DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

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Università degli Studi di Padova – Dipartimento di Ingegneria Industriale

Corso di Laurea in Ingegneria Meccanica

Relazione per la prova finale

ANALISI DELLA RESISTENZA STATICA E A FATICA DI COMPONENTI OTTENUTI DA STAMPA 3D

Tutor universitario: Prof. Alberto Campagnolo

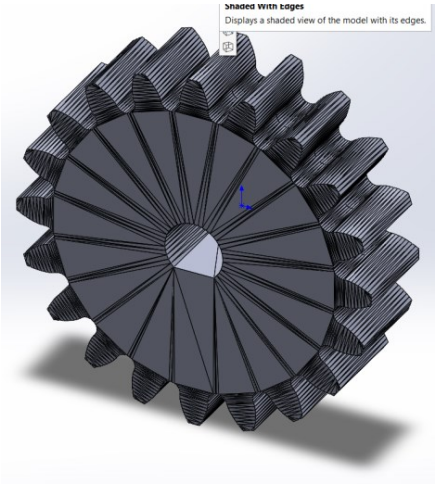
Co-Tutori: Prof.ssa Rachele Bertolini

Laureando*: Nicolini Chiara*

Padova, 19/11/2024

INTRODUZIONE: L'ADDITIVE MANUFACTURING

1. Disegno CAD

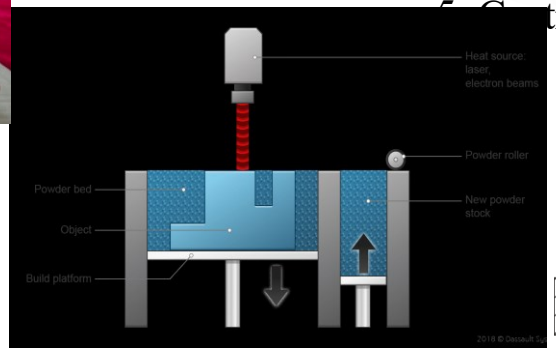


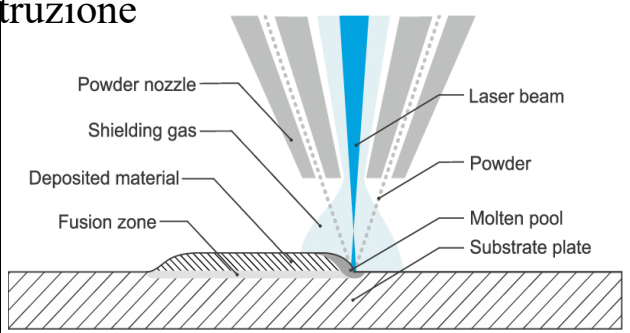
2. File STL

3. Trasferimento e correzione del file

4. Setup di macchina

5. Costruzione





6. Rimozione del pezzo

7. Post-processing

8. Utilizzo

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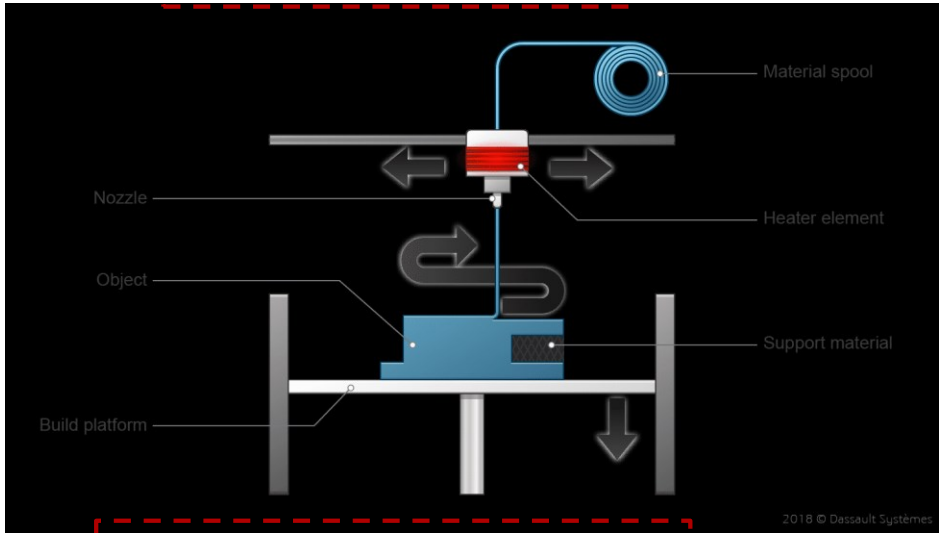
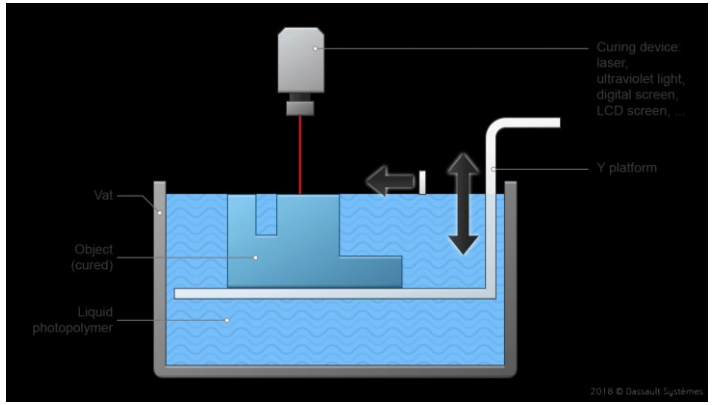
TIPOLOGIE DI MANIFATTURA ADITTIVA

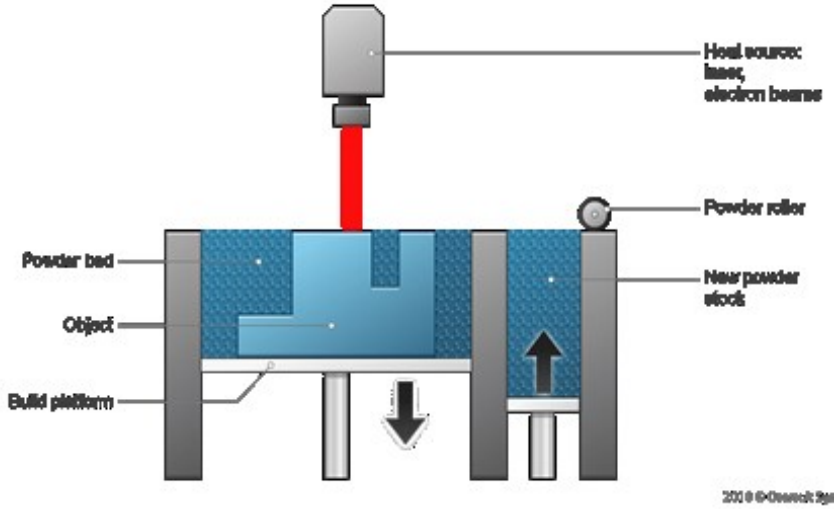
Estrusione del materiale



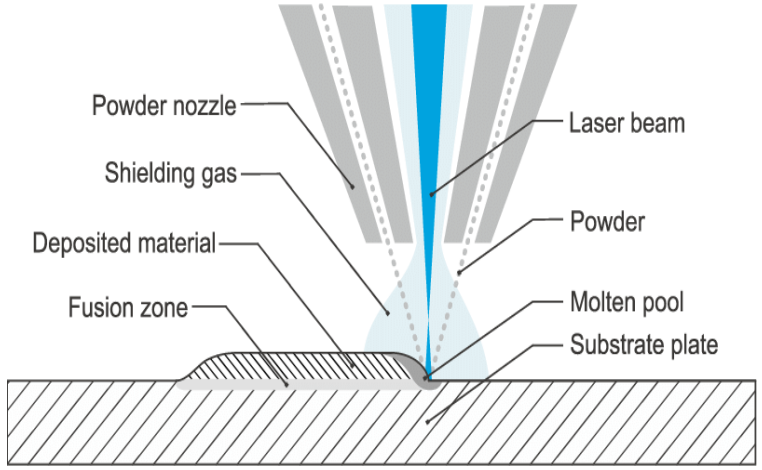
Fotopolimerizzazione a vasca



Fusione a letto di polvere (PBF)



Deposizione diretta di energia (DED)



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PALA DI TURBINA REALIZZATA TRAMITE PBF

https://www.youtube.com/watch?v=nPPHEmDoSHI

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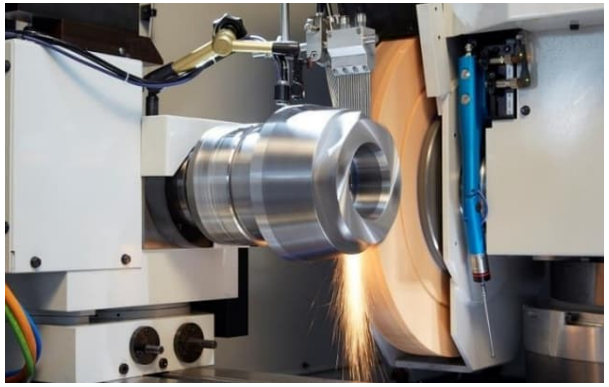
VANTAGGI E SVANTAGGI

Vantaggi	Svantaggi
Personalizzazione	Solidificazione disomogenea
Ridotto spreco di materiale	LoF e Porosità
Possibilità di riciclo del materiale	Necessità di trattamenti post processing



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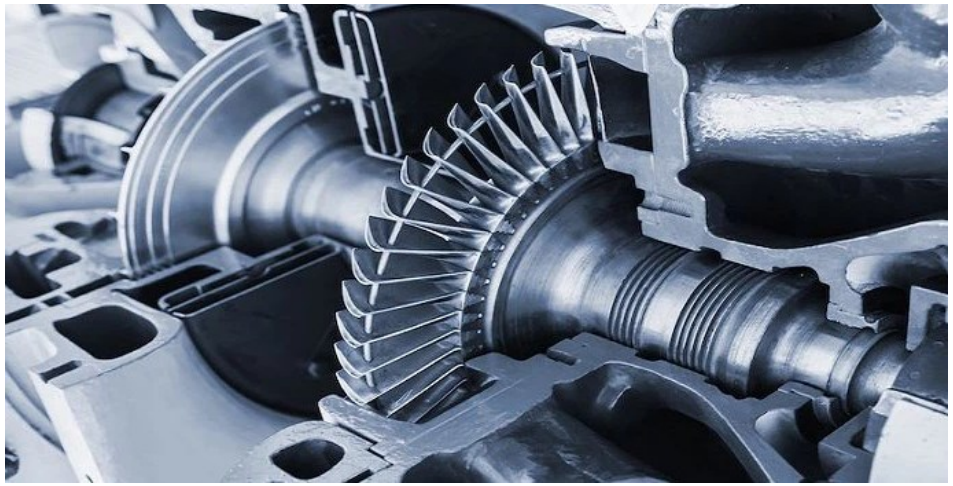
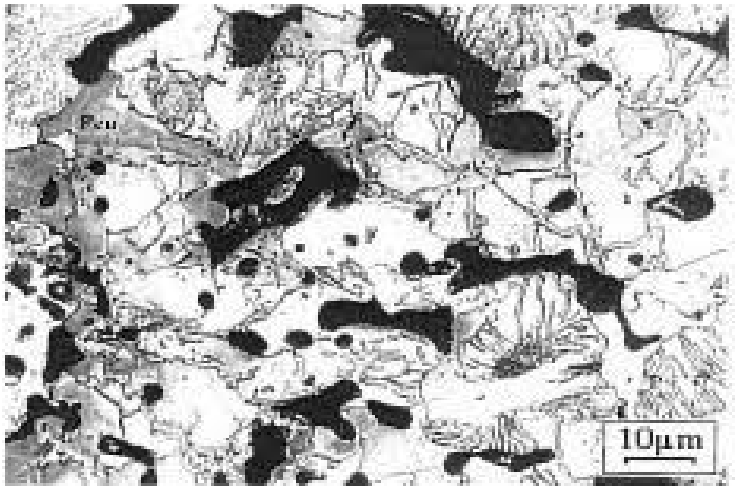
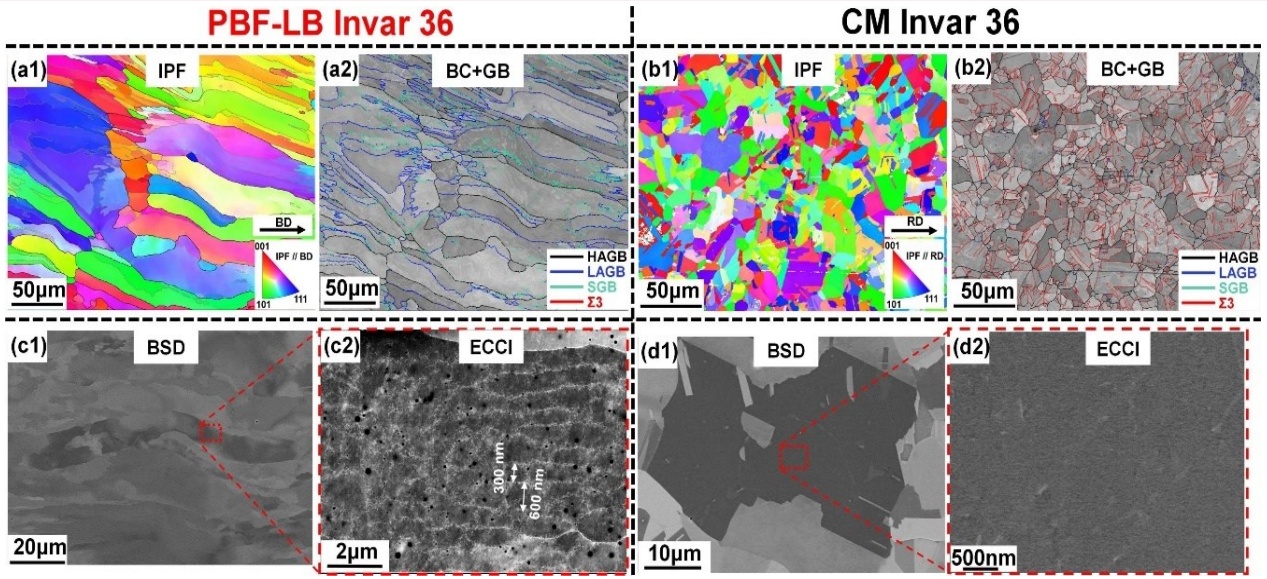
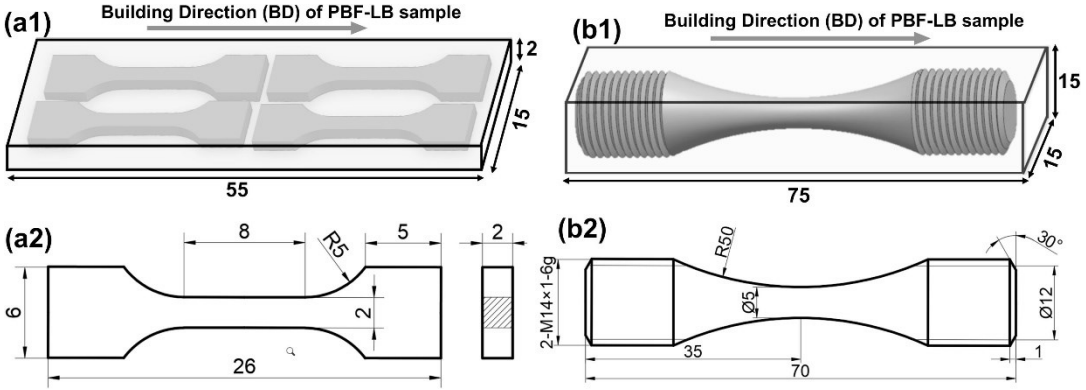


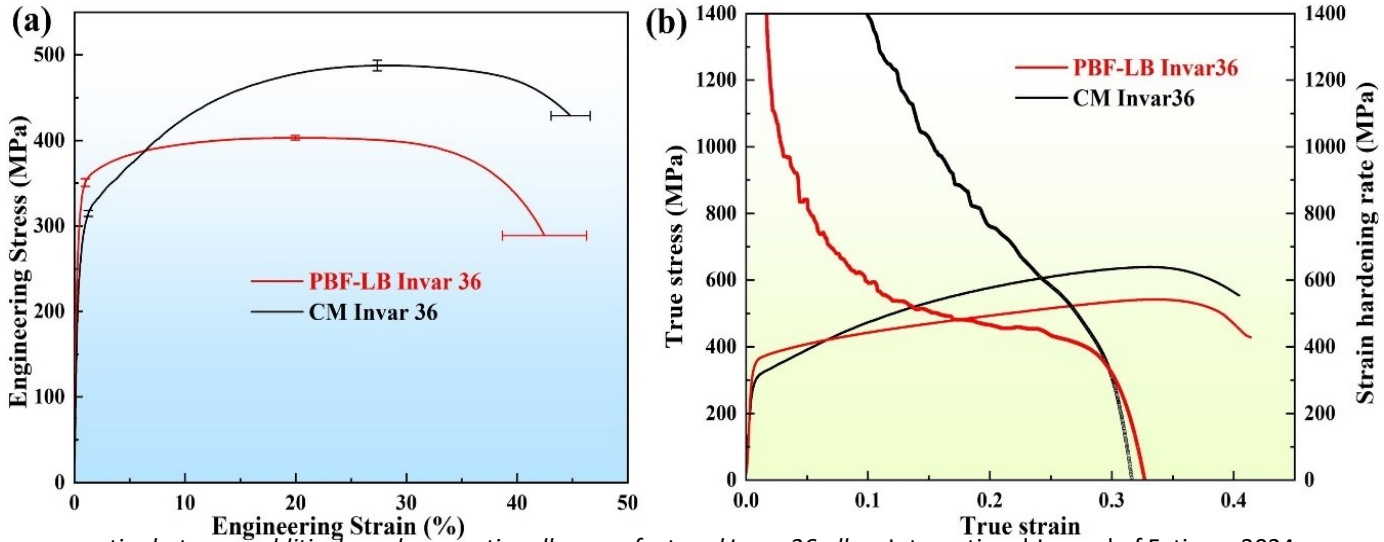


CONFRONTO PROVINI IN INVAR36- STATICA



PBF-LB	CM
Grani colonnari	Struttura equiassica
Alta presenza di dislocazioni	Bassa presenza di dislocazioni
$\sigma_s >, UTS <, n <$	$\sigma_s <, UTS >, n >$





Xinxi Liu, Yuhao Zhou, Jie Chen, Daygon An, Xifeng Li, Jun Chen. *Comparative investigation of fatigue properties between additively and conventionally manufactured Invar 36 alloy.* International Journal of Fatigue, 2024

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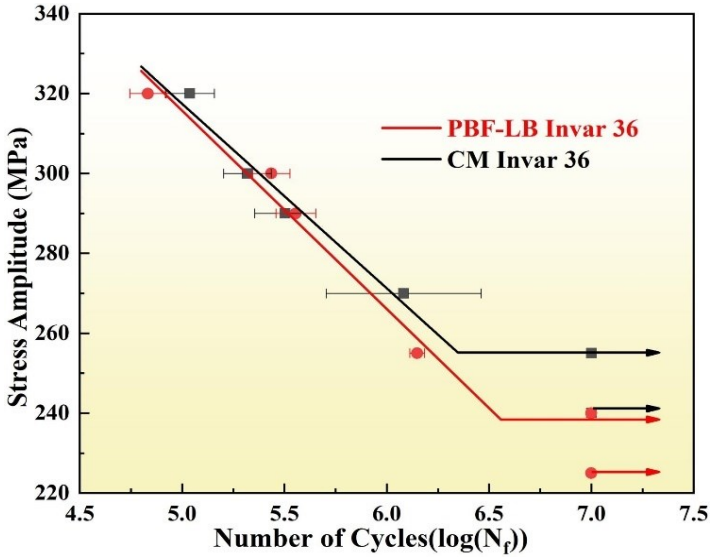
CONFRONTO PROVINI IN INVAR36- FATICA



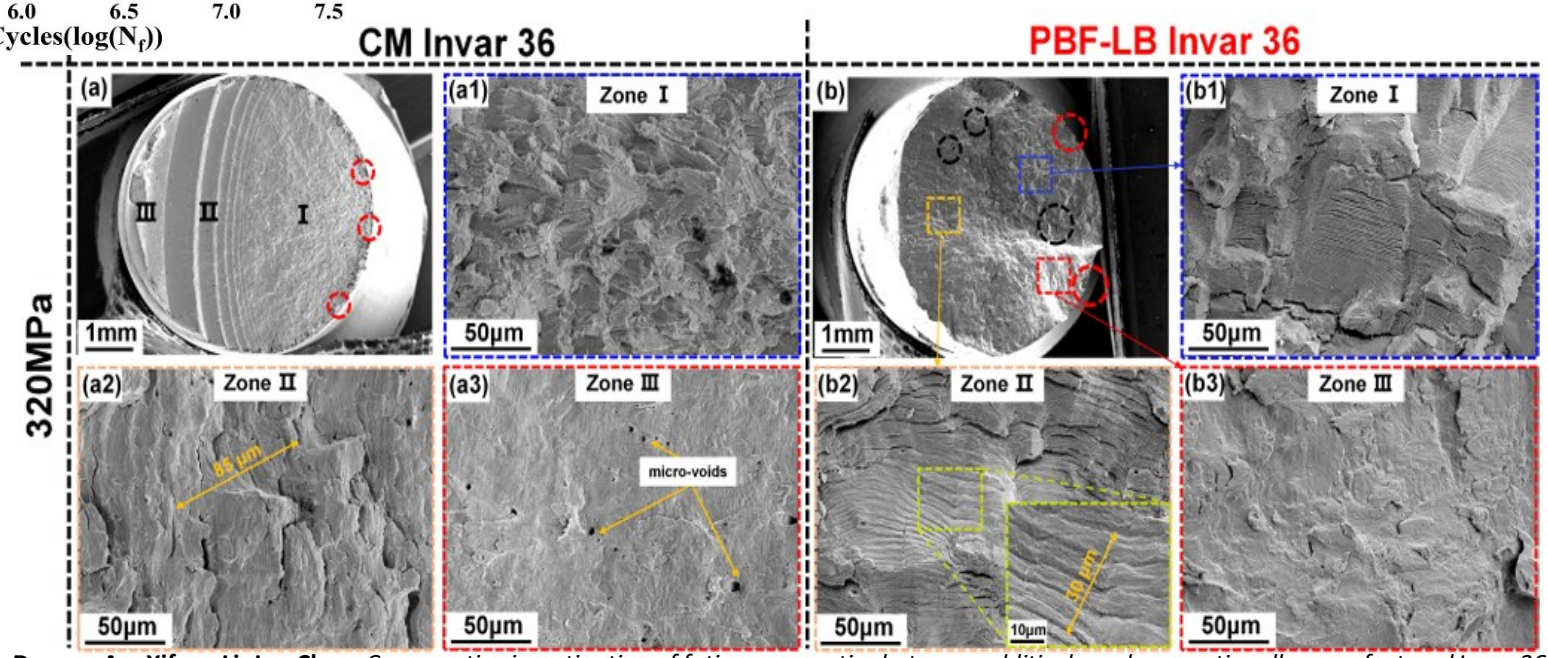
Parametri delle prove a fatica

Carico assiale

$R = -1$

$f = 10 \div 100\ Hz$

PBF-LB	CM
$\sigma_{A,\infty,-1} <$	$\sigma_{A,\infty,-1} >$
Superficie di frattura disomogenea	3 zone definite nella superficie di frattura
Alta resistenza alla propagazione della cricca	Bassa resistenza alla propagazione della cricca



Xinxi Liu, Yuhao Zhou, Jie Chen, Daygon An, Xifeng Li, Jun Chen. *Comparative investigation of fatigue properties between additively and conventionally manufactured Invar 36 alloy.* International Journal of Fatigue, 2024

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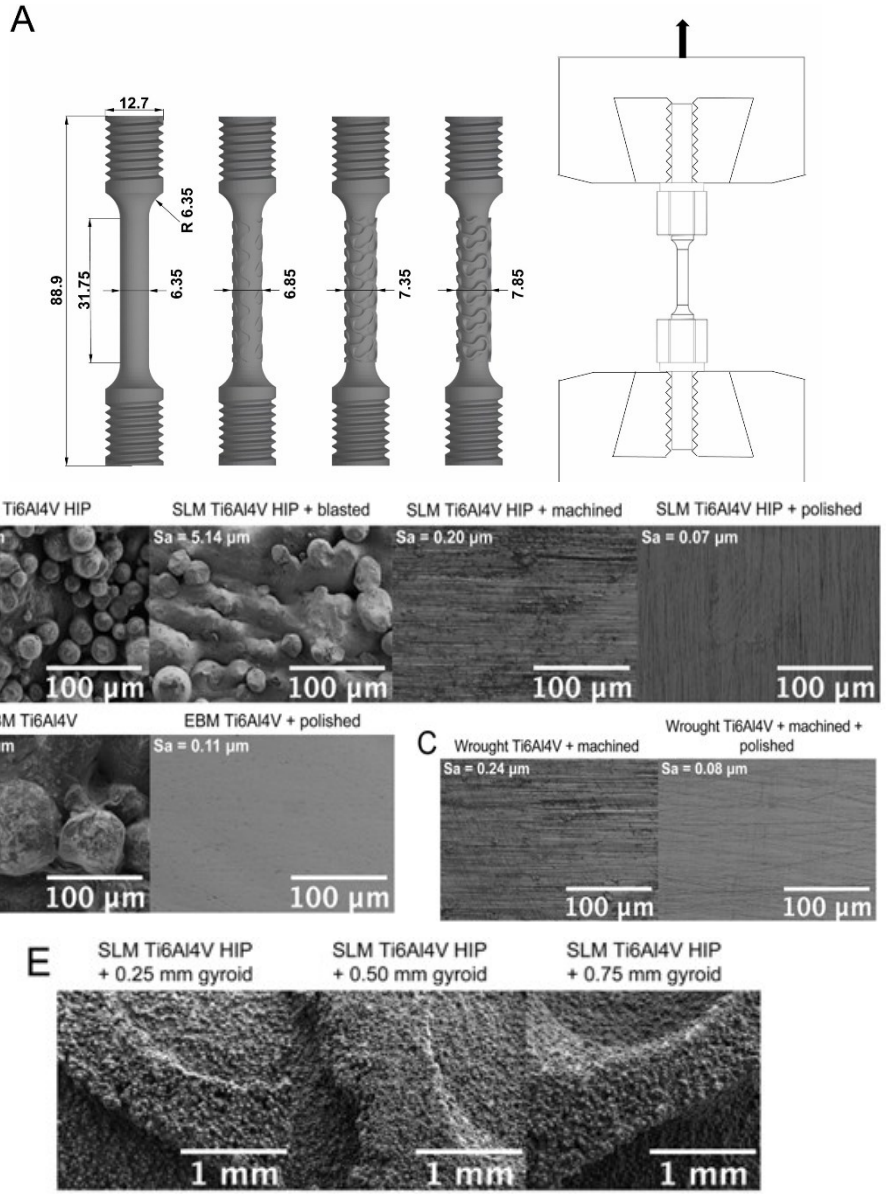
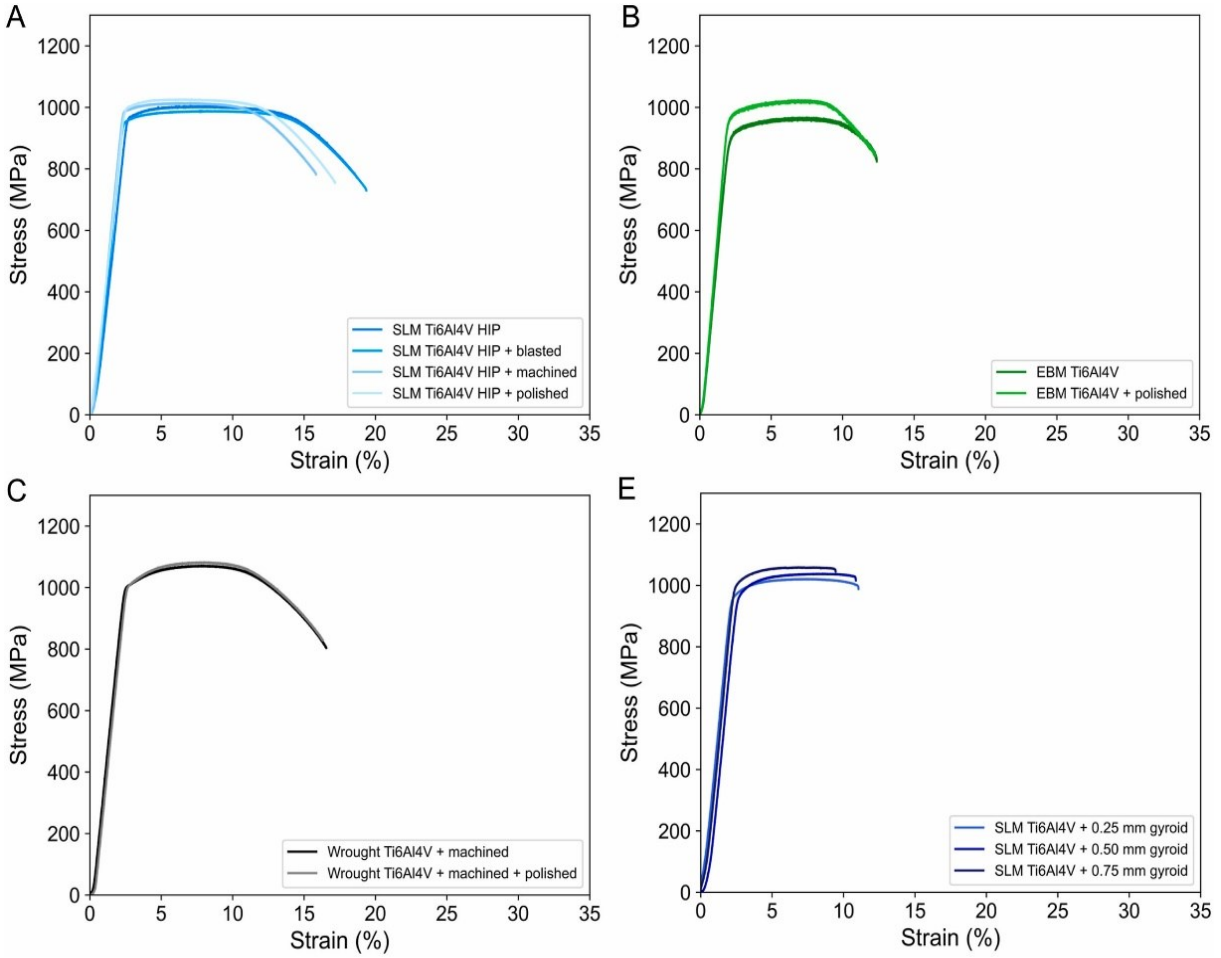
CONFRONTO PROVINI IN TI6AL4V- STATICA



- Componenti SLM hanno proprietà comparabili ai CM.
- $\varepsilon_{MAX\,gyroid}$ è la minima tra tutti i componenti.



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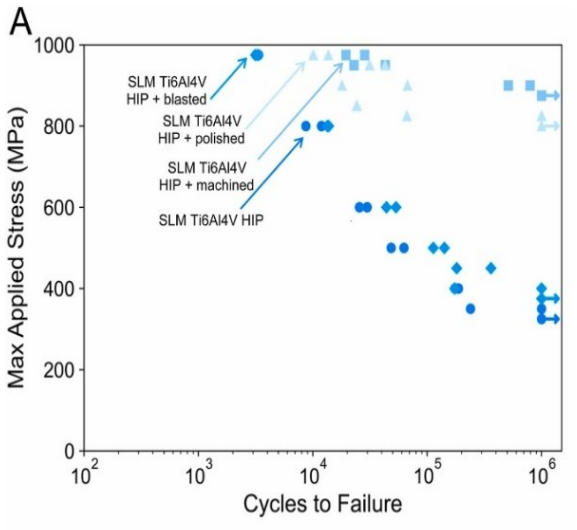
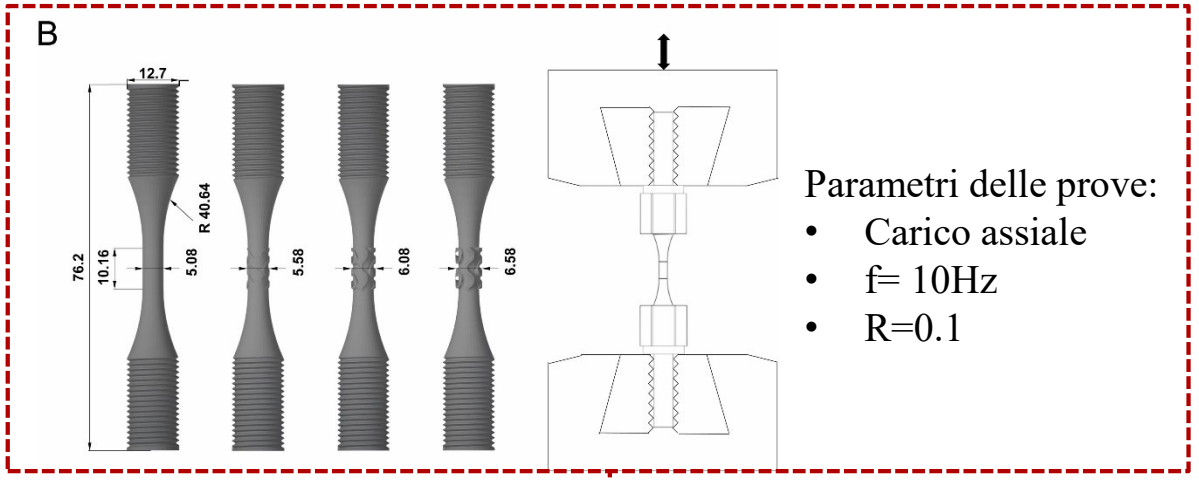
Zhongwei Xu, An Liu, Xishu Wang. *Fatigue performance differences between rolled and selective laser melted Ti6Al4V alloys.* Materials Characterization, 2022

CONFRONTO PROVINI IN TI6AL4V- FATICA

Confronto tra finiture superficiali

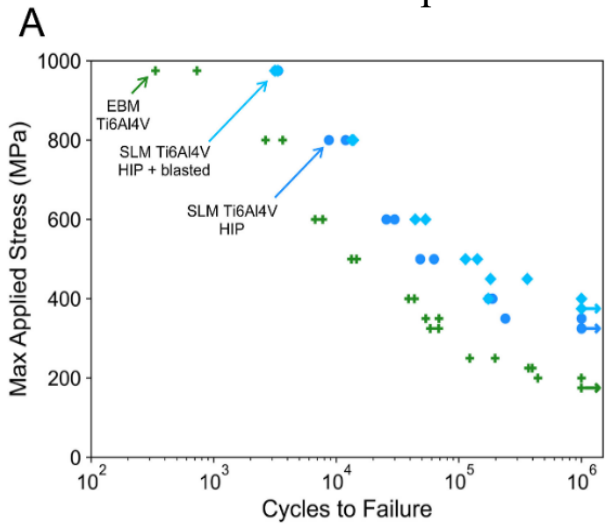


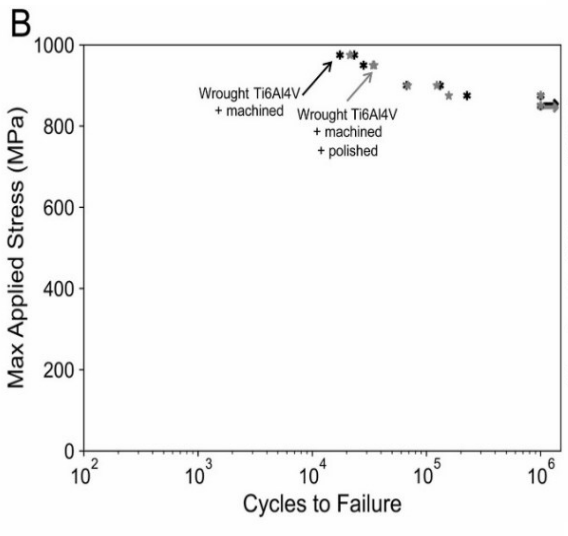


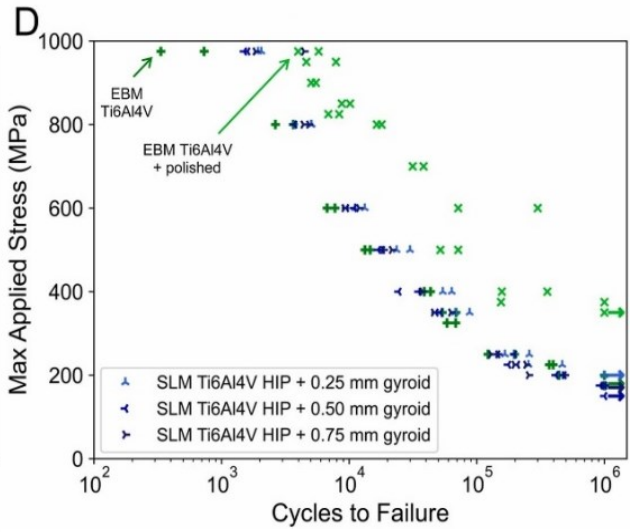
Parametri delle prove:

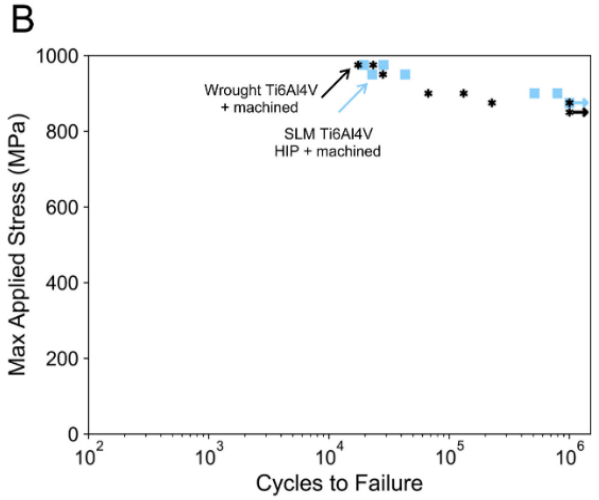
- Carico assiale
- f= 10Hz
- R=0.1

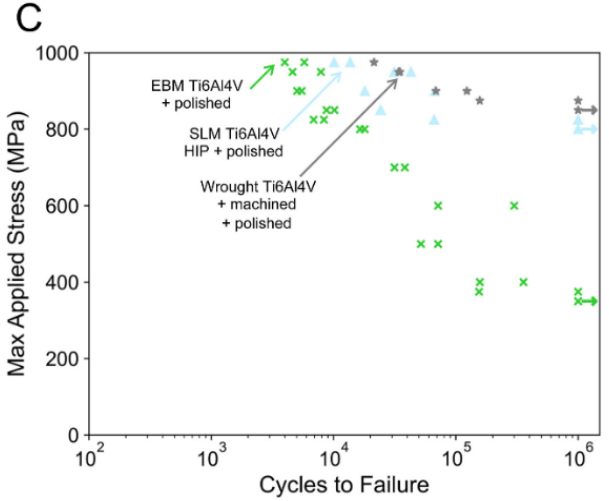
Confronto tra processi











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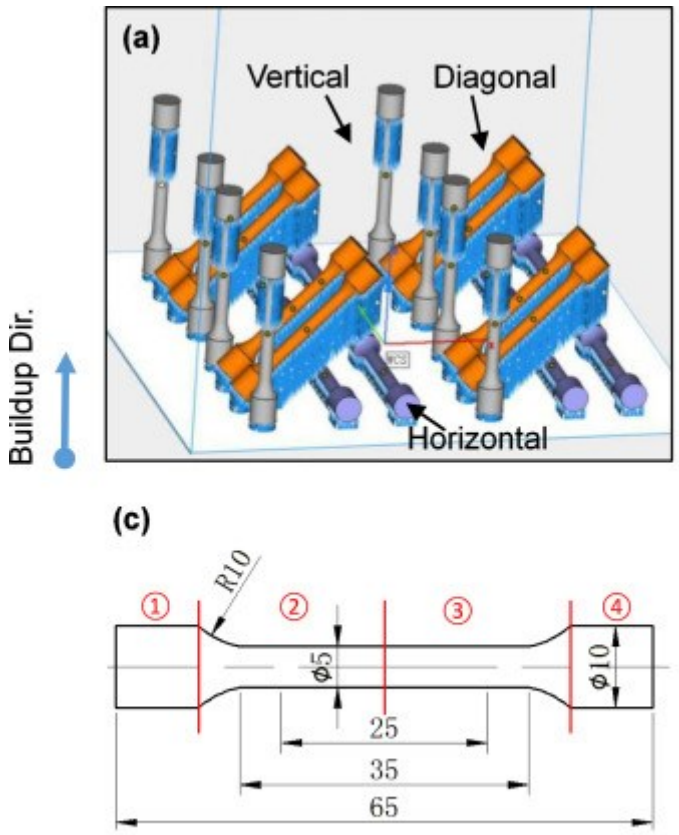
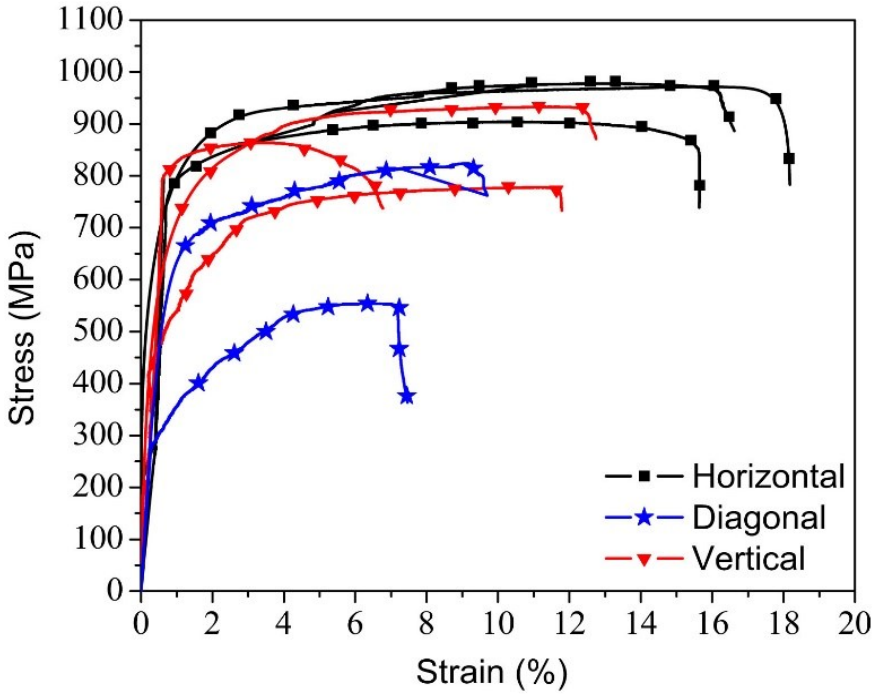
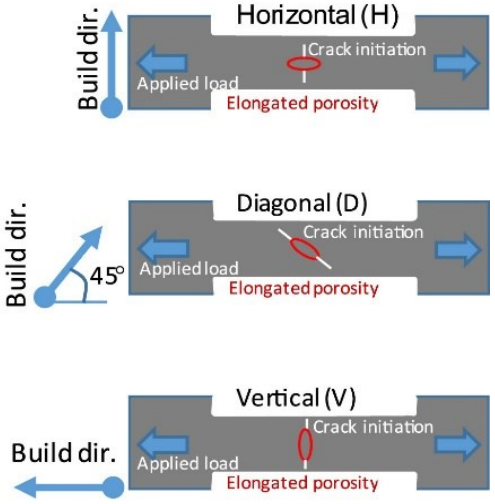
Zhongwei Xu, An Liu, Xishu Wang. *Fatigue performance differences between rolled and selective laser melted Ti6Al4V alloys.* Materials Characterization, 2022

CONFRONTO PROVINI IN TI6AL4V- DIVERSE BD





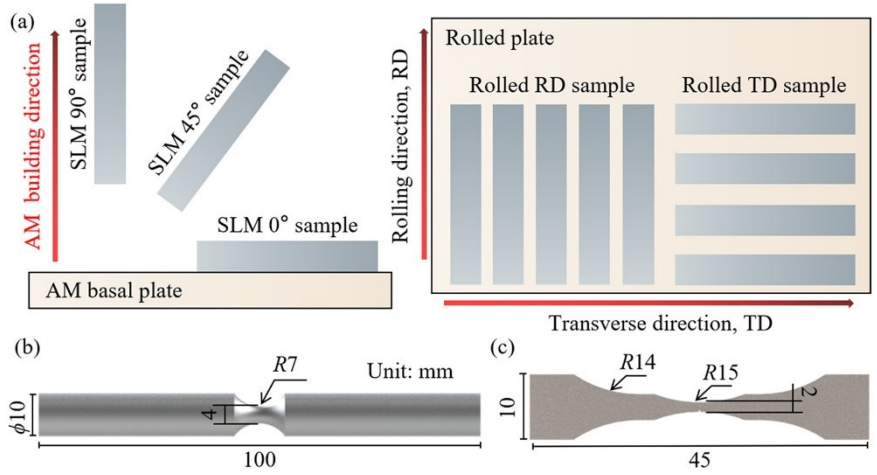


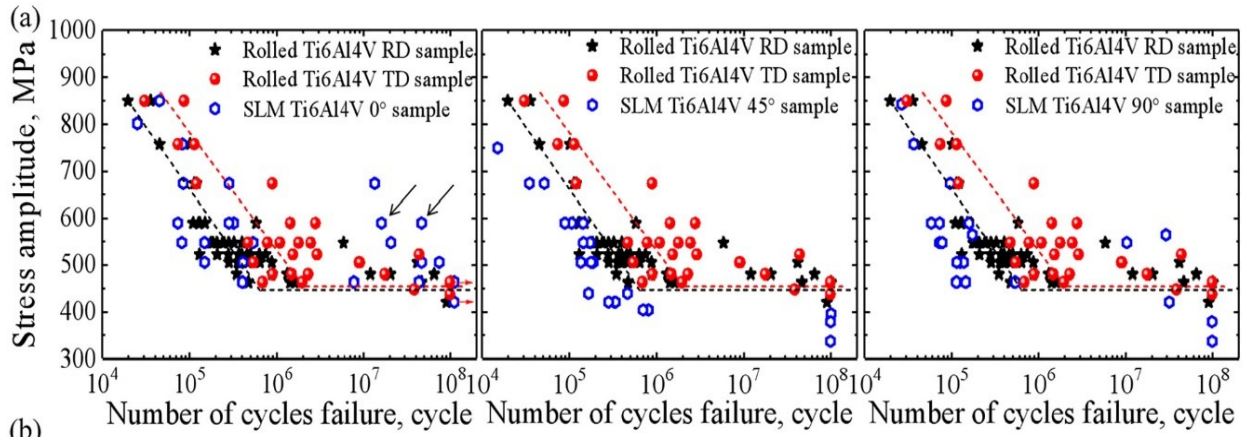
- I difetti nei componenti orizzontali sono orientati in modo favorevole;
- Le tensioni residue in componenti orizzontali sono meno elevate

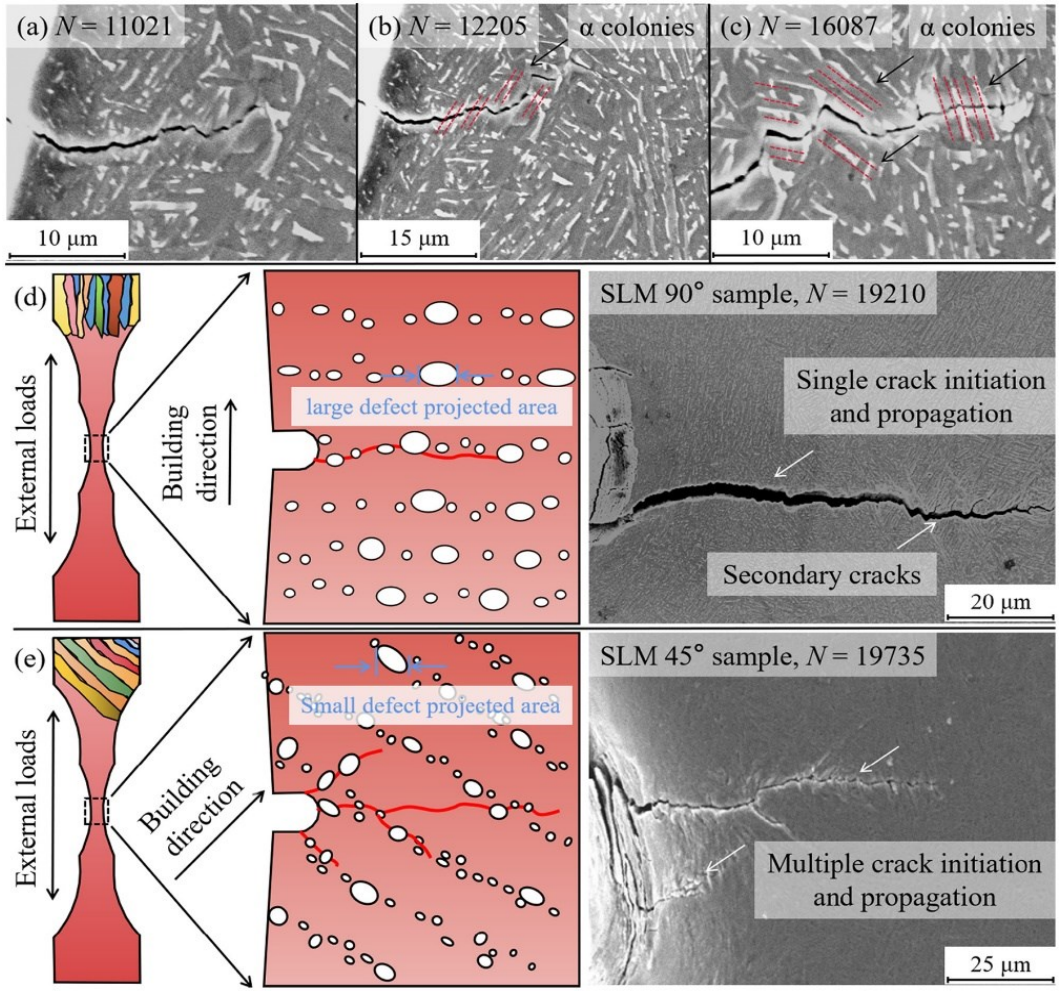
M. Wang, H.Q. Li, D.J. Lou, C.X. Qin, J. Jiang, X.Y. Fang, Y.B. Guo. *Microstructure anisotropy and its implication in mechanical properties of biomedical titanium alloy processed by electron beam melting.* Materials Science and Engineering: A

CONFRONTO PROVINI IN TI6AL4V- DIVERSE BD

Parametri delle prove: Flessione rotante, $R = -1$, $f = 60\ Hz$

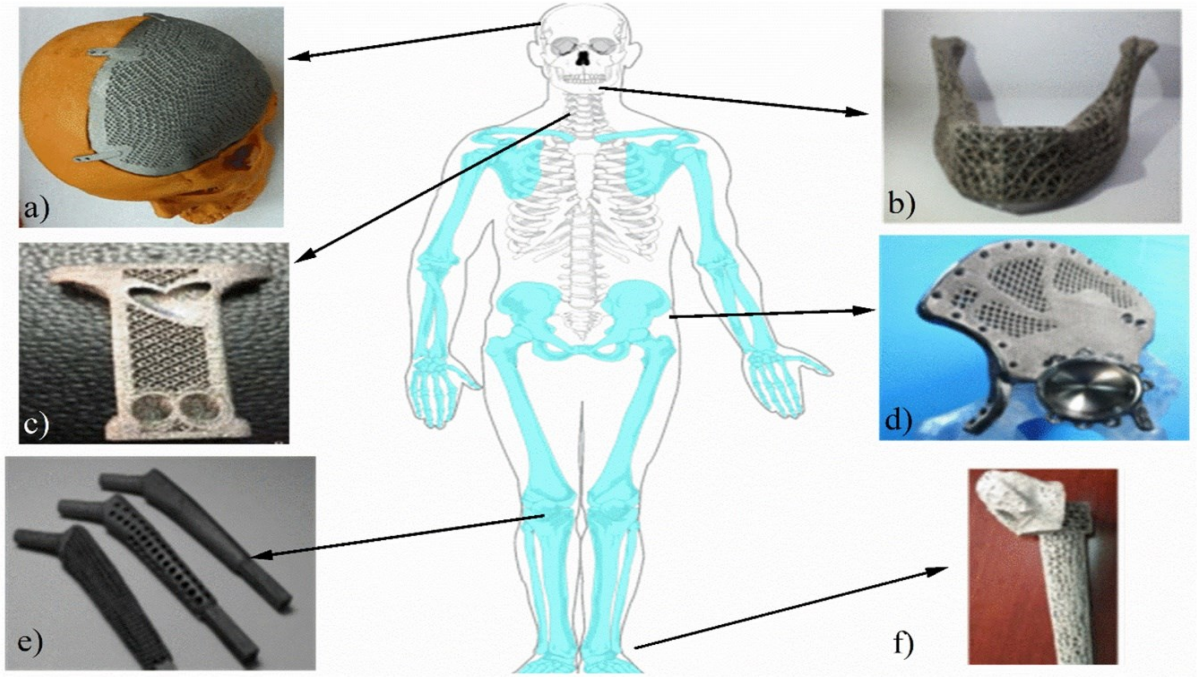






M. Wang, H.Q. Li, D.J. Lou, C.X. Qin, J. Jiang, X.Y. Fang, Y.B. Guo. *Microstructure anisotropy and its implication in mechanical properties of biomedical titanium alloy processed by electron beam melting.* Materials Science and Engineering: A, 2019

AM IN AMBITO BIOMEDICO



Vantaggi Ti6Al4V	Svantaggi Ti6Al4V
Eccellente biocompatibilità	Bassa resistenza all'usura
Buone proprietà meccaniche, resistente alla corrosione	Promuove la formazione di biofilm batterici
Promuove integrazione ossea	Rischio di allentamento

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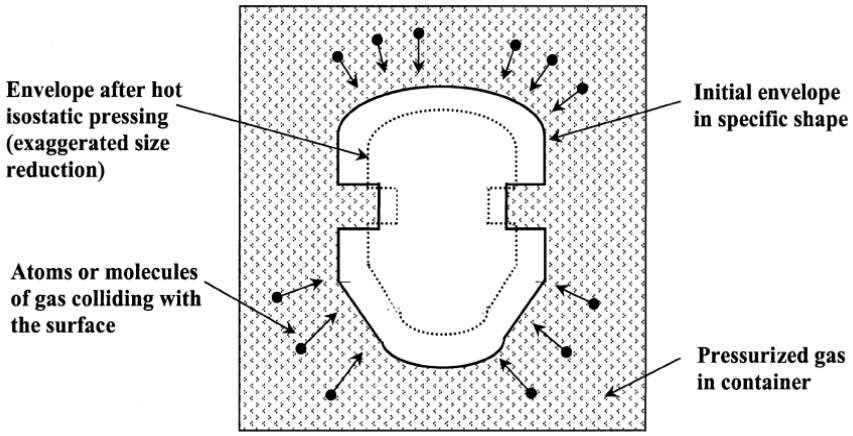
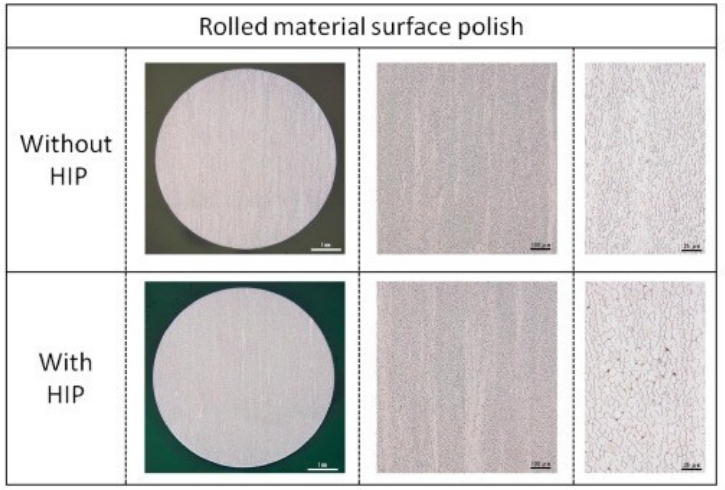
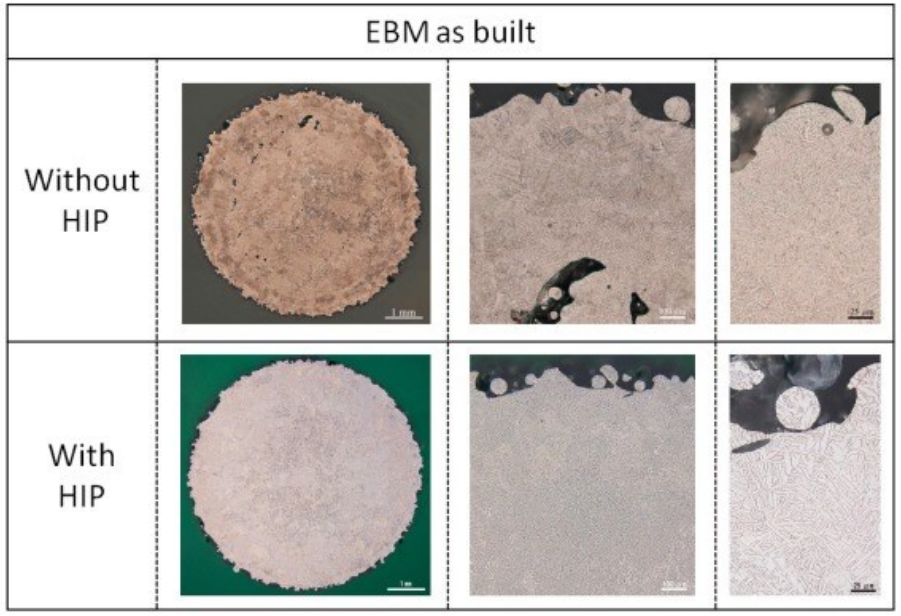
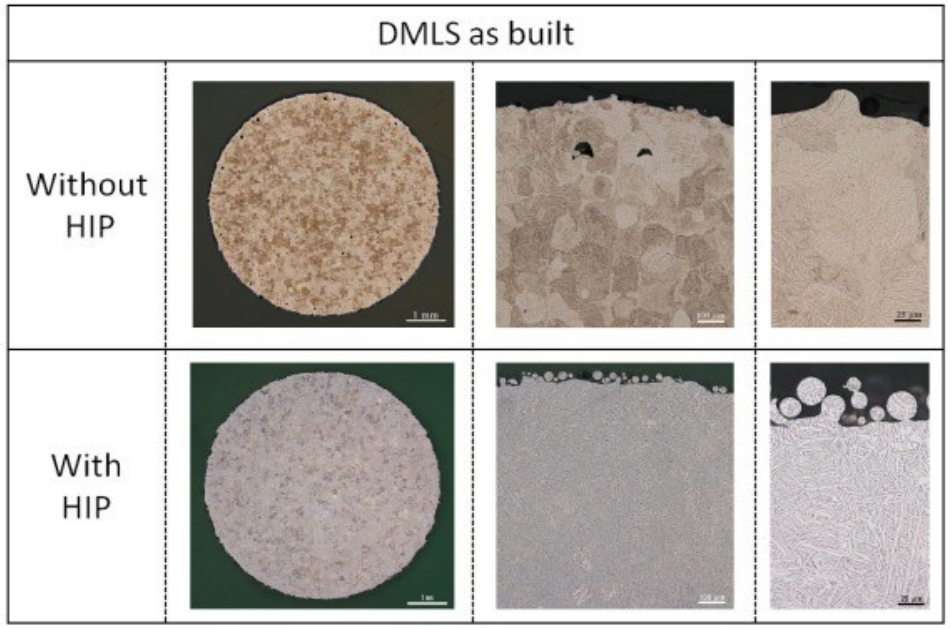
TRATTAMENTO HIP SU COMPONENTI AM









Hiroshige Masuo, Yuzo Tanaka, Shotaro Morokoshi, Hajime Yagura, Tetsuya Uchida, Yasuhiro Yamamoto, Yukitaka Murakami. *Influence of defects, surface roughness and HIP on the fatigue strength of Ti-6Al-4V manufactured by additive manufacturing.* International Journal of Fatigue, 2018

TRATTAMENTO HIP SU COMPONENTI AM

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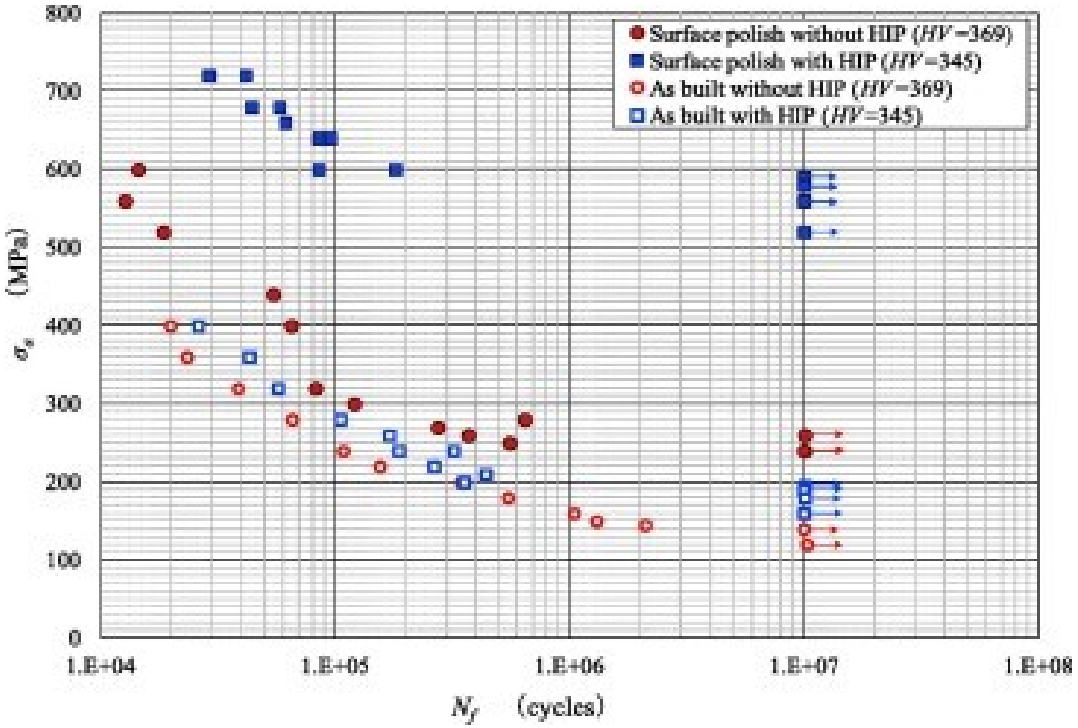
EBM



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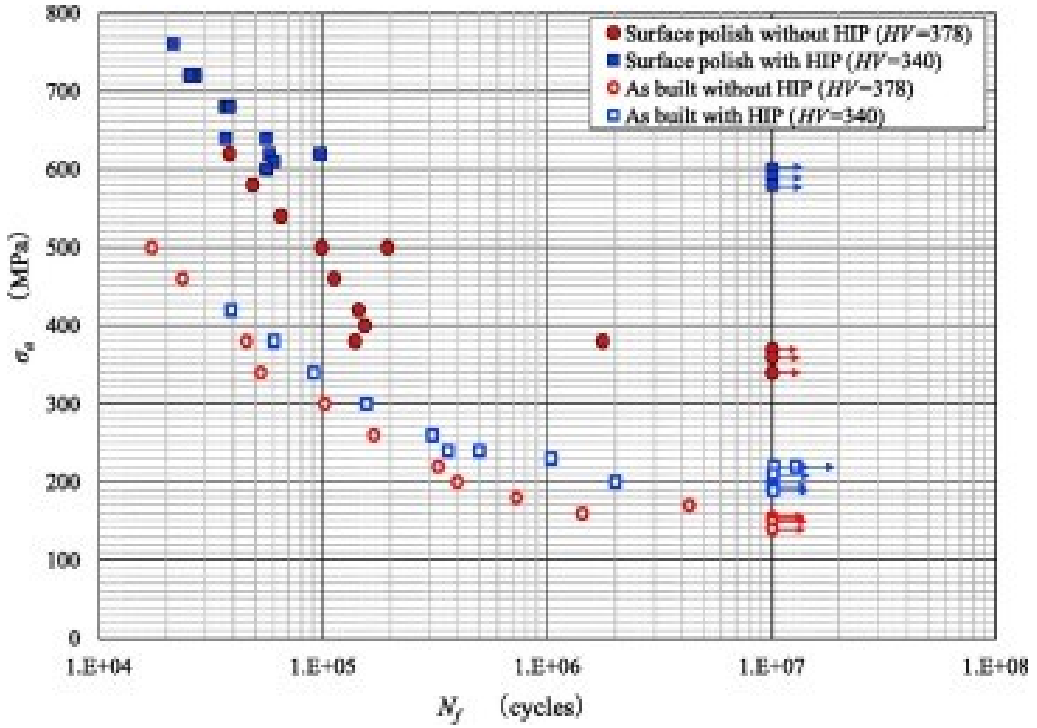
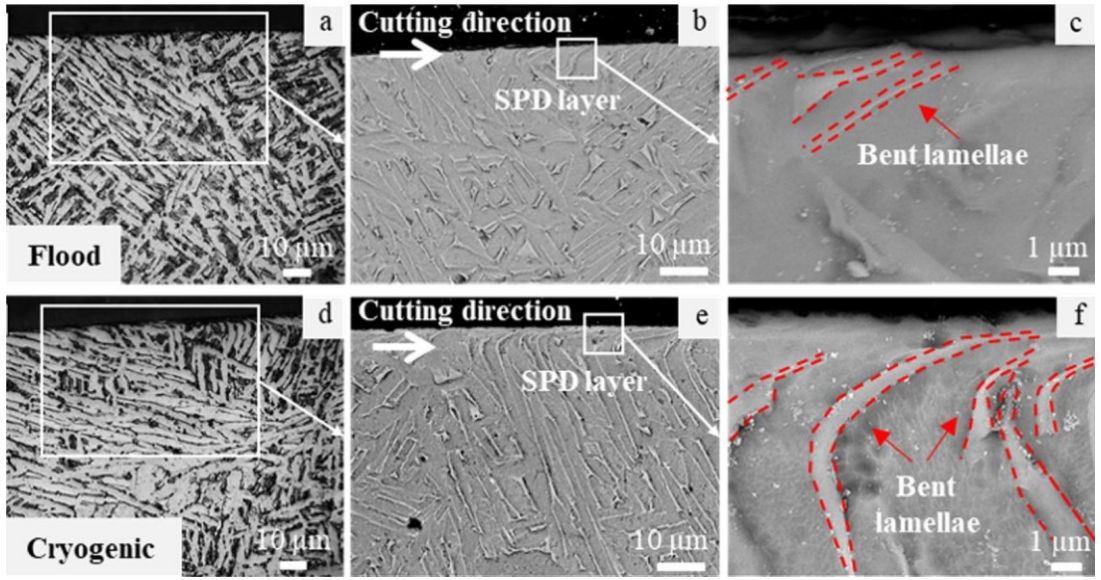
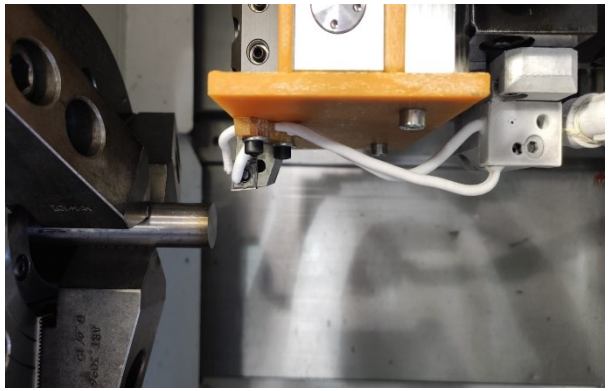


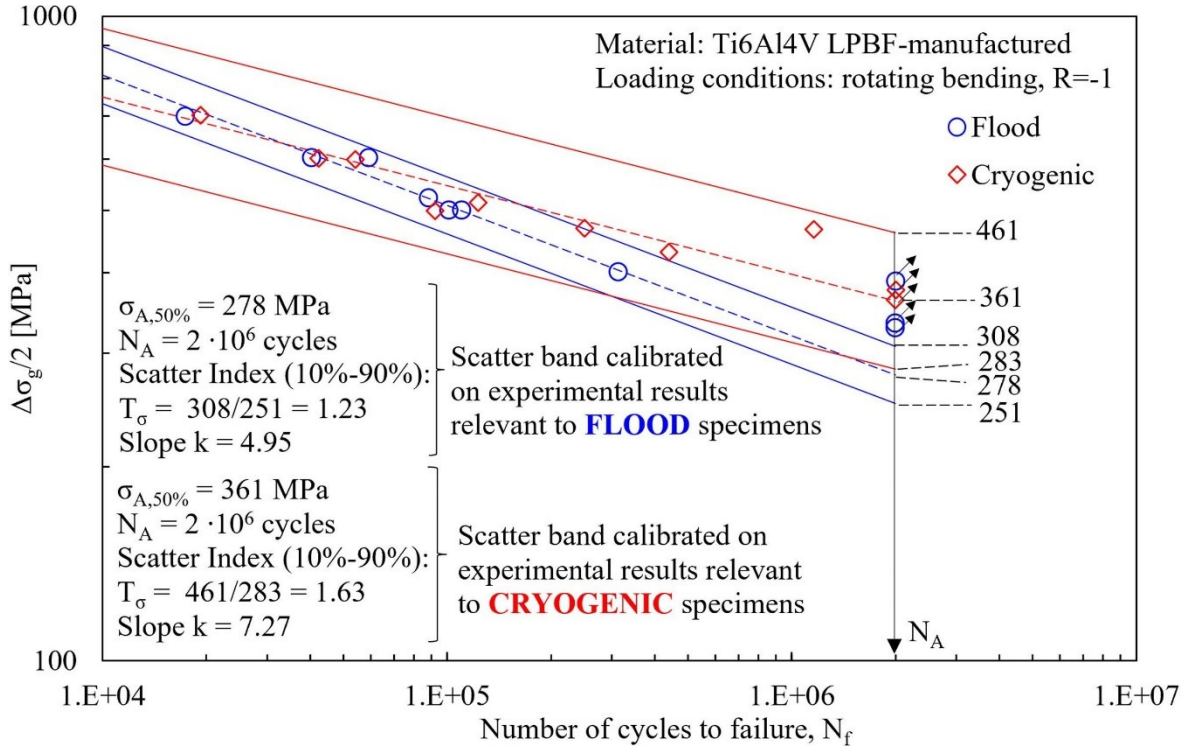
Hiroshige Masuo, Yuzo Tanaka, Shotaro Morokoshi, Hajime Yagura, Tetsuya Uchida, Yasuhiro Yamamoto, Yukitaka Murakami. *Influence of defects, surface roughness and HIP on the fatigue strength of Ti-6Al-4V manufactured by additive manufacturing.* International Journal of Fatigue, 2018

TORNITURA CRIOGENICA SU COMPONENTI AM





Vantaggi della lavorazione criogenica
- Ecosostenibile
- Aumento microdurezza
- Aumento tensioni residue di compressione
- Aumento vita a fatica per elevato numero di cicli



Rachele Bertolini, Alberto Campagnolo, Marco Sorgato, Andrea Ghiotti, Stefania Bruschi, Giovanni Meneghetti. *Fatigue strength of LPBF Ti6Al4V machined under flood and cryogenic lubri-cooling conditions.* International Journal of Fatigue, 2022

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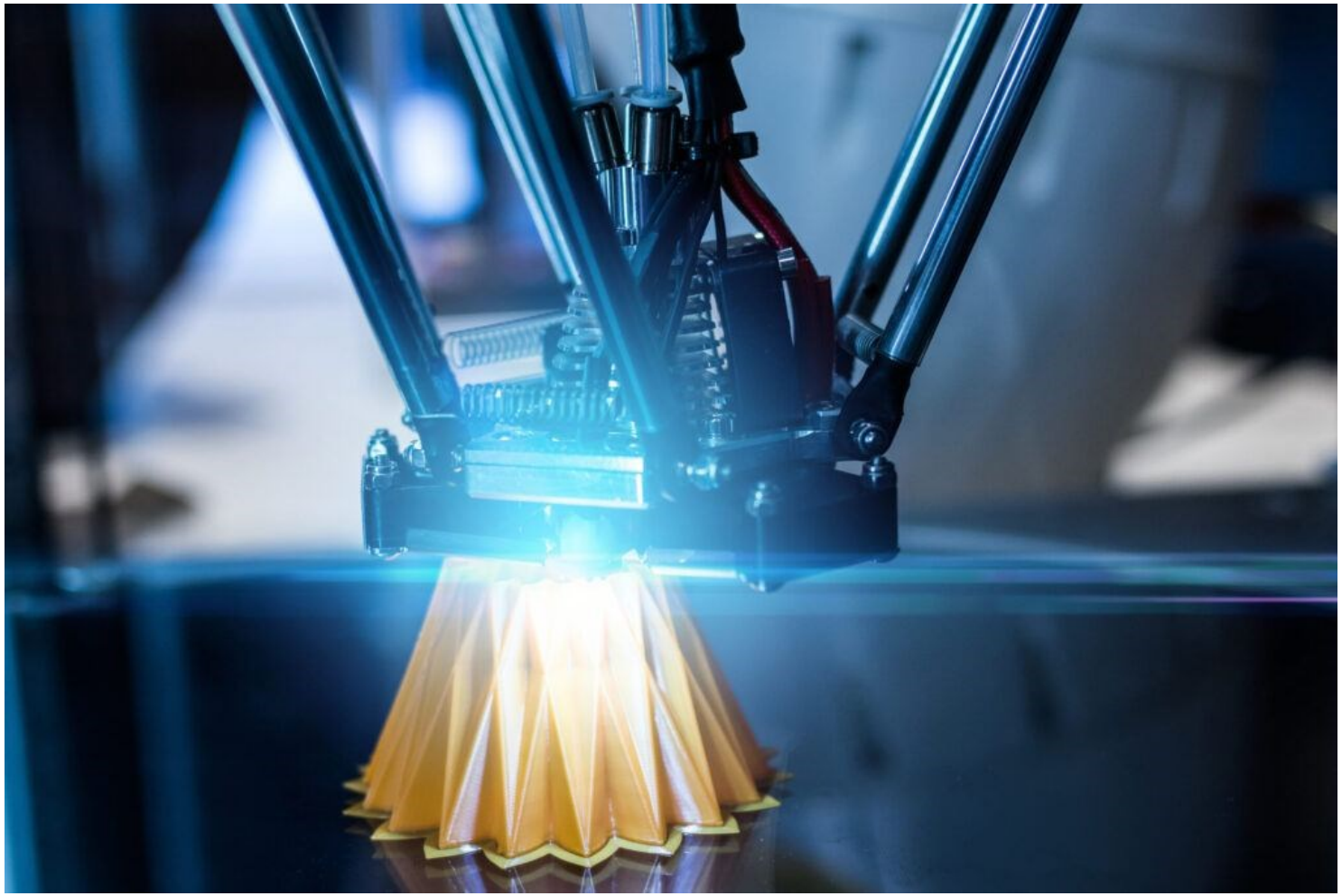
CONCLUSIONI



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