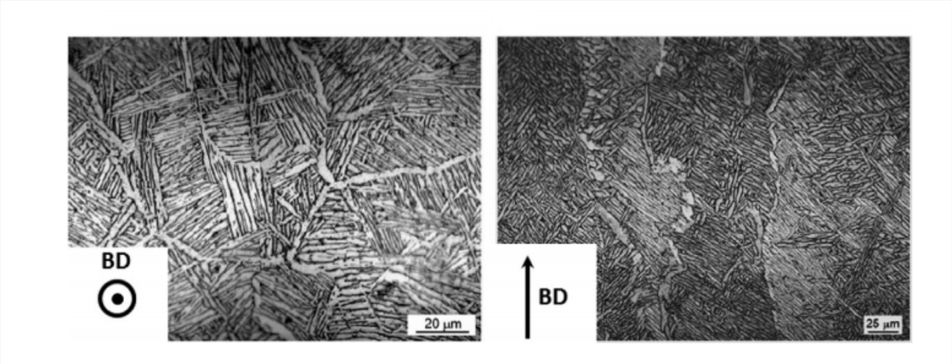
Asal Gaz Ortamı (Ar, He)

PBF-LB
- SLM (Eritme)
- SLS (Sinterleme)

Lee, Hyub et. al. (2017). Lasers in additive manufacturing: A review. International Journal of Precision Engineering and Manufacturing-Green Technology.

Anizotropik Davranış / Tarama Yönünün Etkisi





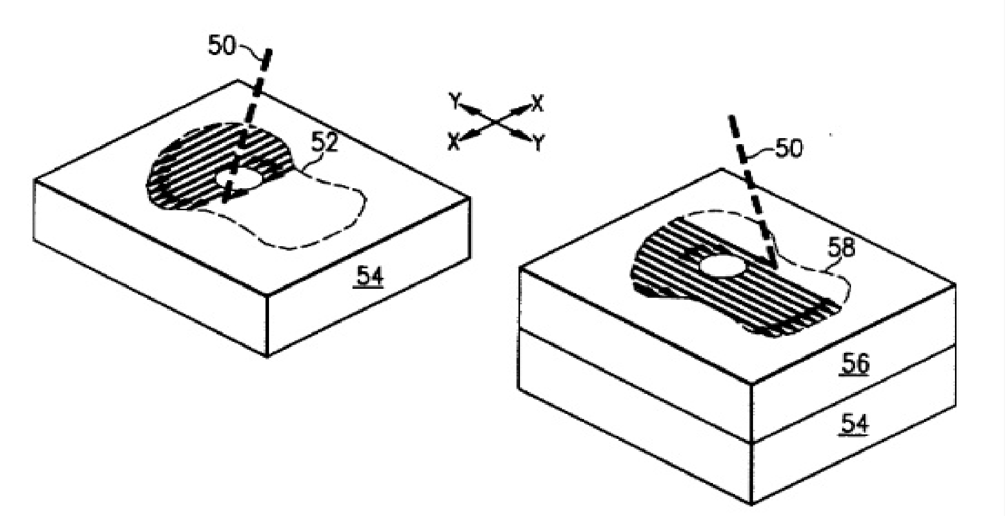
X2CrNiMo17-12-2

Üretim doğrultusu	Çekme dayancı (MPa)	Akma dayancı (MPa)	% Uzama
YX	668 ± 3	397± 3	37± 1
XZ	695± 3	423± 3	41± 1.9
ZX	564± 3	387± 3	35± 0.6
Döküm	551	205	60

Hamza et. Al. (2017) Hamza Hassn Alsalla, Available at: effect-of-build-orientation-on-the-surface-quality-microstructure-and-mechanical-properties-of-selective-laser-melting-316l-stainless-steel

Yığma Stratejisi

Çapraz tarama metodu



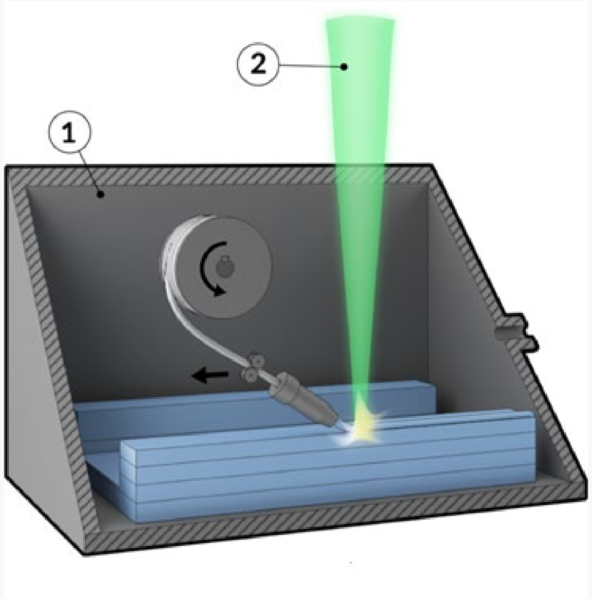
Yöntemin avantajları:

- Yüksek yüzey kalitesi
- İç gerilmelerin azalması
- Çarpılmanın azalması

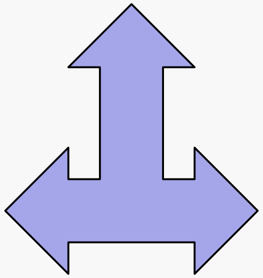
US5155324A - Method for selective laser sintering with layerwise cross-scanning. (1992, October 13). Google Patents. https://patents.google.com/patent/US5155324A/en

Elektron Işını

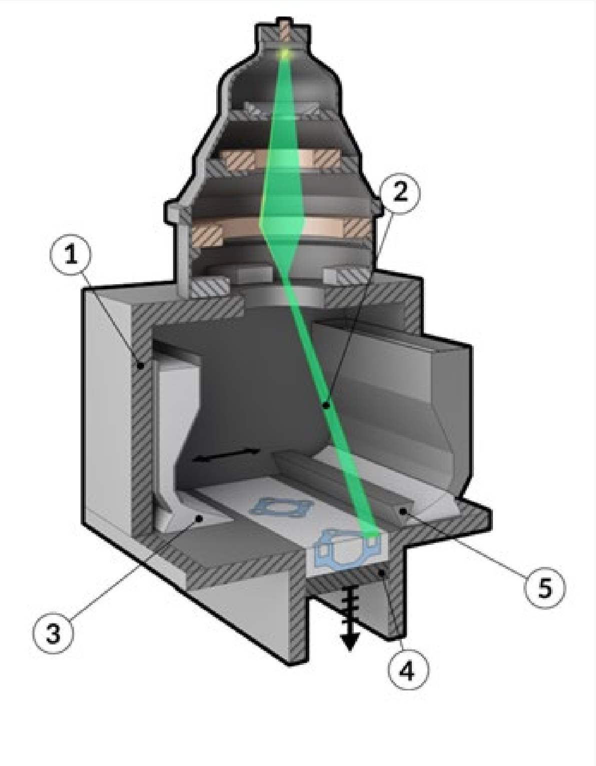
DED-EB



Vakum altında



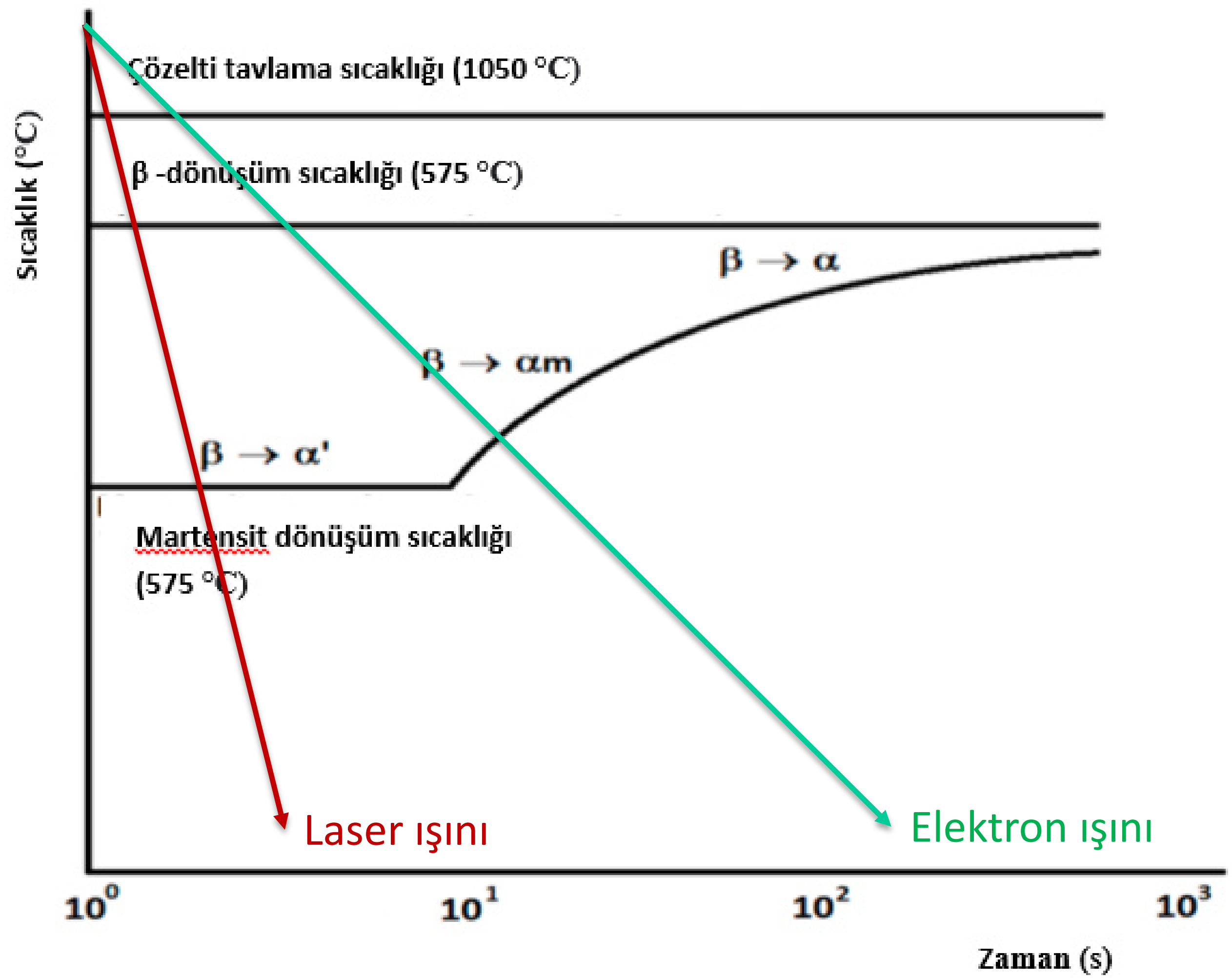
PBF-EB



Electron Beam Freeform Fabrication, EBF3. (n.d.). TECHNIQUE AND KNOWLEDGE TRANSFER | Find Suppliers, Processes & Material. https://www.manufacturingguide.com/en/electron-beam-freeform-fabrication-ebf3

GSI SLV Türkiye

GSI SLV



Ti-6Al-4V

Sing, Swee et. Al.. (2015). Laser and electron-beam powder-bed additive manufacturing of metallic implants: A review on processes, materials and designs. Journal of orthopaedic research : official publication of the Orthopaedic Research Society.

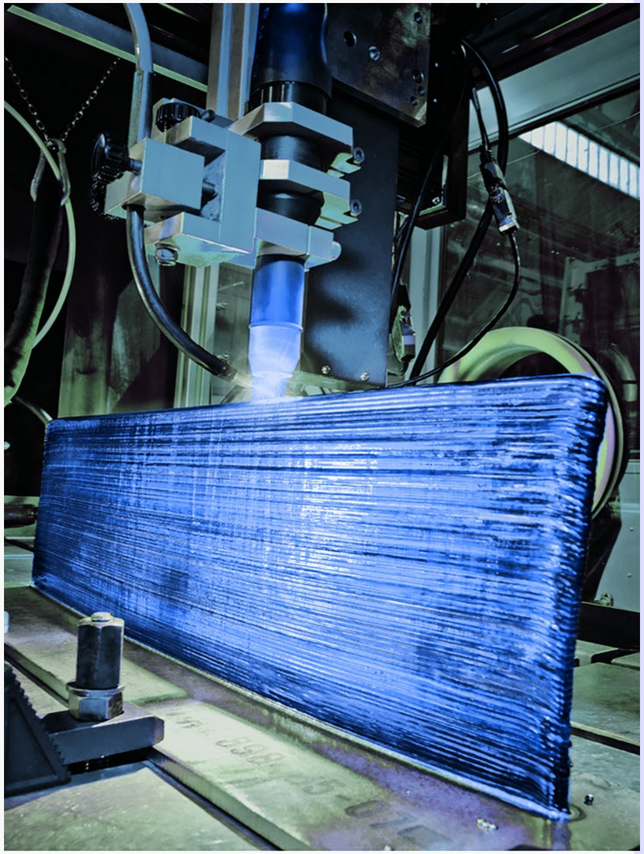
DVS

DED-Ark

MAG
- Ar-CO_2
- Ar-CO_2-O_2

MIG
- Ar
- Ar-He

Plazma



- Yüksek yığma verimliliği
- Yüksek üretim hızı
- Haznesiz üretim
- Büyük geometri kapasitesi
- Düşük maliyet

- Düşük yüzey kalitesi
- ikinci bir işleme gereksinimi
- Karmaşık şekiller için uygun değil.

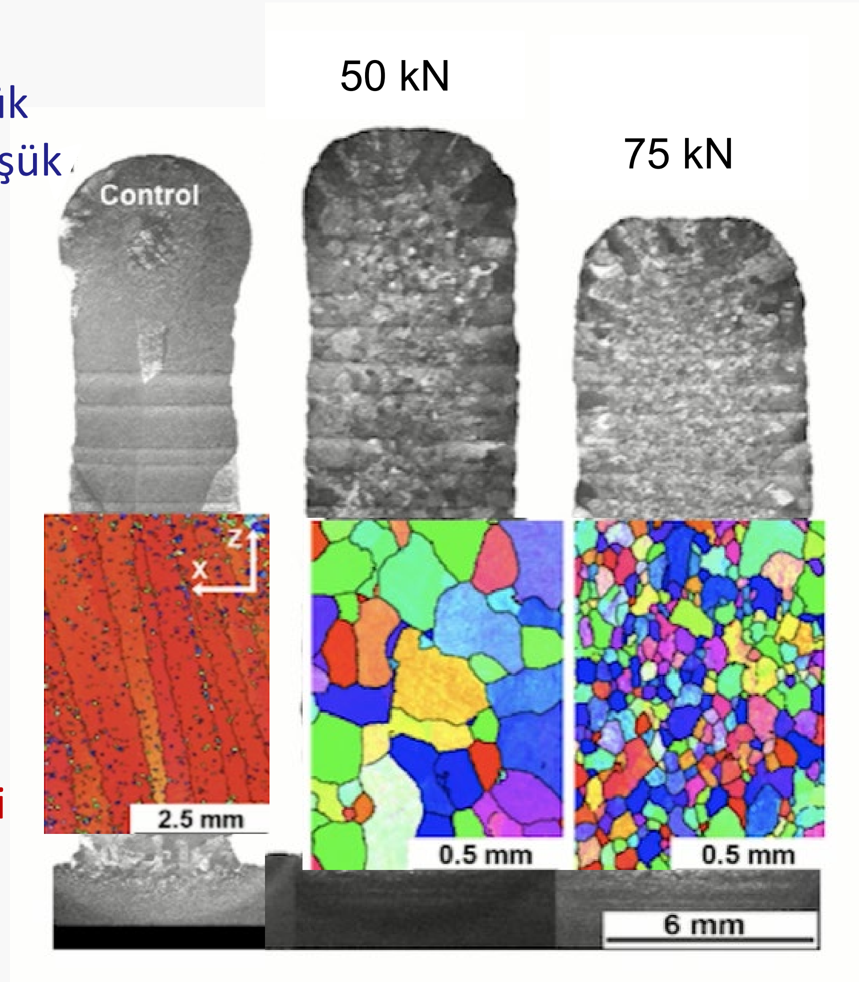
DED-Ark Hibrit

DED-Ark Hibrit

«Ark yönteminin düşük enerji yoğunluğu / düşük termik gradyan»

Kolumnar taneler

- Sürünme
- Dayanç değerleri
- Süneklik değerleri
- Anizotropik davranış



«Dinamik yeniden kristallenme»

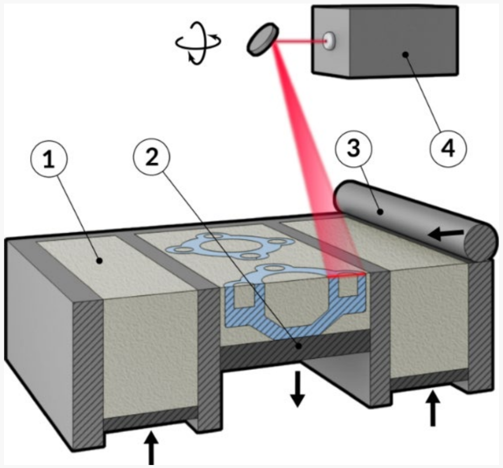
Eşeksenli taneler

- Mikro yapı
- Artık gerilim
- Çarpılma

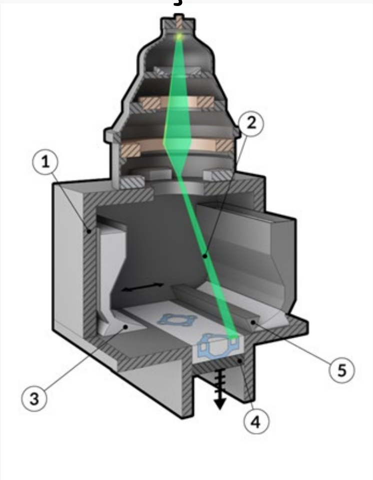
Sefene, E. et. al. (2022). Metal hybrid additive manufacturing: State-of-the-art. *Progress in Additive Manufacturing*.
Cunningham, C,. et. Al. (2018). Invited review article: Strategies and processes for high quality wire arc additive manufacturing. *Additive Manufacturing*.

Özet

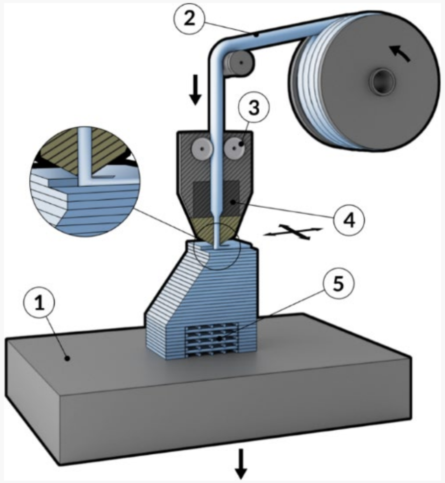
Laser ışını



Elektron ışını



Ark



Üretim hızı →

← Yüzey kalitesi / ölçü hassasiyeti

Ürün boyutu →

← Ekipman fiyatı

Electron Beam Freeform Fabrication, EBF3. (n.d.). TECHNIQUE AND KNOWLEDGE TRANSFER | Find Suppliers, Processes & Material. https://www.manufacturingguide.com/en/electron-beam-freeform-fabrication-ebf3

Kaynakça

- Attaran, M. (2017). Additive Manufacturing: The Most Promising Technology to Alter the Supply Chain and Logistics. *Journal of Service Science and Management*
- Ashby, M. F. (1999). *Materials selection in mechanical design*. Butterworth-Heinemann.
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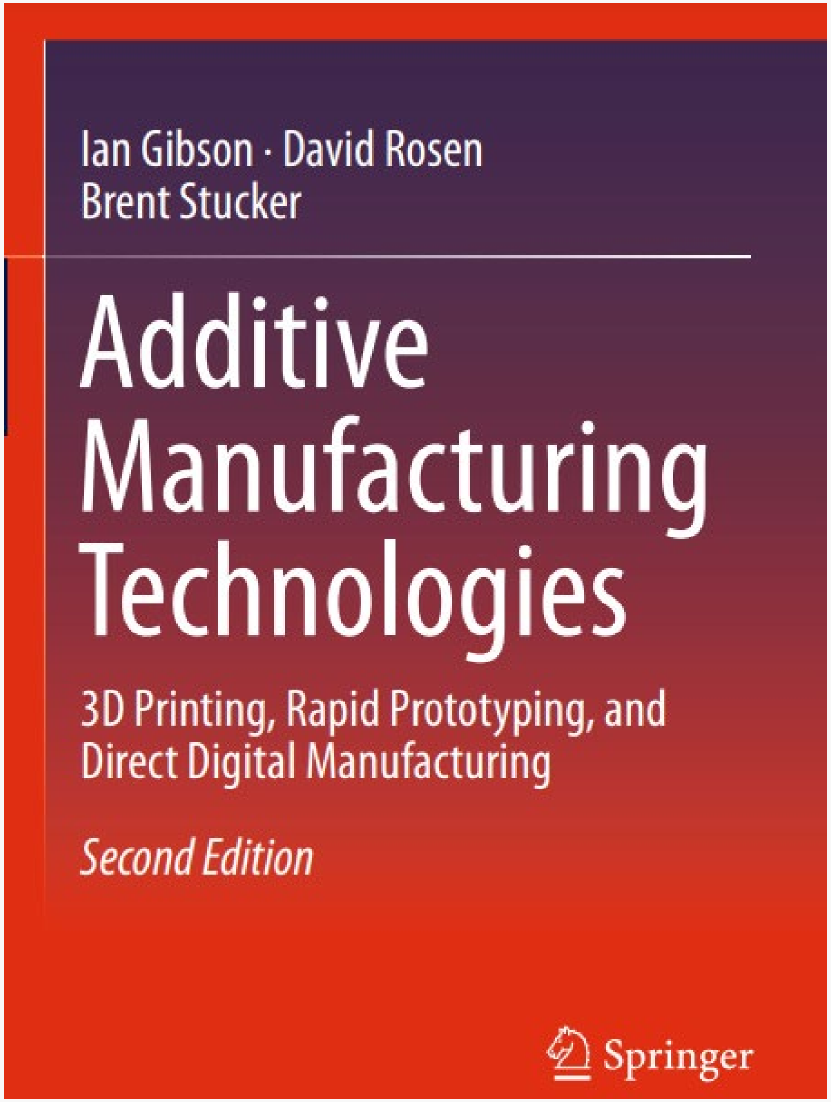
- metal-am.com/introduction-to-metal-additive-manufacturing-and-3d-printing/applications-for-additive-manufacturing-technology
- International Additive Manufacturing Qualification System, “Additive Manufacturing Qualifications,” IAMQS, 2019. www.ewf.be/additive-manufacturing.
- Lee, Hyub et. al. (2017). Lasers in additive manufacturing: A review. International Journal of Precision Engineering and Manufacturing-Green Technology.
- Hamza et. Al. (2017) Hamza Hassn Alsalla, Available at: effect-of-build-orientation-on-the-surface-quality-microstructure-and-mechanical-properties-of-selective-laser-melting-316l-stainless-steel

Kaynakça

- *US5155324A - Method for selective laser sintering with layerwise cross-scanning*. (1992, October 13). Google Patents. https://patents.google.com/patent/US5155324A/en
- *Electron Beam Freeform Fabrication, EBF3*. (n.d.). TECHNIQUE AND KNOWLEDGE TRANSFER | Find Suppliers, Processes & Material. https://www.manufacturingguide.com/en/electron-beam-freeform-fabrication-ebf3
- Sing, Swee et. Al.. (2015). Laser and electron-beam powder-bed additive manufacturing of metallic implants: A review on processes, materials and designs. Journal of orthopaedic research : official publication of the Orthopaedic Research Society. 34. 10.1002/jor.23075.
- Gibson, I., Rosen, D., & Stucker, B. (2014). *Additive manufacturing technologies: 3D printing, rapid Prototyping, and direct digital manufacturing*. Springer.
- Sefene, E. et. al. (2022). Metal hybrid additive manufacturing: State-of-the-art. *Progress in Additive Manufacturing*.
- Cunningham, C,. et. Al. (2018). Invited review article: Strategies and processes for high quality wire arc additive manufacturing. *Additive Manufacturing*.

Tavsiye



2010, 2015

Teşekkürler.