

Potenzialità della tecnologia AM nella fabbricazione di impianti custom-made

Relatore: Professor Alessandro Fortunato

Gruppo di ricerca



Prof. Luca Tomesani
Professor and manufacturing
group coordinator



Prof. Alessandro Fortunato
Associate professor and laser
group coordinator



Ph.D ing. Alessandro Ascari
Senior assistant professor
Main research topic: laser welding



Ph.D ing. Erica Liverani
Research fellow.
Main research topic: PBF additive
manufacturing



Ph.D ing. Antonio Candido
Research fellow.
Main research topic: data analysis, modeling,
machine learning for manufacturing



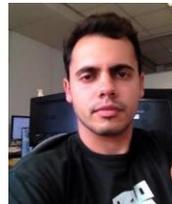
M.Sc Giuseppe Valli
Ph.D student.
Main research topic: PBF additive manufacturing



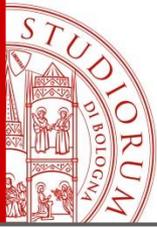
M.Sc Flavia Lerra
Ph.D student.
Main research topic: grinding processes modeling
and optimization



M.Sc Vincenzo Dimatteo
Ph.D student.
Main research topic: laser welding of highly
reflective materials for automotive applications



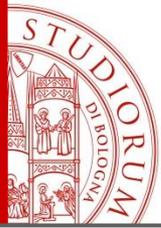
M.Sc Eriel Pérez Zapico
Research fellow.
Main research topic: laser welding of highly
reflective materials for automotive applications



Gruppo Laser: attrezzature e principali attività di ricerca

- 3 kW CW Laserline diode laser (1000 μm delivery fiber core diameter)
- 3 kW CW nLight Yb:fiber laser (50 μm delivery fiber core diameter)
- 1 kW CW Trumpf Nd:YAG laser (300 μm delivery fiber core diameter)
- 300-3000 W Q-CW long pulse Yb:fiber IPG laser (50 μm delivery fiber core diameter)
- 200 W long pulse Nd:YAG Trumpf laser (400 μm delivery fiber core diameter)
- 100 W short pulse Yb:fiber SPI laser
- 20 W short pulse Yb:fiber IPG laser
- 7 W ultra-short pulse Ti:Sapphire Light Conversion laser
- GTV 2 hoppers powder feeder + GTV 6-ways powder nozzle
- 6 axes anthropomorphic robot + 1 axis rotary positioner
- Several fixed focal and galvo focusing heads
- Sisma Mysint 100 SLM PBF 3D printing machine

- Tempra laser
- Saldatura laser di materiali dissimili e alto-riflettenti
- Saldatura e taglio laser di film sottili di materiale polimerico per il packaging
- Ablazione e marcatura laser
- Manifattura additiva a letto di polvere
- Manifattura additiva per deposizione diretta



Partner industriali e collaborazioni



Packaging
machines
manufacturer



a coesia company
Packaging
machines
manufacturer



Ice cream
machines
manufacturer



Packaging
machines
manufacturer



Grinding machines and
tools manufacturer



Beverage packaging
and packaging
machines
manufacturer



Leader of
automatic bar
feeders

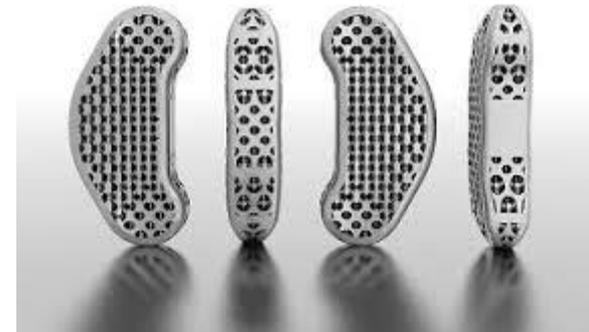
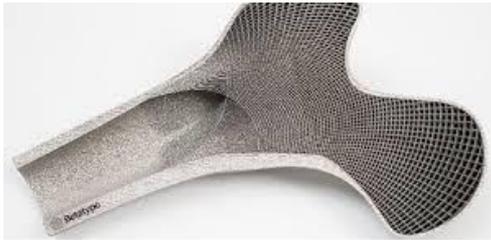


Big Data Innovation & Research Excellence



POTENZIALITA'

1. Protesi **personalizzate** (geometria e superficie articolare)
2. Design ottimizzato → più libertà nella progettazione
3. Possibilità di stampa di **strutture reticolari** → possibilità di ottimizzare l'osteointegrazione e diminuire il fenomeno dello stress shielding

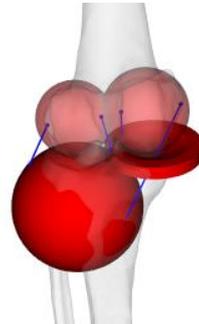


Metodo

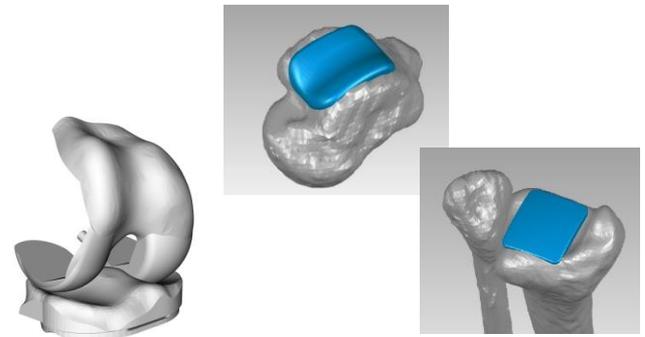
Anatomia del paziente



Modello cinematico



Progettazione dell'impianto personalizzato



Test e validazione cinematica

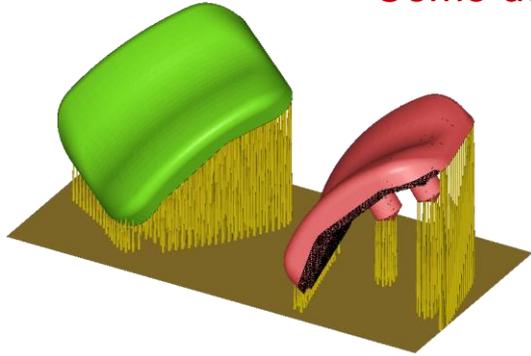


PRODUZIONE DELL'IMPIANTO



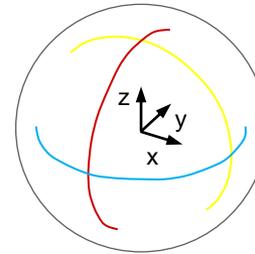
Produzione: a quali domande è necessario trovare la risposta giusta

Come devo supportarlo?



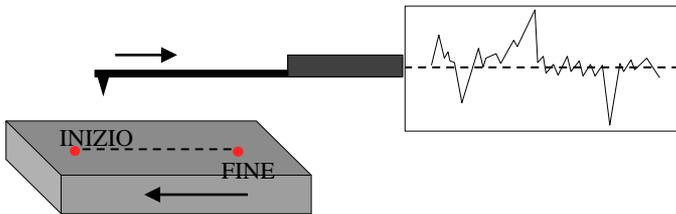
1. Forma e dimensione
2. Distribuzione

Come è meglio orientarlo e cosa cambia?

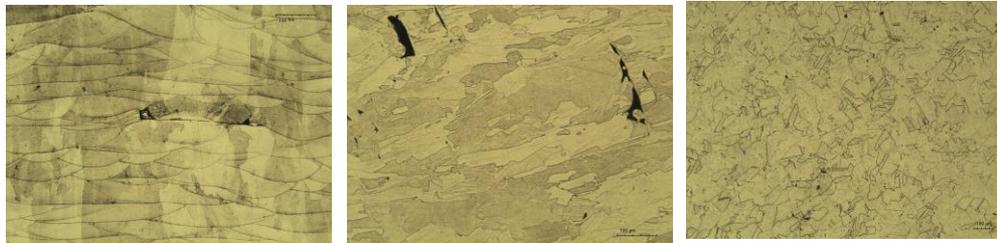
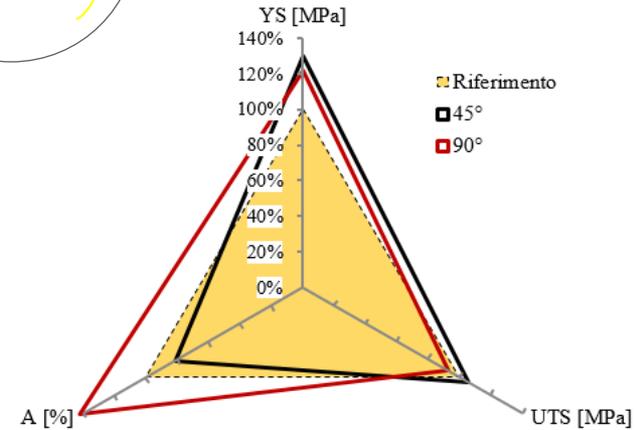


Traslazione lungo x, y e z
Rotazione attorno x, y e z

Quali post-processi devo prevedere?

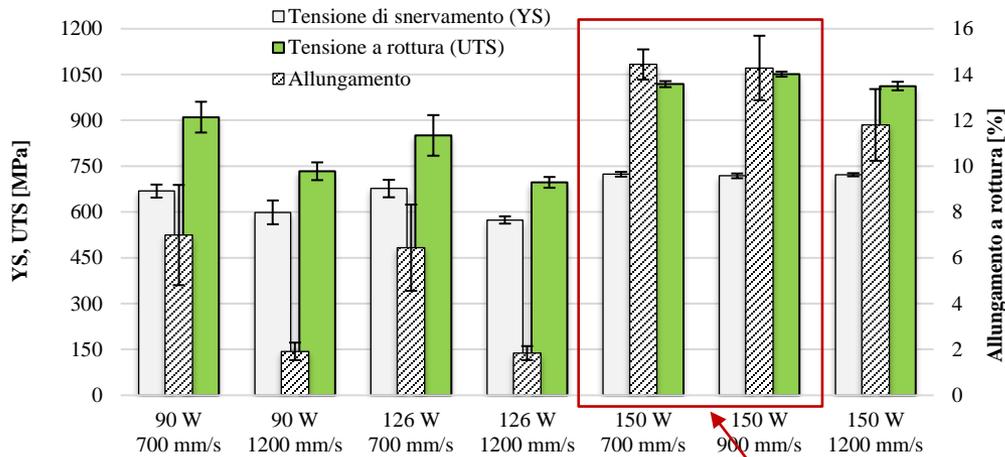


1. Finitura
2. Trattamento termico

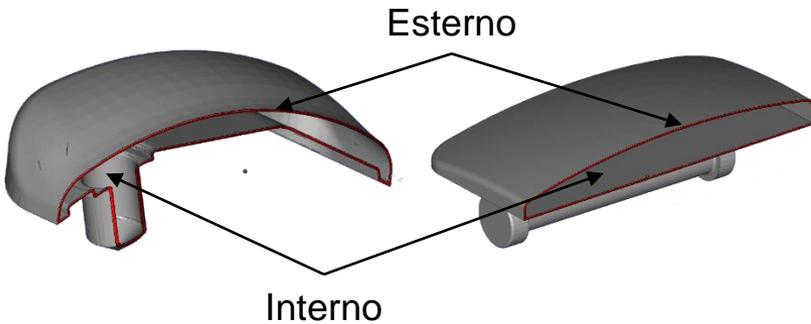
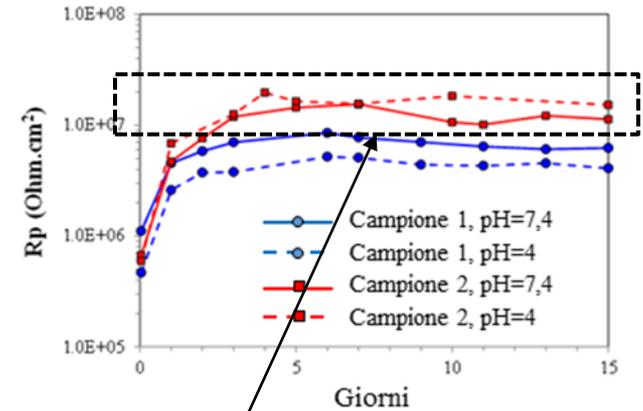


Parametri di processo e strategie di stampa

Ottimizziamo un componente solido



Resistenza di polarizzazione



Elevata resistenza meccanica

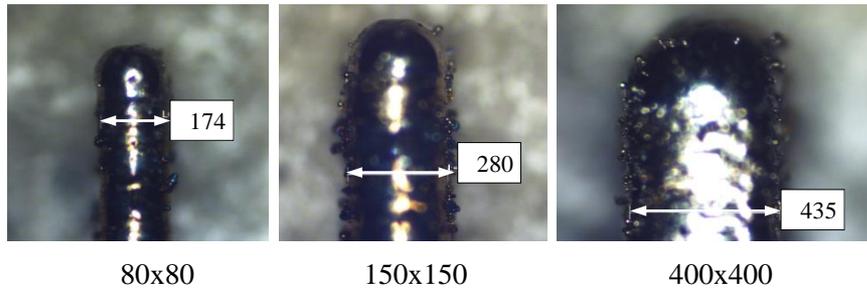
Elevata resistenza a corrosione

Volume interno	126	700	0,05	180
Volume esterno	90	1200	0,07	53,6

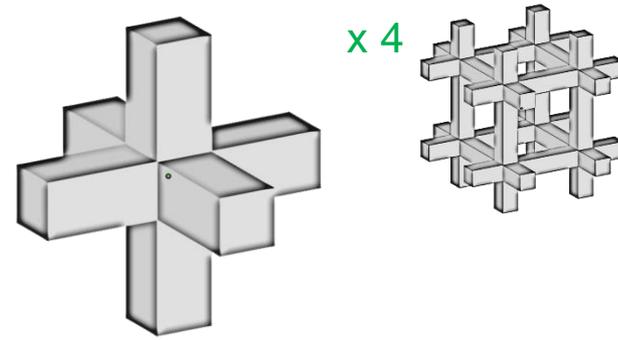
Potenza [W]	Velocità di scansione [mm/s]	Distanza tra le tracce [mm]	Fluenza [J/mm³]
126	700	0,05	180
90	1200	0,07	53,6

Strutture reticolari: potenzialità

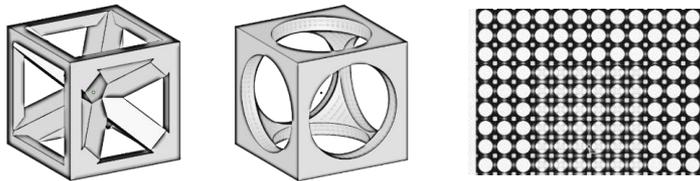
1. Dettagli di poche centinaia di micron



4. E' possibile fabbricare strutture regolari e ripetibili

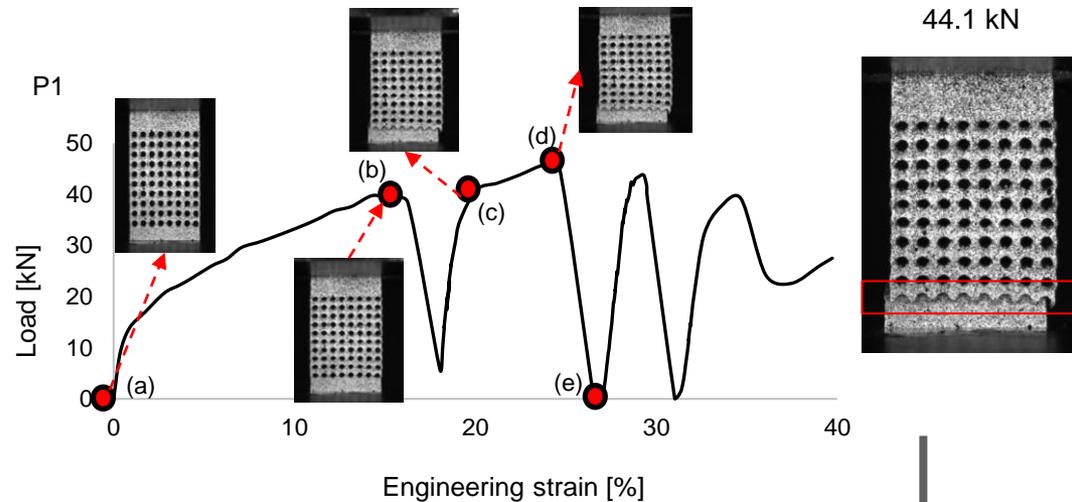
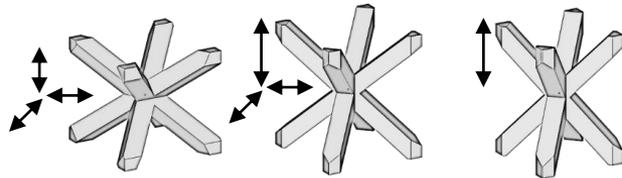


2. A geometria personalizzata

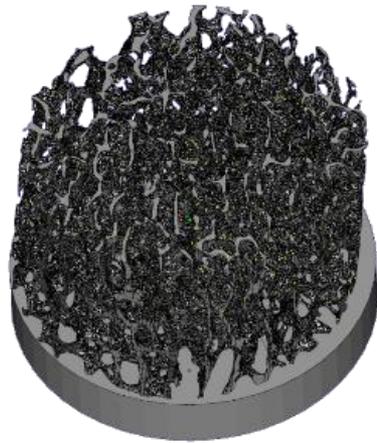


5. Con proprietà meccaniche differenti

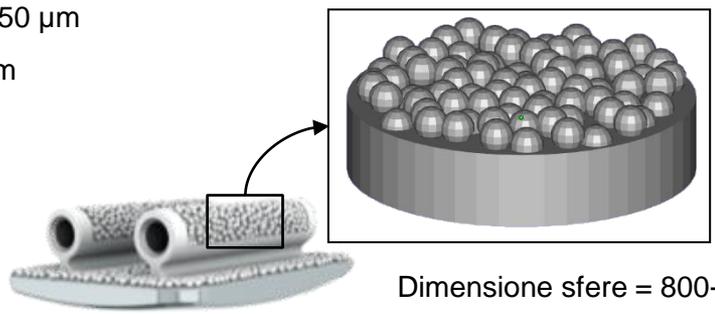
3. Anche variabile lungo una o più direzioni



Strutture reticolari: a geometria definita o replica di quella biologica?

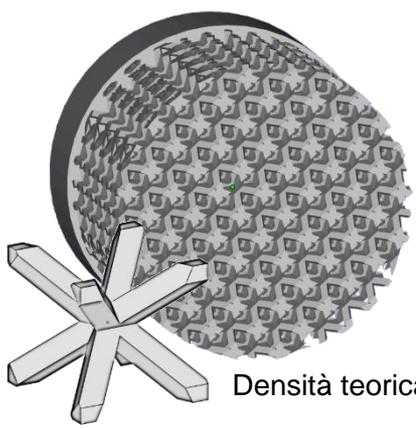


- Densità dell'osso trabecolare = 17,02%
- Spessore medio della trabecola = 150 μm
- Dimensione media dei pori = 670 μm

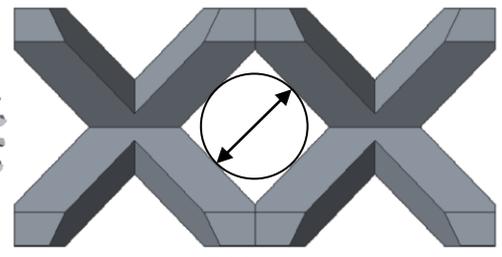


Dimensione sfere = 800-1000 μm

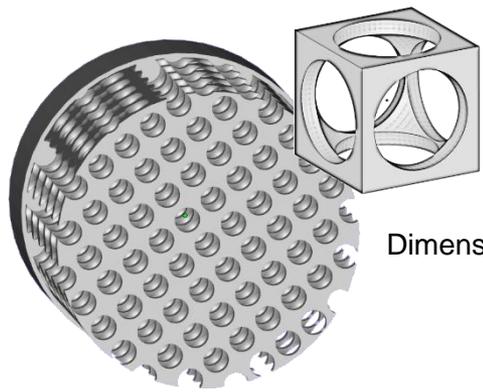
Riproduzione dello stato dell'arte



Densità teorica = 21,9 %



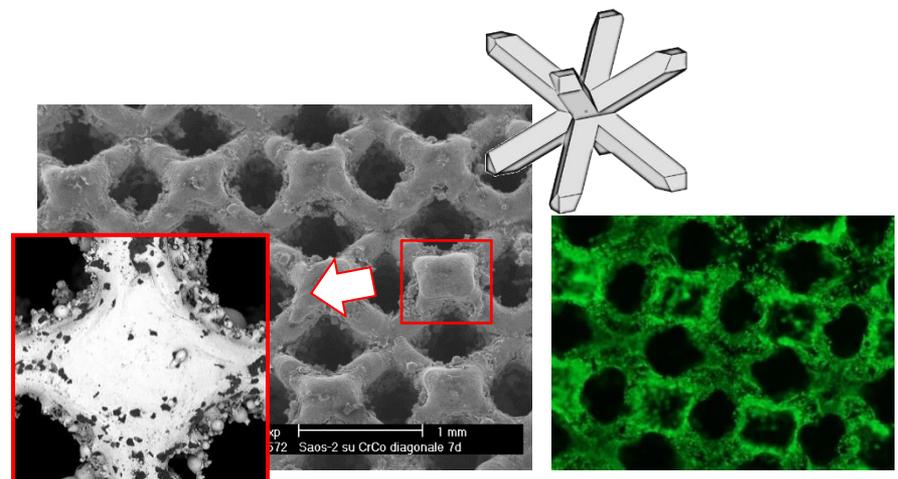
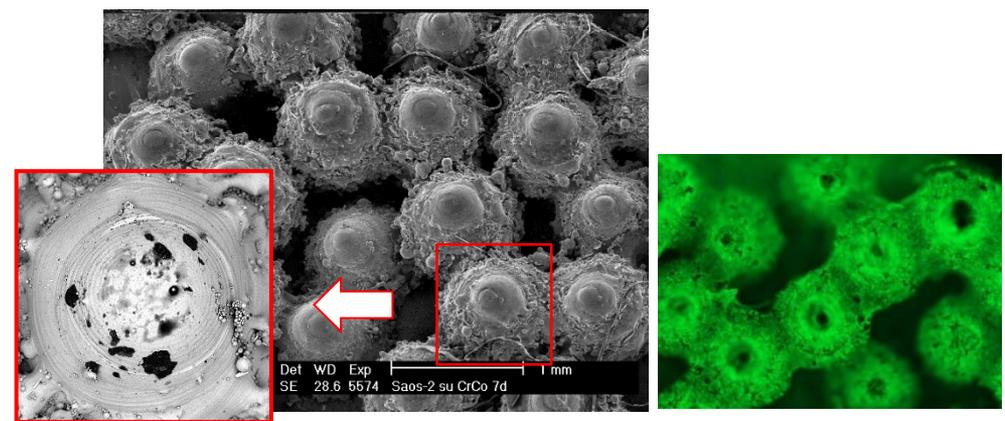
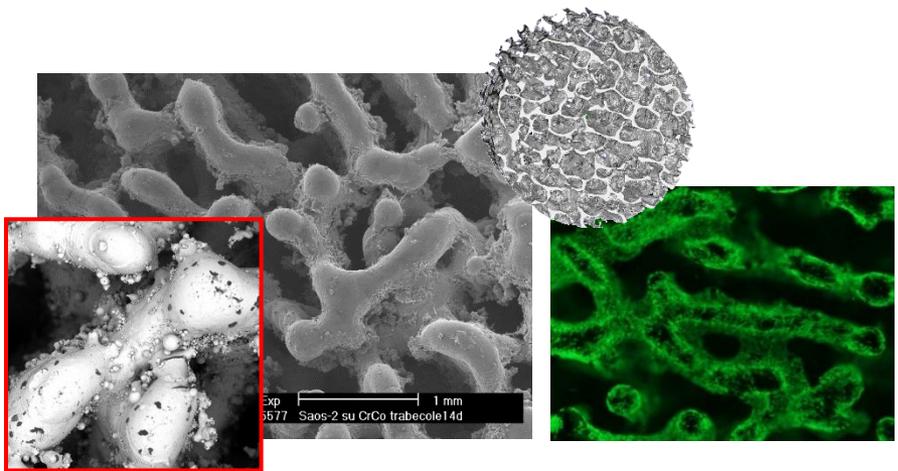
510 μm



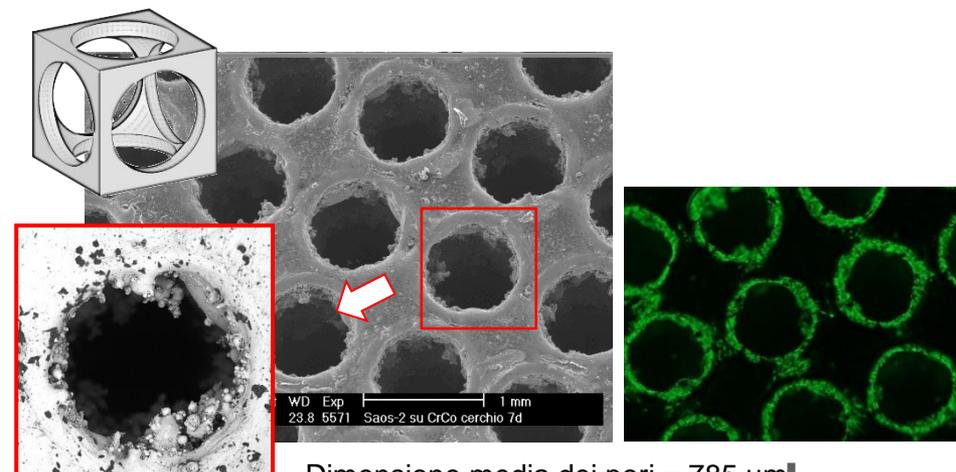
Dimensione dei pori = 800 μm

Densità teorica = 22 %

Strutture reticolari: difetti e definizione nei confronti della vitalità cellulare

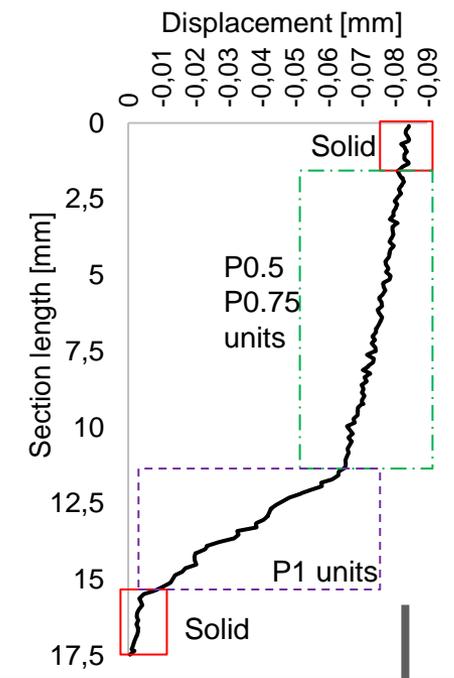
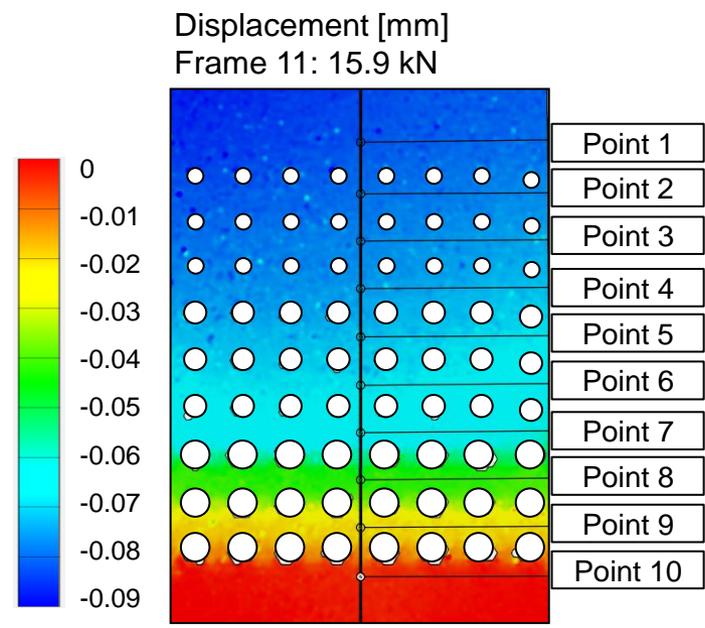
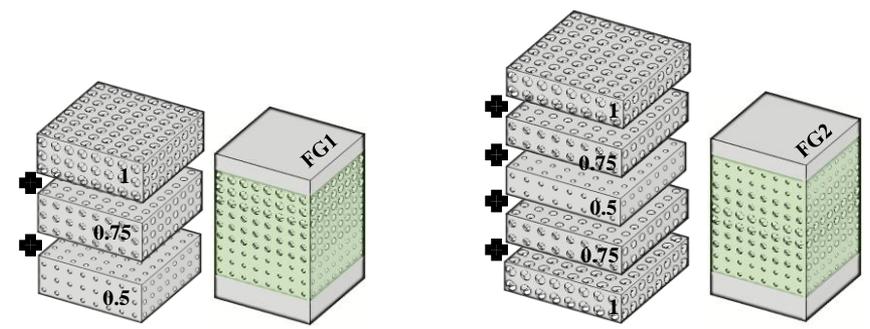
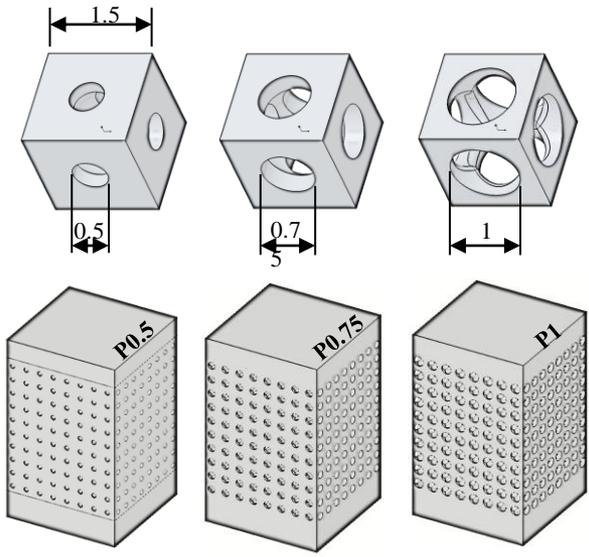


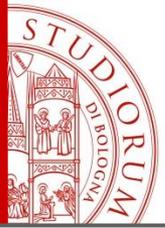
Dimensione media sfera passante = 400 μ m
Errore > 20%



Dimensione media dei pori = 785 μ m
Errore \approx 2%

Da strutture reticolari a strutture a rigidità variabile

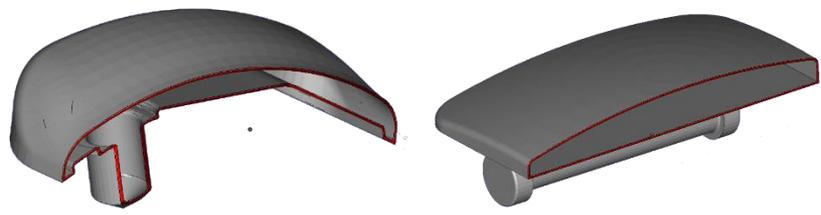




Riassumendo

STEP 1

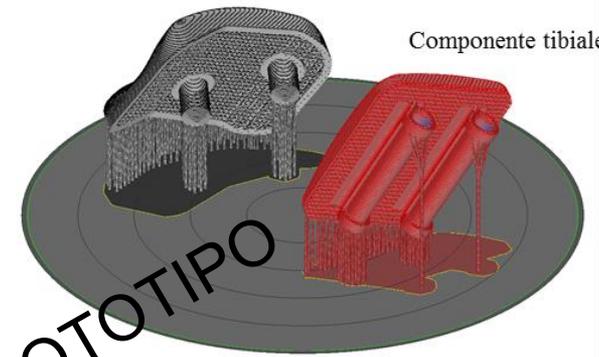
Parametri e strategia di stampa ottimizzati



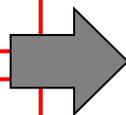
	Potenza [W]	Velocità di scansione [mm/s]	Distanza tra le tracce [mm]	Fluenza [J/mm ³]
Volume interno	126	700	0,05	180
Volume esterno	90	1200	0,07	53,6

Componente talare

Componente tibiale

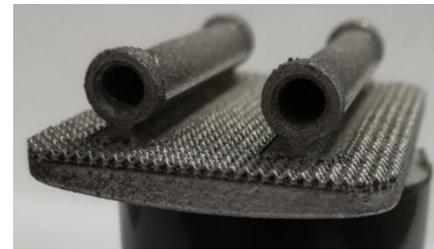
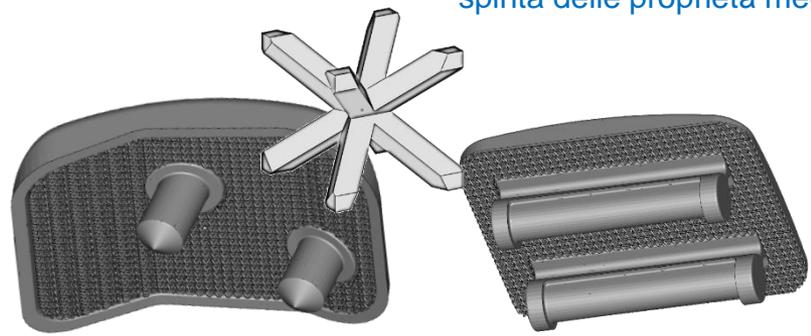


PROTOTIPO



STEP 2

Struttura reticolare ottimizzata → verso un'ottimizzazione spinta delle proprietà meccaniche





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