POLITECNICO
MILANO 1863

Stampa 3D di materiali compositi e innovativi

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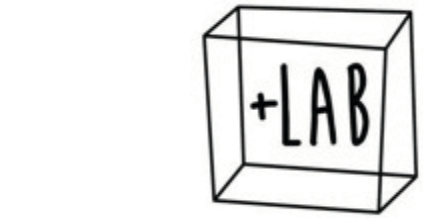
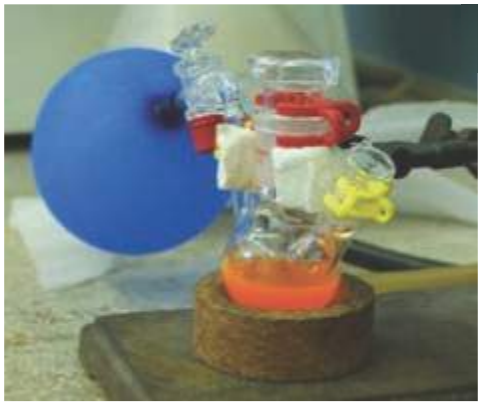
Dipartimento di Chimica, Materiali e Ingegneria Chimica
'Giulio Natta'

12 ottobre 2016

+LAB
la ricerca sulla stampa 3D

Applicazioni





Materiali

Processi


+LAB

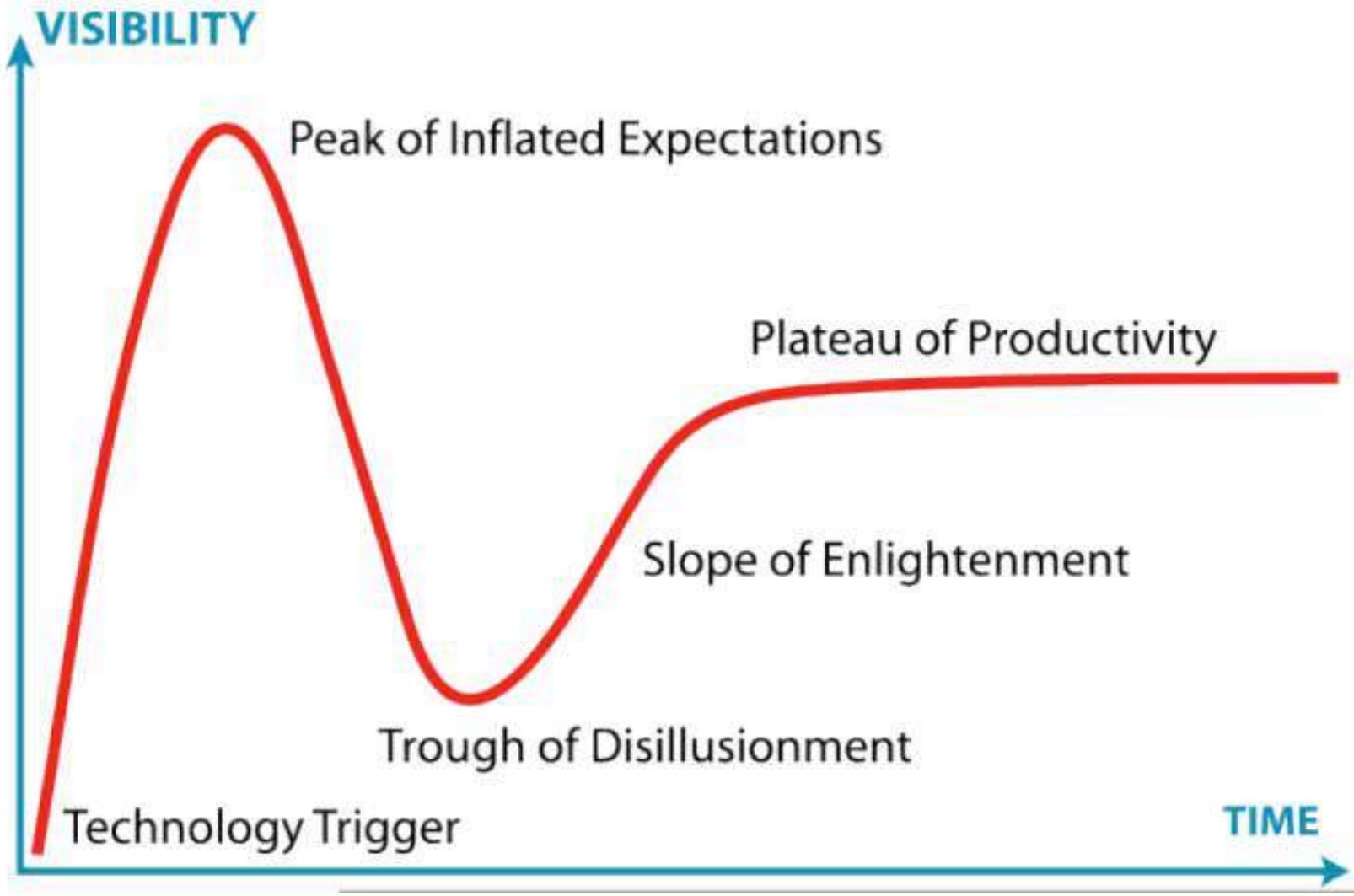
Designer.

Matteo.

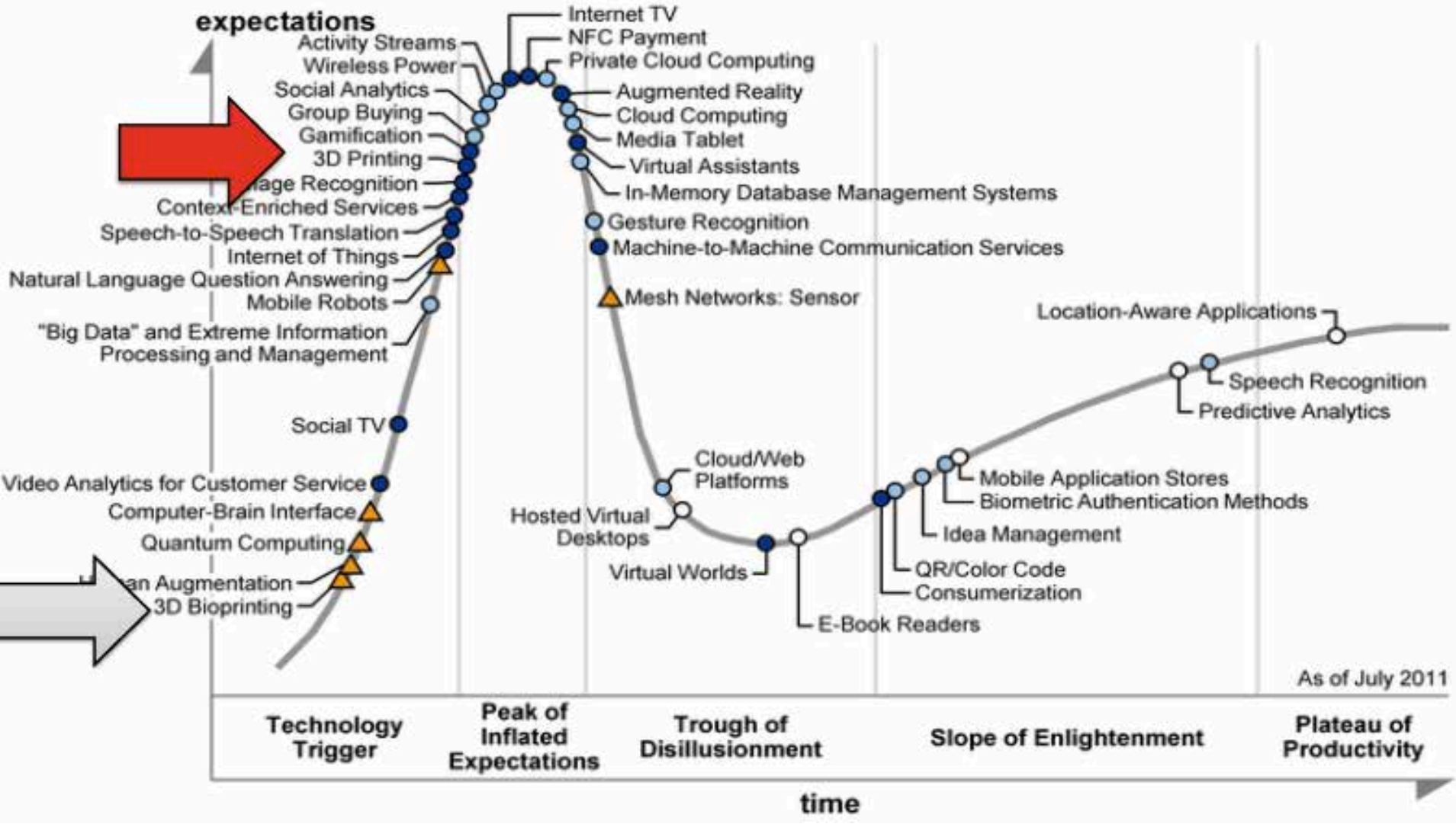
#quellicheil+LAB

La stampa 3D #COMESTA?

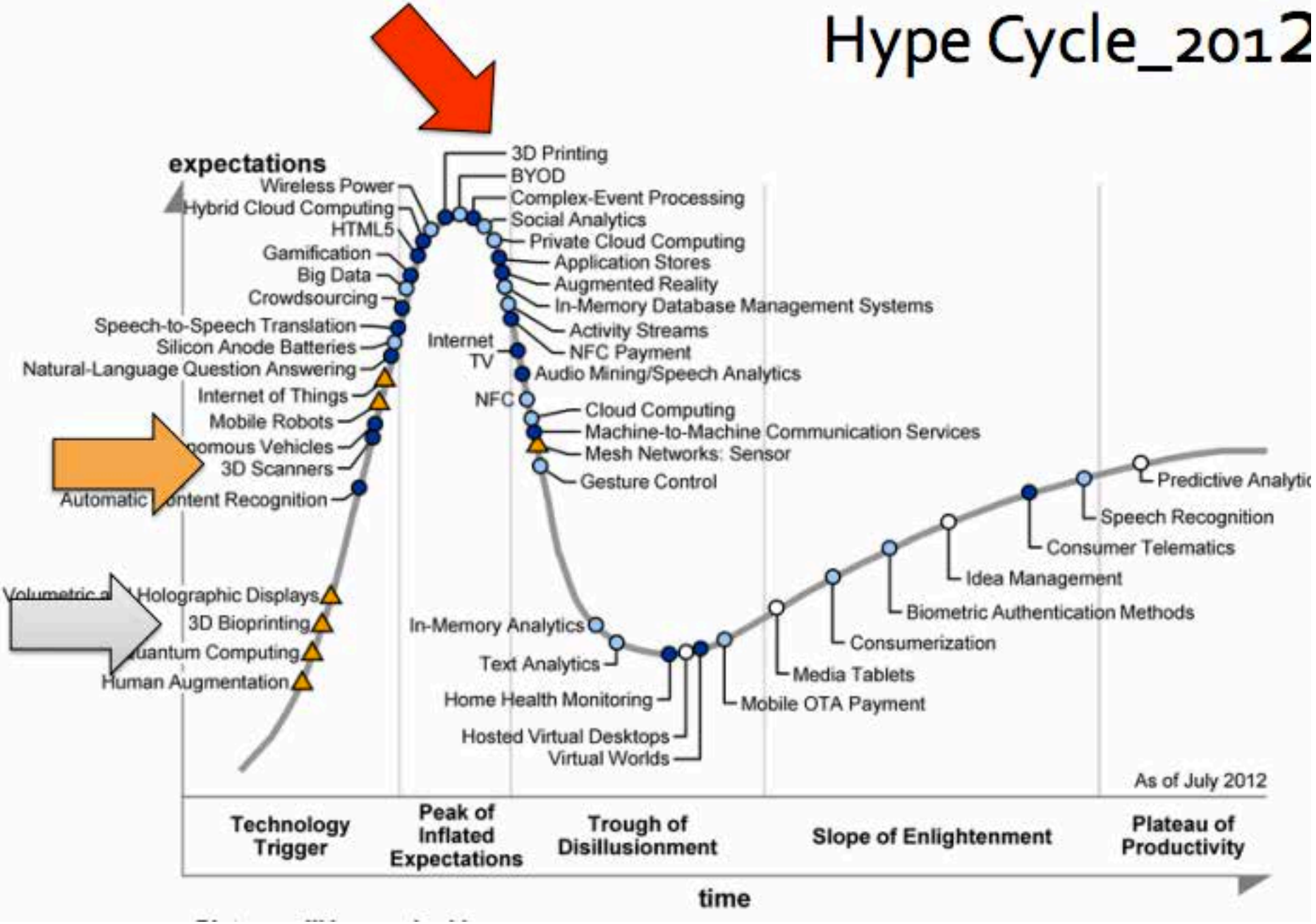
Hype Cycle
by Gartner



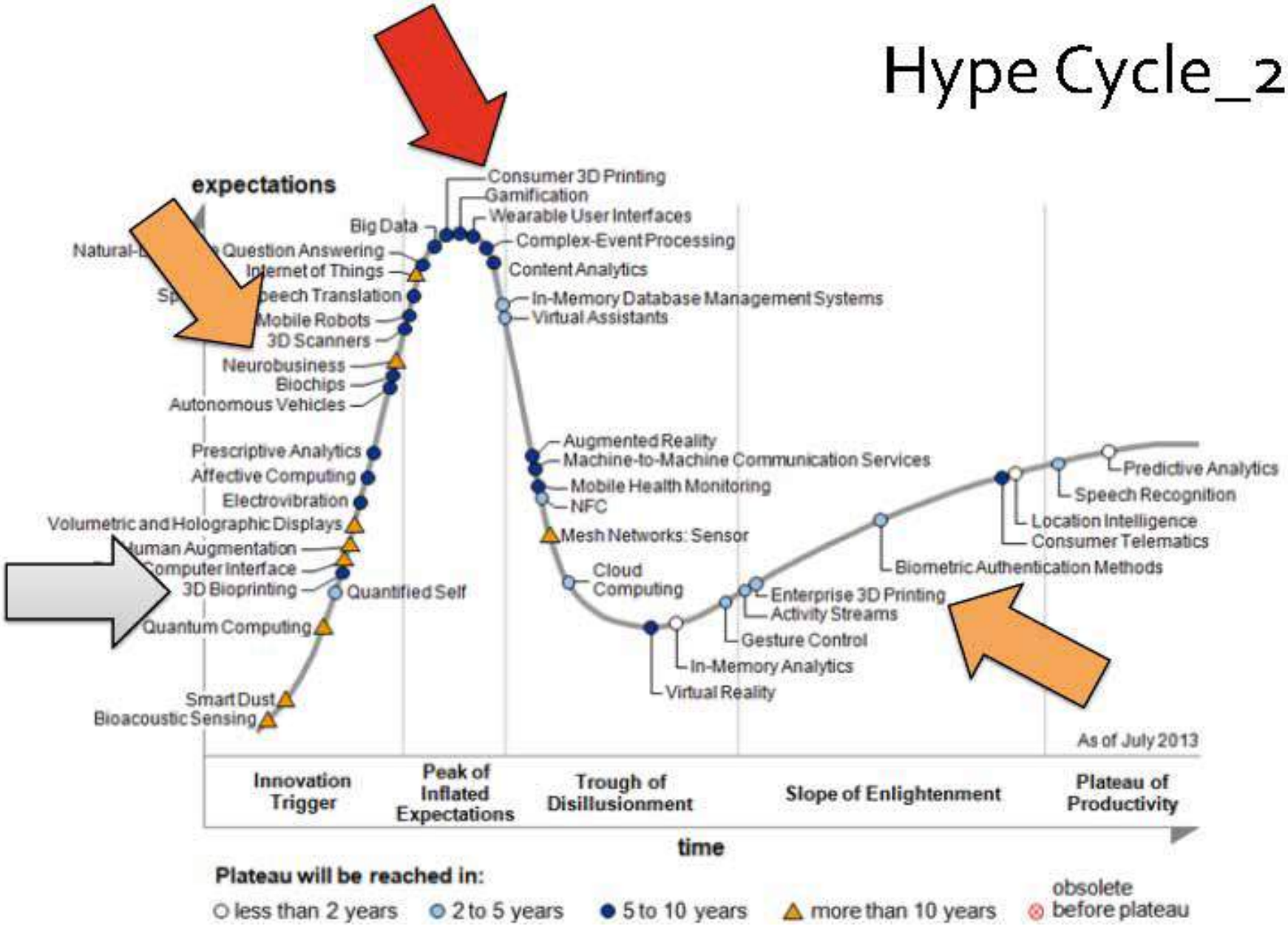
Hype Cycle_2011



Hype Cycle_2012

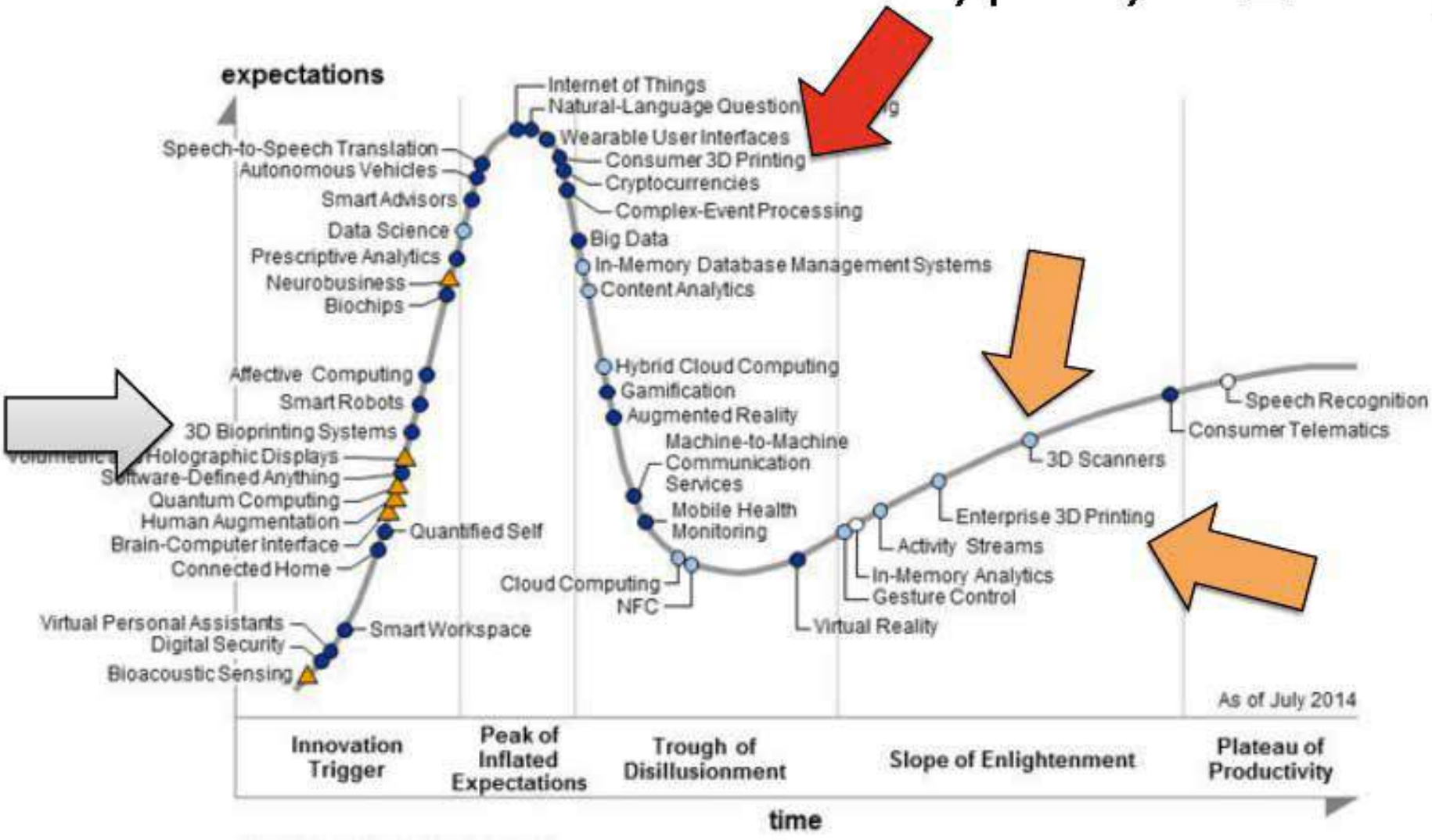


Hype Cycle_2013



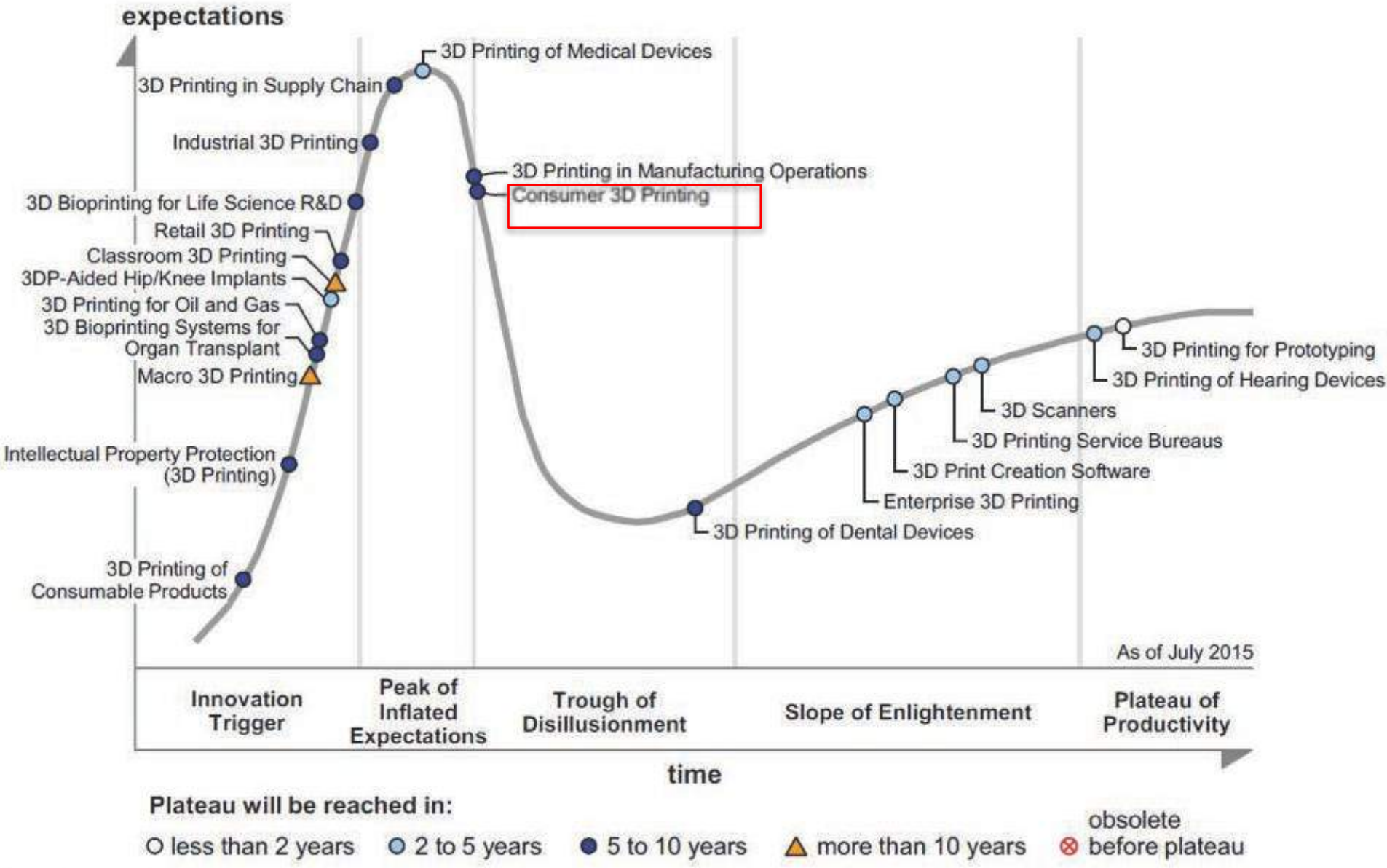
Hype Cycle_2015

Hype Cycle_2014



3D Hype Cycle_2015

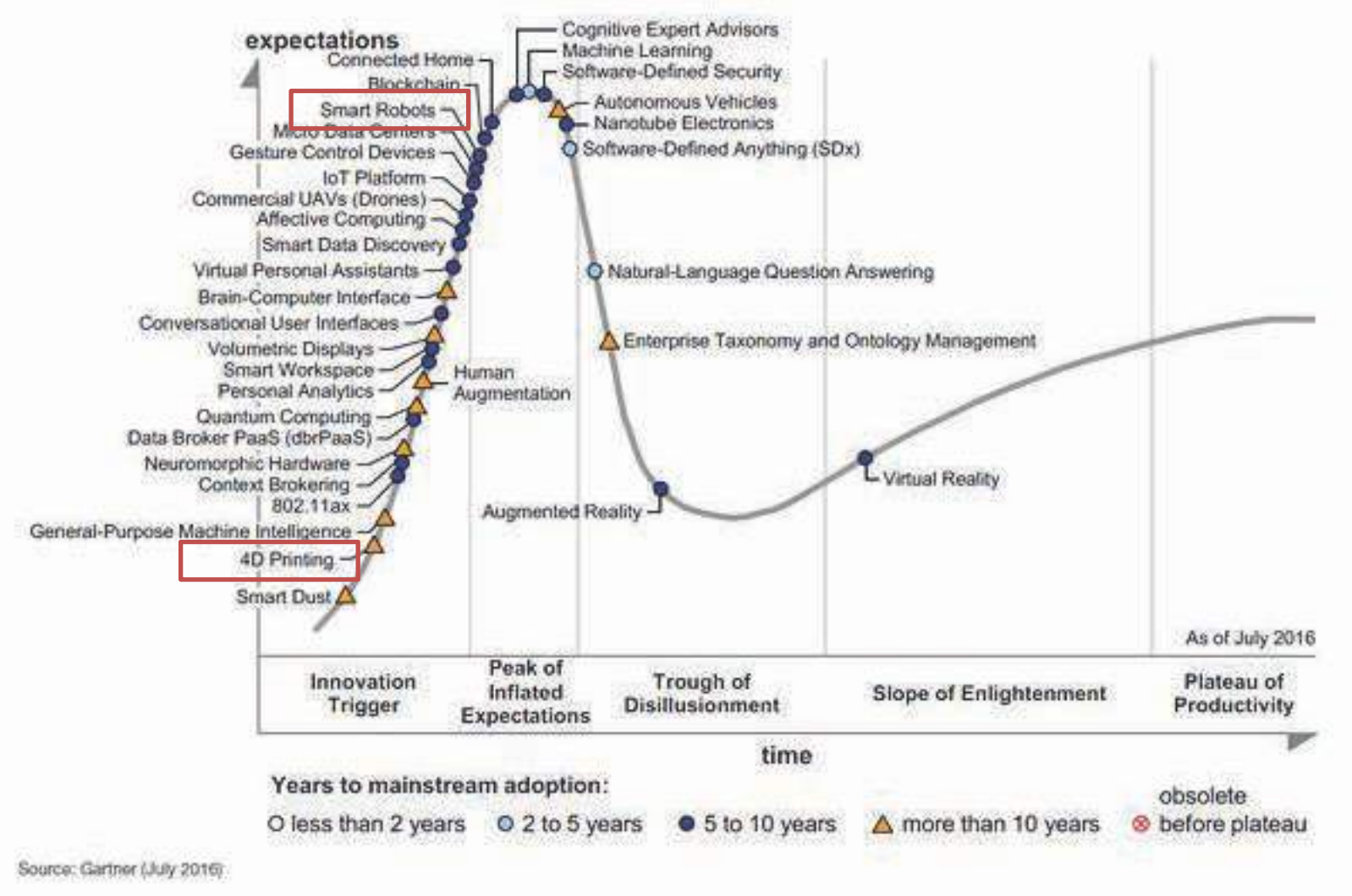
Figure 1. Hype Cycle for 3D Printing, 2015



Source: Gartner (July 2015)

Emerging Technologies

3D Hype Cycle_2016



#Nuove sfide con i materiali per la stampa 3D.

.

Dalla Technoteca 4.0

#Grande e’ bello

Oltre il PLA....
... oltre il filamento.

#Fare flessibile

La gomma in 3D.

#finiture

Sotto la superficie… il suono.

#fare arte

Vecchi materiali.
Nuove tecnologie.

FILAMENTO caricato in carbonio….
… grafene, nanotubi, e oltre.

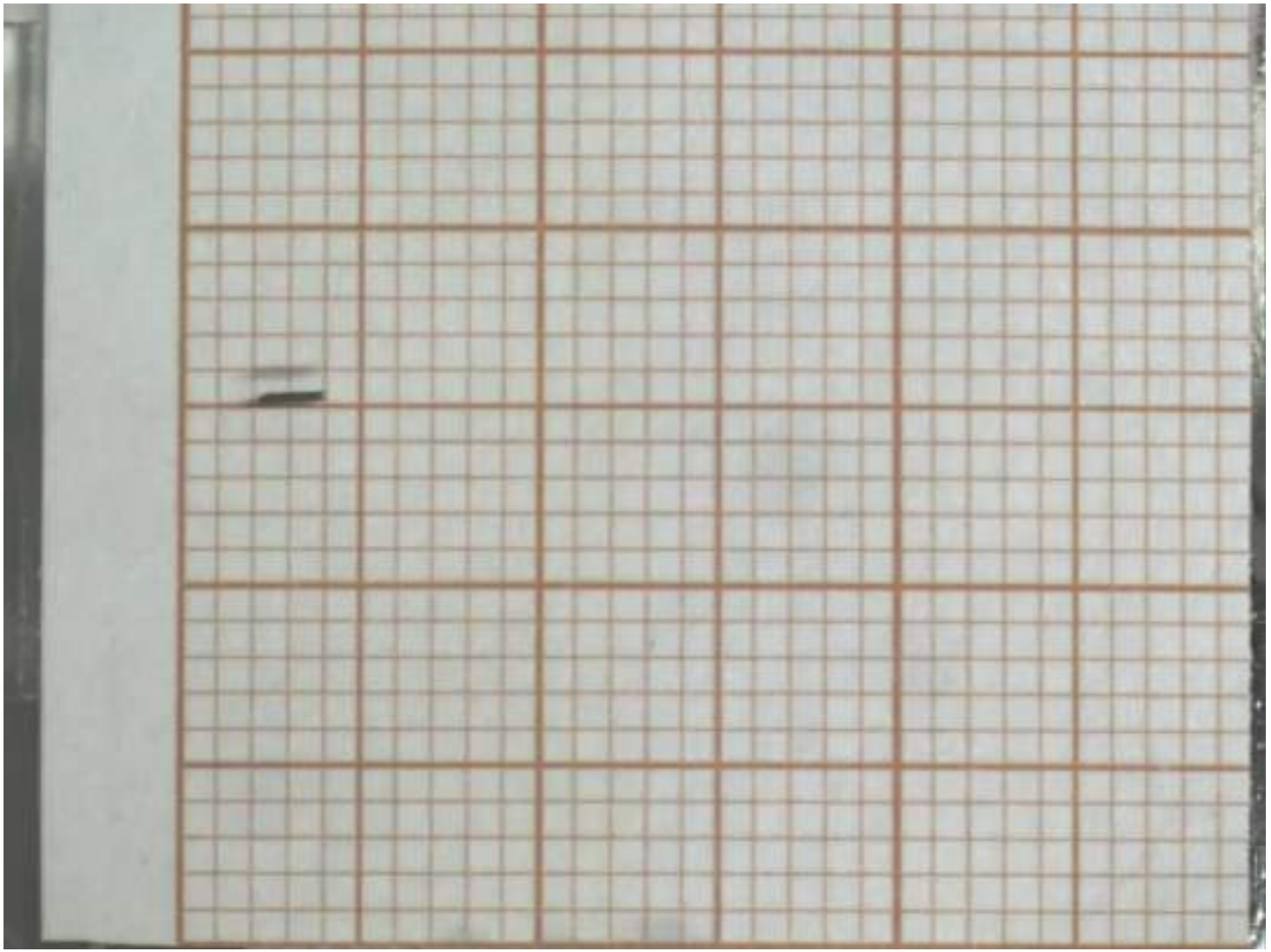
L’OPPORTUNITA’

+MATERIALI

I MATERIALI
nella STAMPA 3D
fanno tanto.
Forse ANCHE di Più.

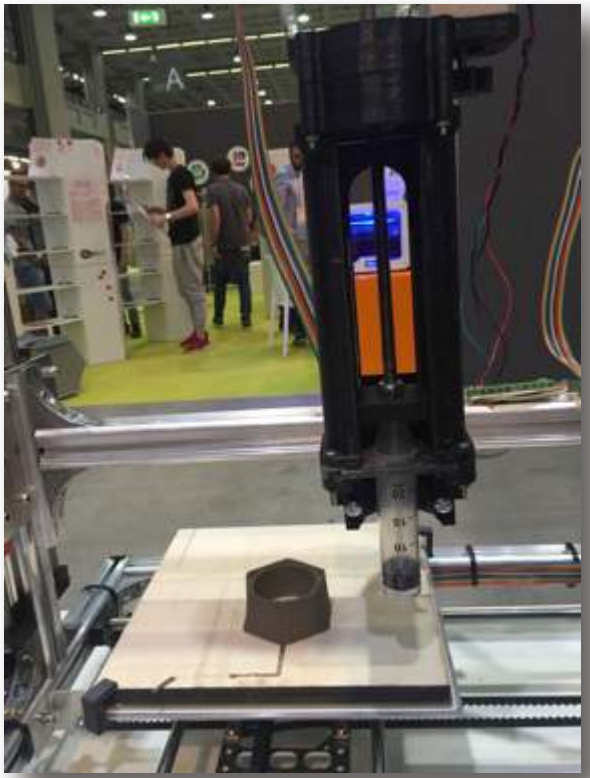
Fare molto piccolo….

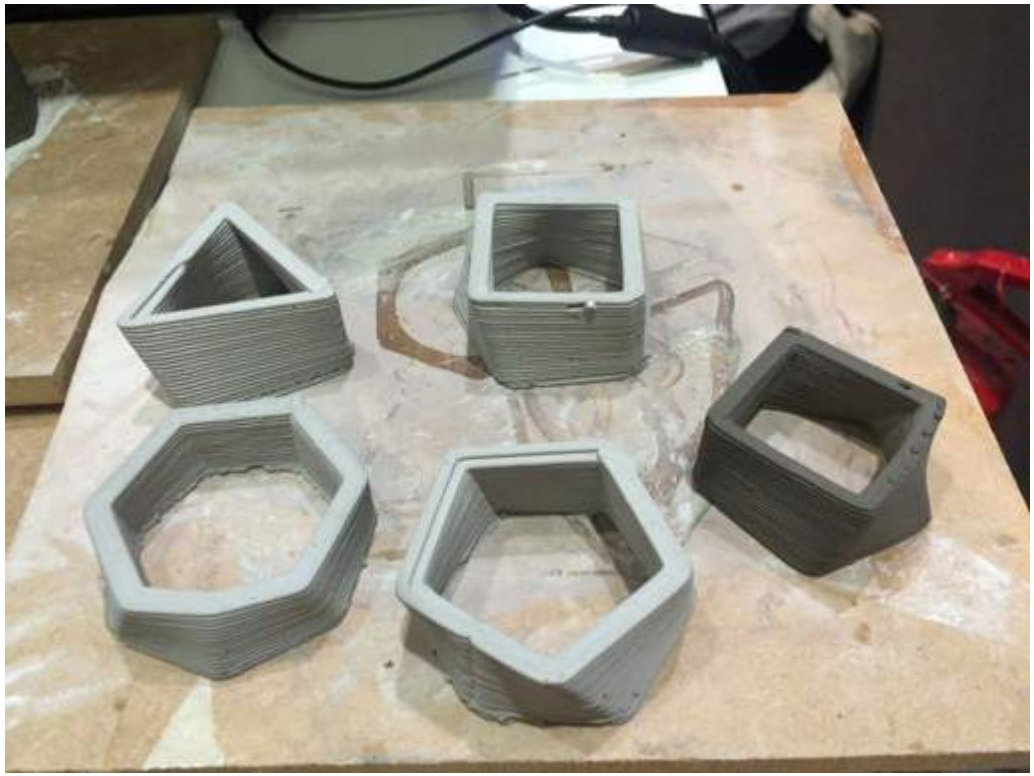
Resine magnetiche e….Microroborot



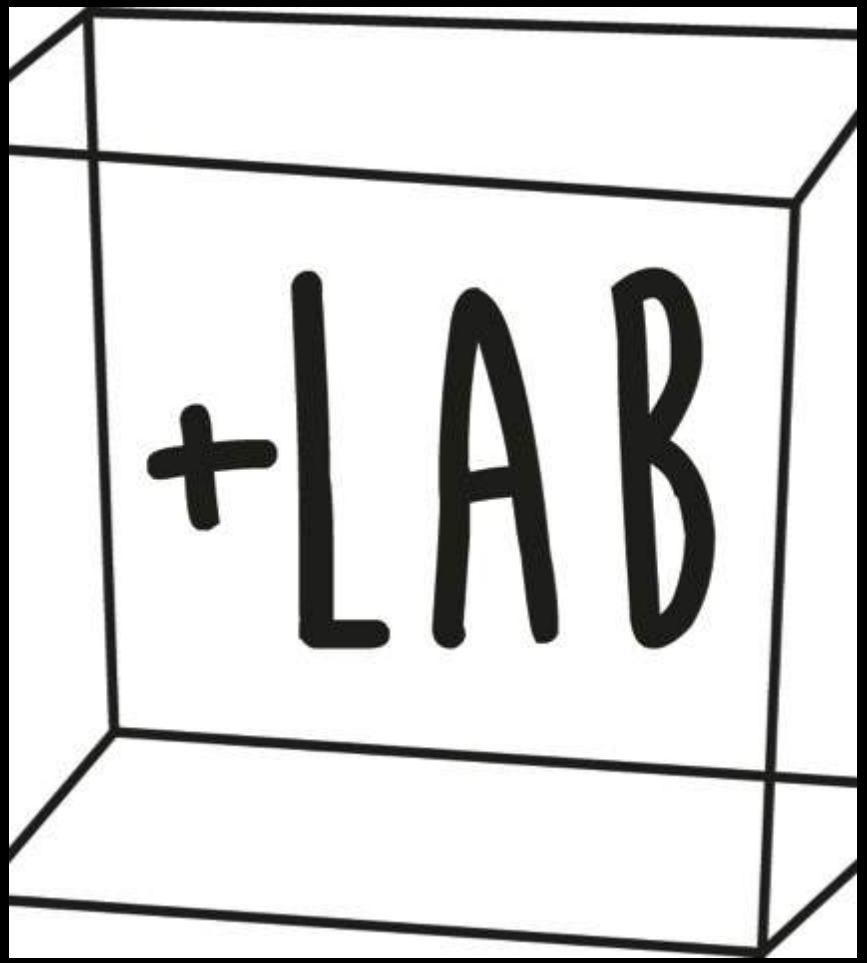
GEOPOLIMERI

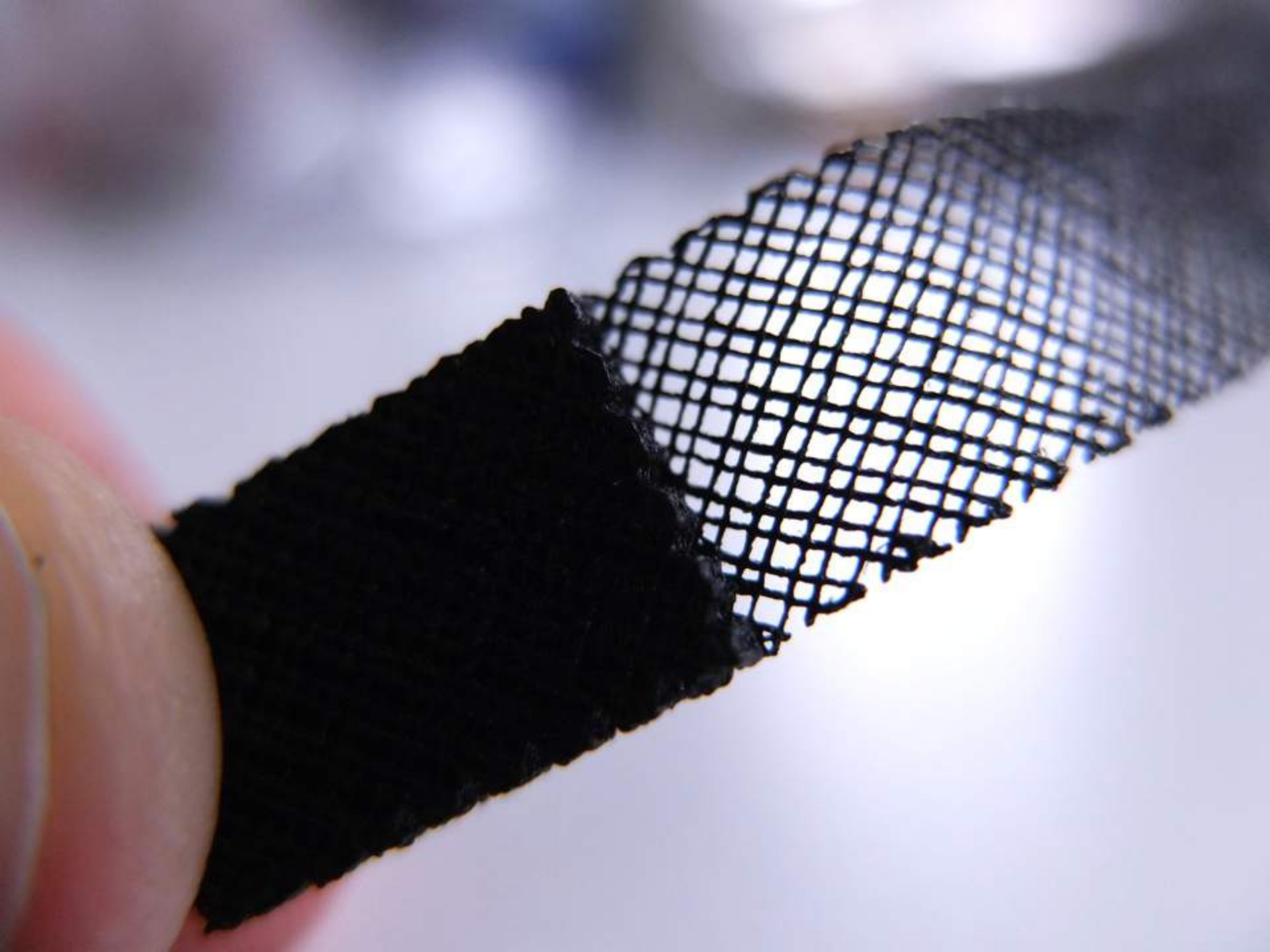
Dal passato… al futuro.





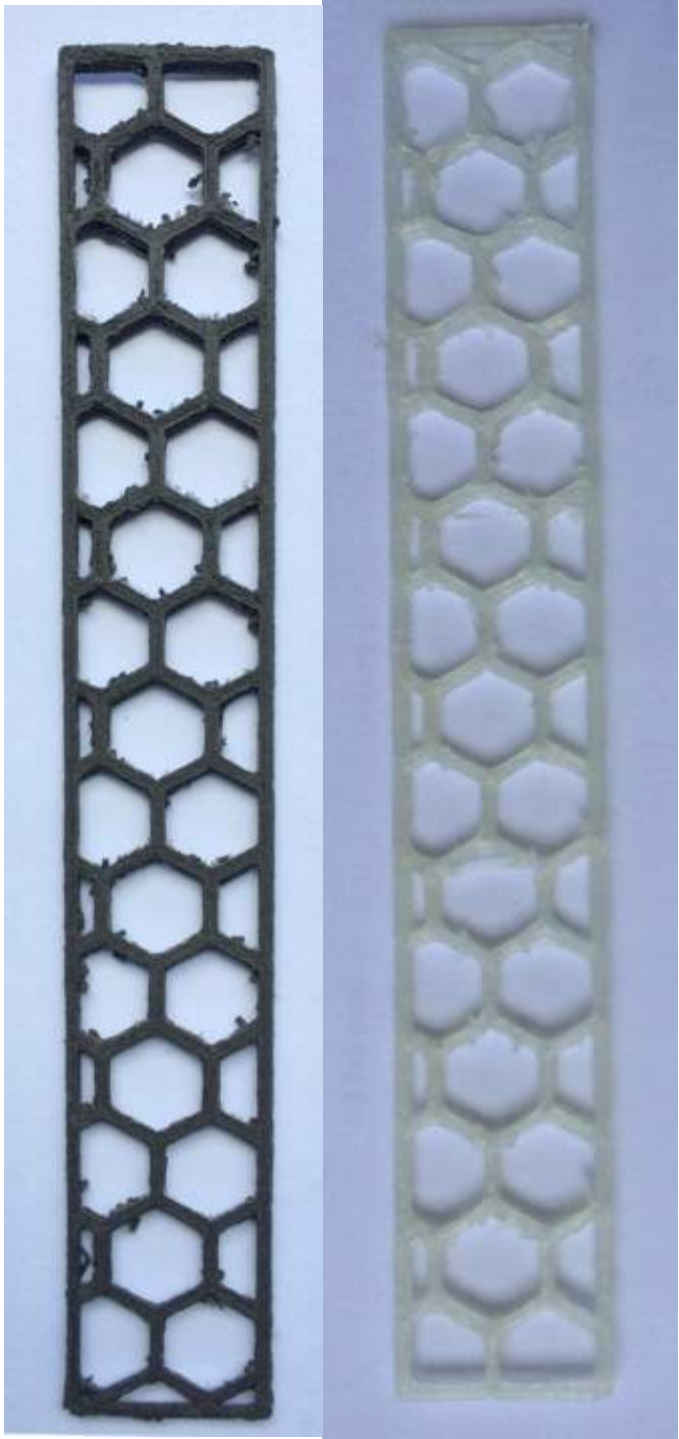
+COMPOSITI


+LAB

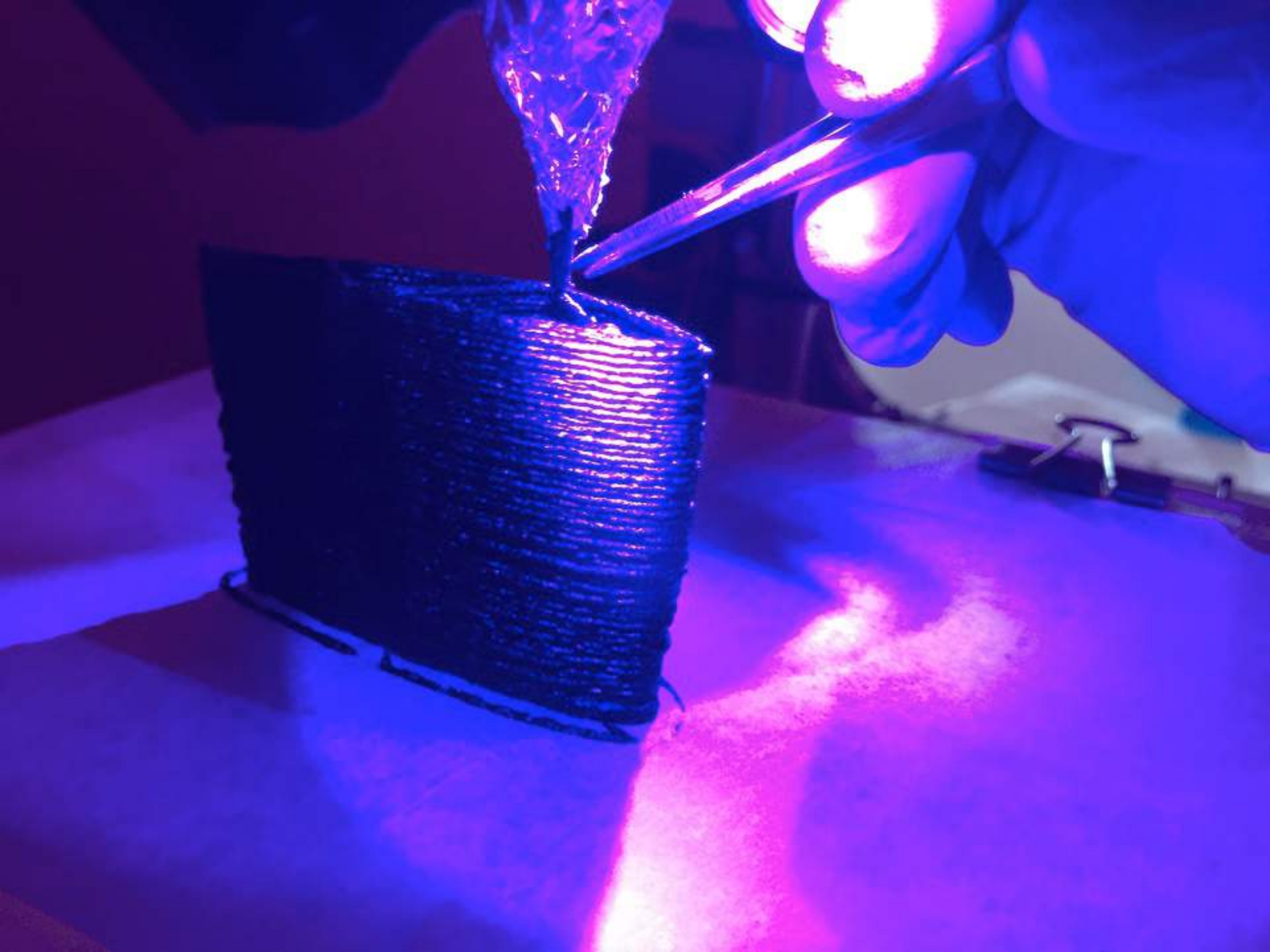


Resine epossidiche
foto e termopolimerizzabili

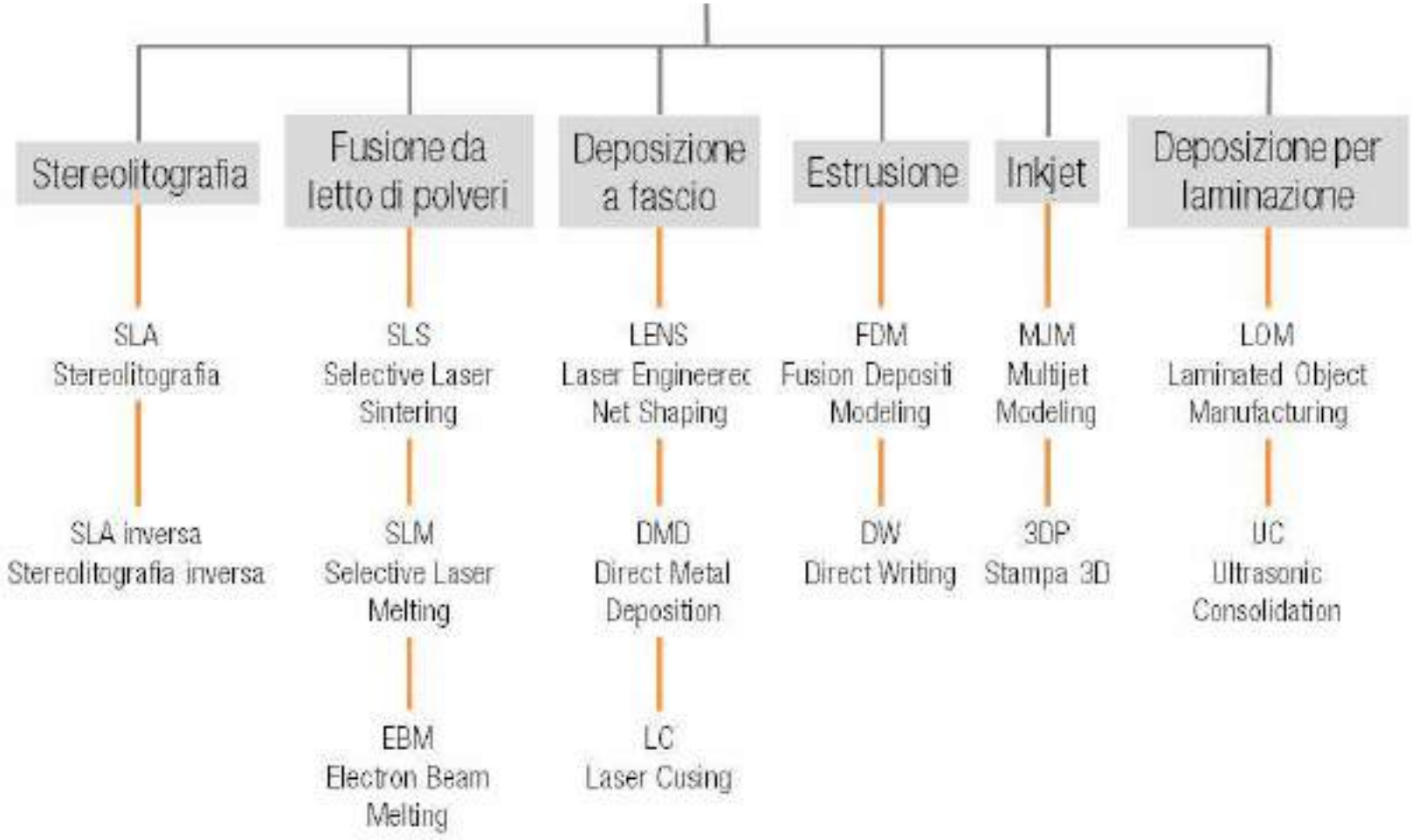
- Fibre corte di carbonio
- Fibre corte di vetro
- Lignina
- Particelle di Al
- Particelle di Fe
- Particelle di Ag
- FIBRE BIOBASED



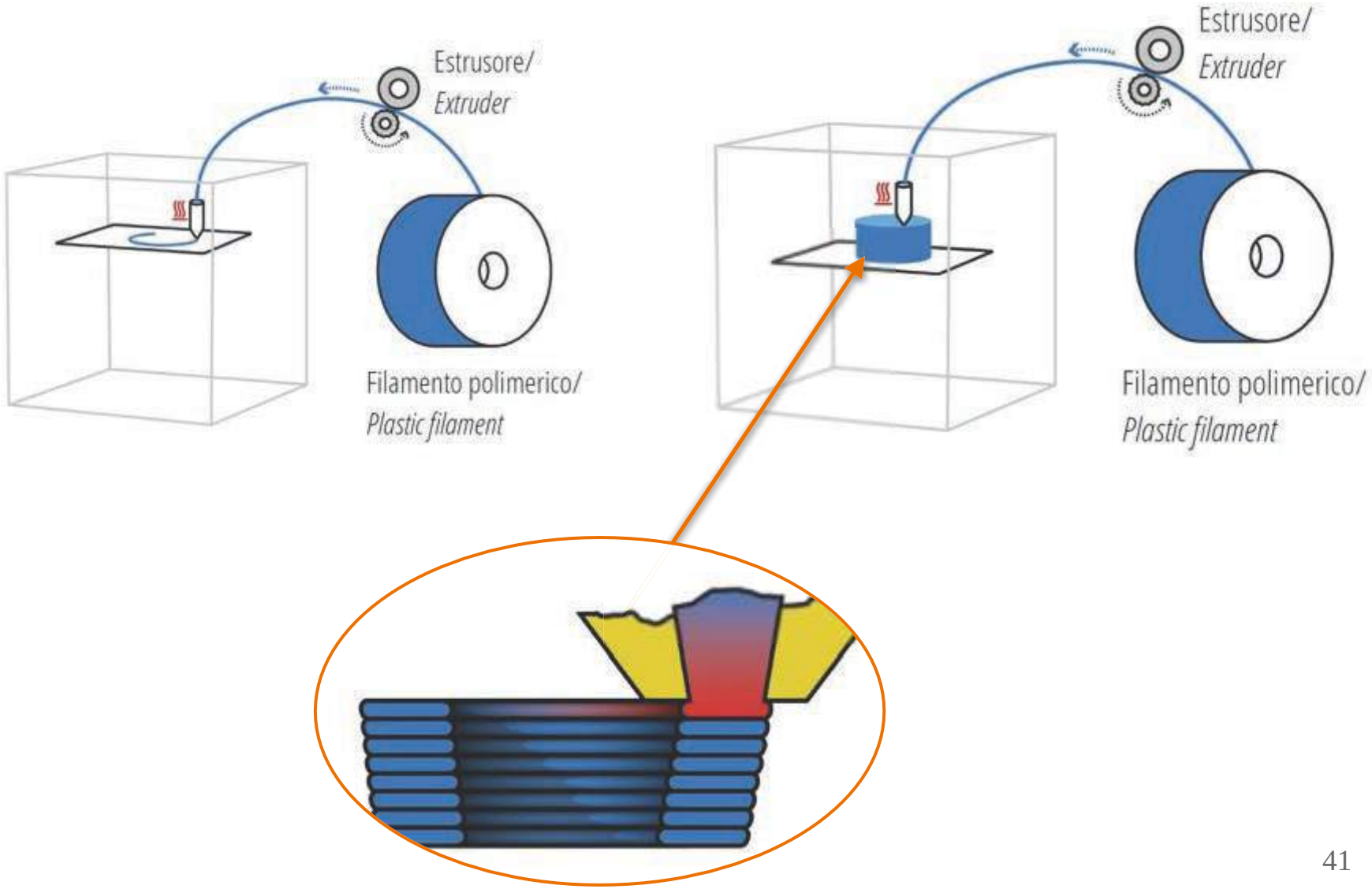
#FIBRE LUNGHE



La manifattura additiva



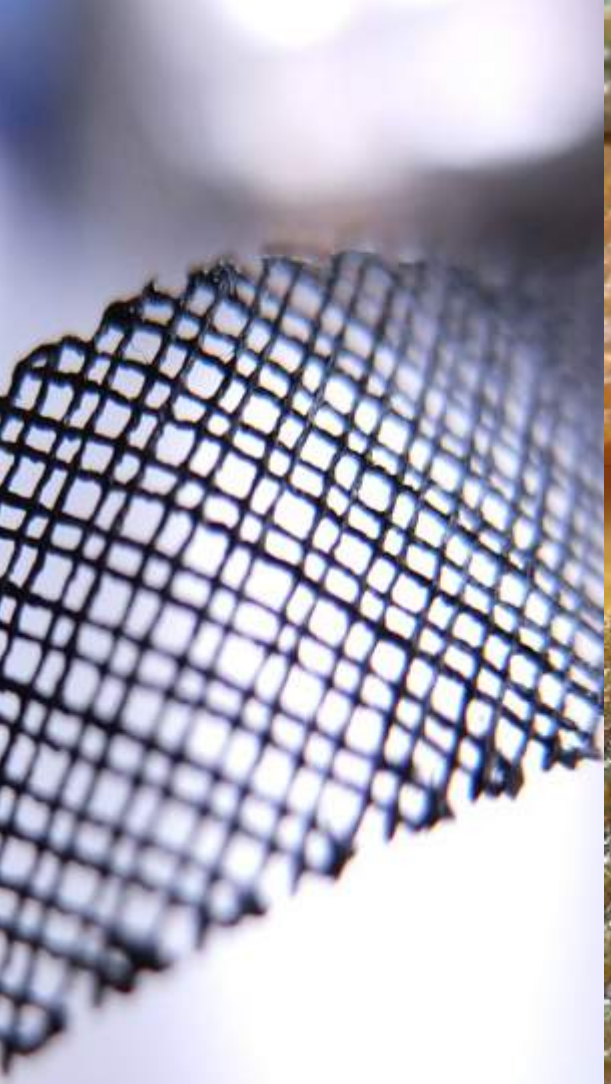
layer by layer process



L’idea

L’idea

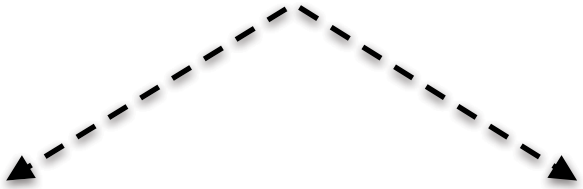
E’ possibile ottenere materiali compositi da tecnologie additive a basso costo?



le 3 linee di ricerca

Quale matrice per la manifattura additiva di compositi

MATRICE

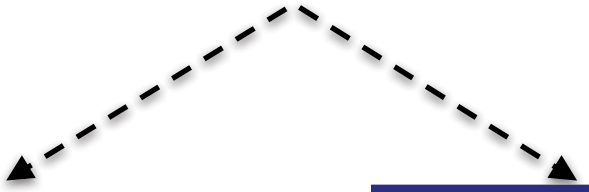


Matrice Termoplastica

Matrice Termoindurente

Quale matrice per la manifattura additiva di compositi

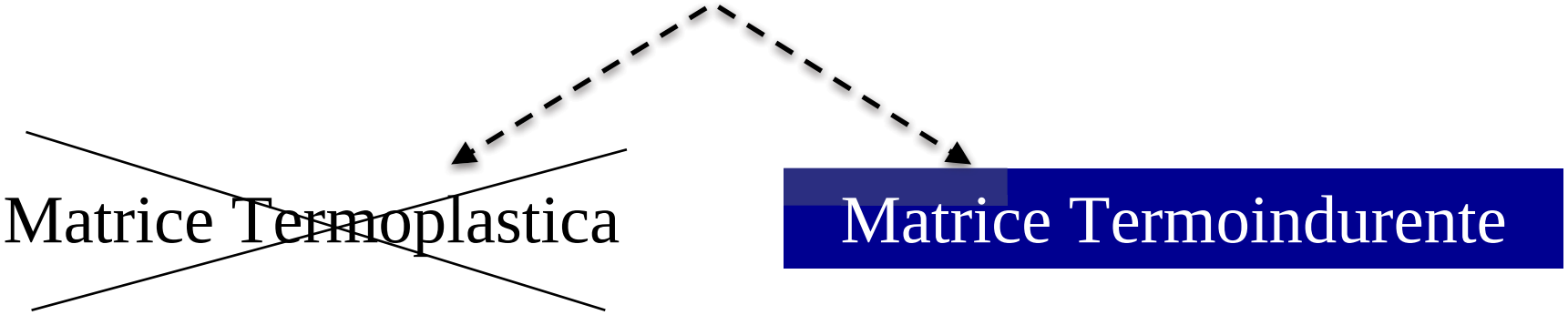
MATRICE



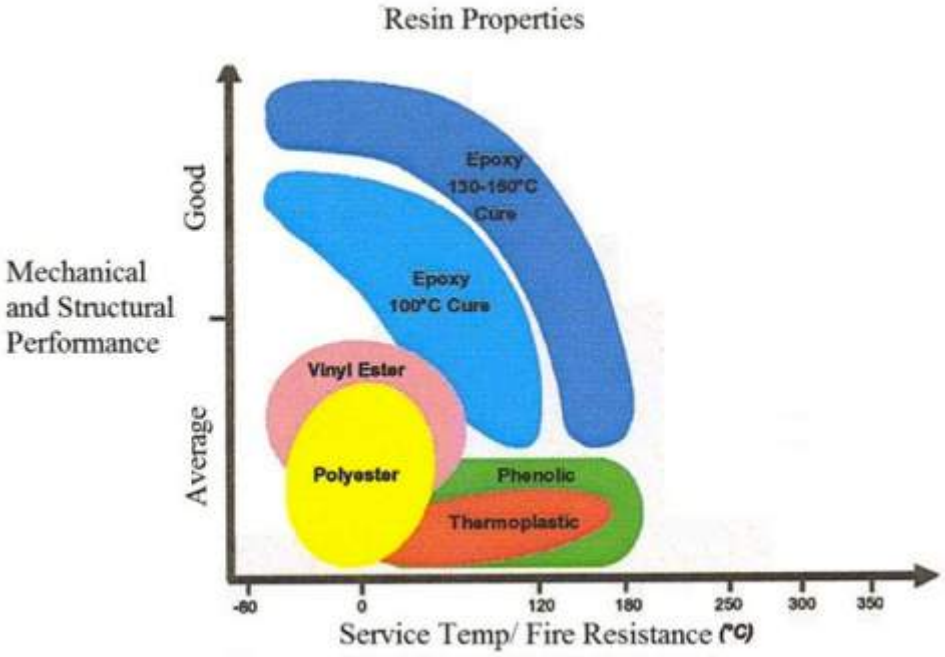
Matrice Termoplastica

Matrice Termoindurente

Quale matrice per la manifattura additiva di compositi



L’importanza della matrice



Matrice Termoindurente

- Prestazioni meccaniche
- Resistenza chimica
- Temperature di esercizio
- Bassa igroscopicità
- Costo

L’importanza della matrice

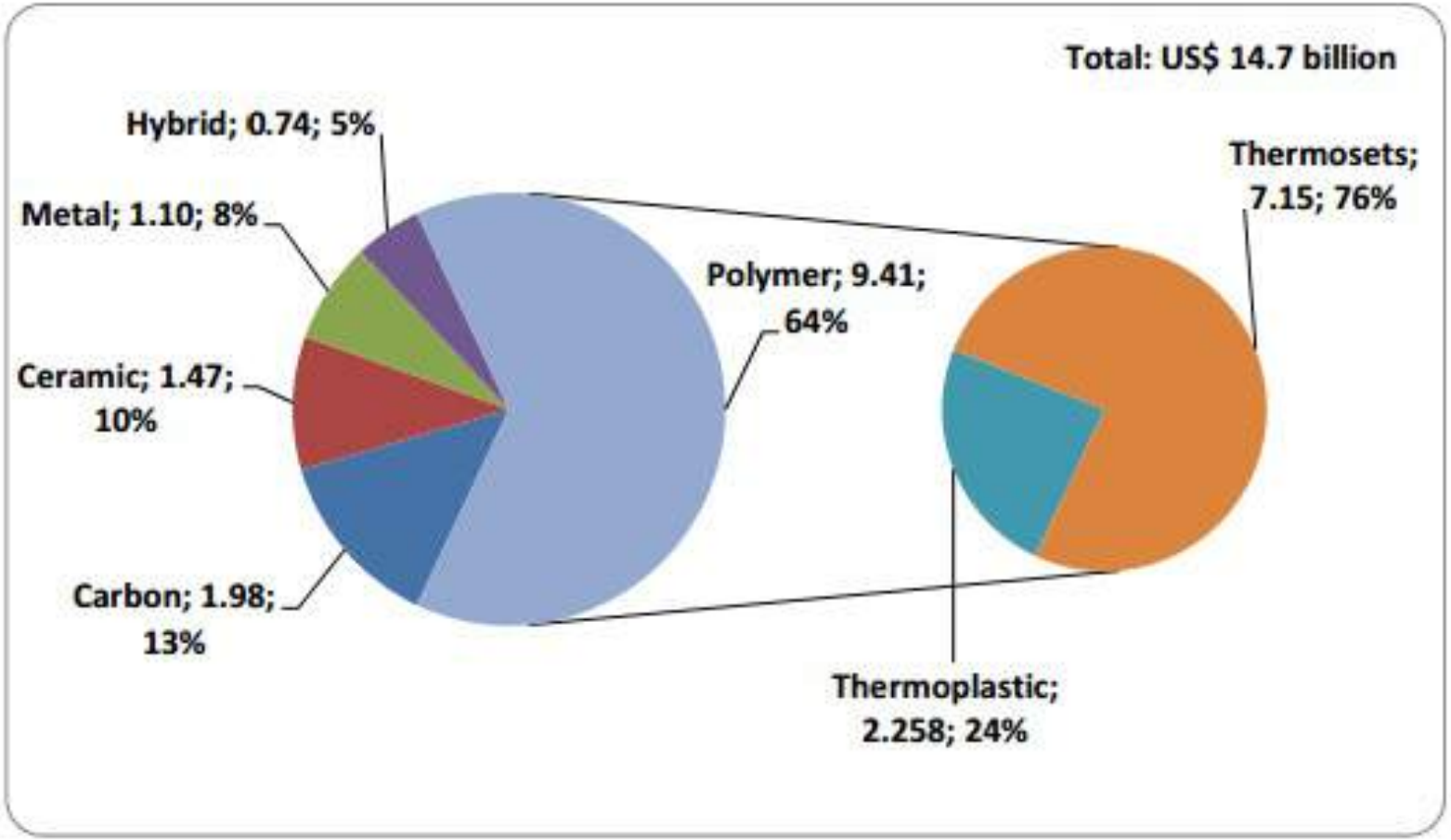
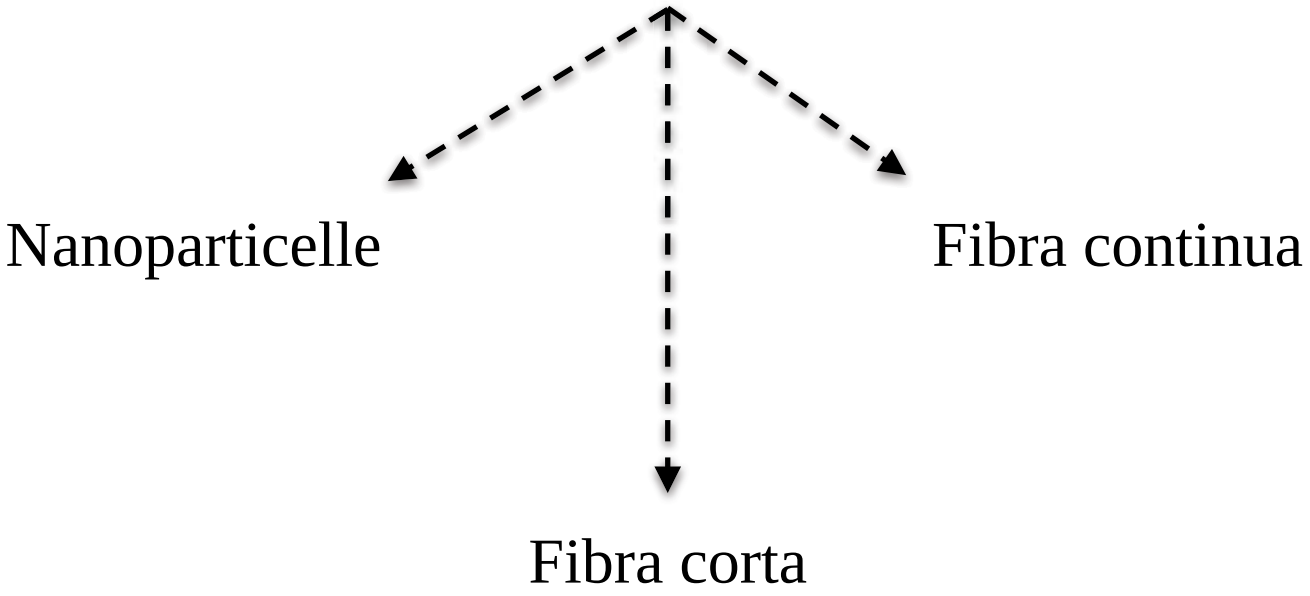


Fig. 7: Carbon composite revenues in US$ billion by matrix material (2013). [2]

COMPOSITES MARKET REPORT 2014: *Carbon Composites & Federation of reinforced plastics*

MATERIALI COMPOSITI
a matrice termoindurente

3 linee di ricerca

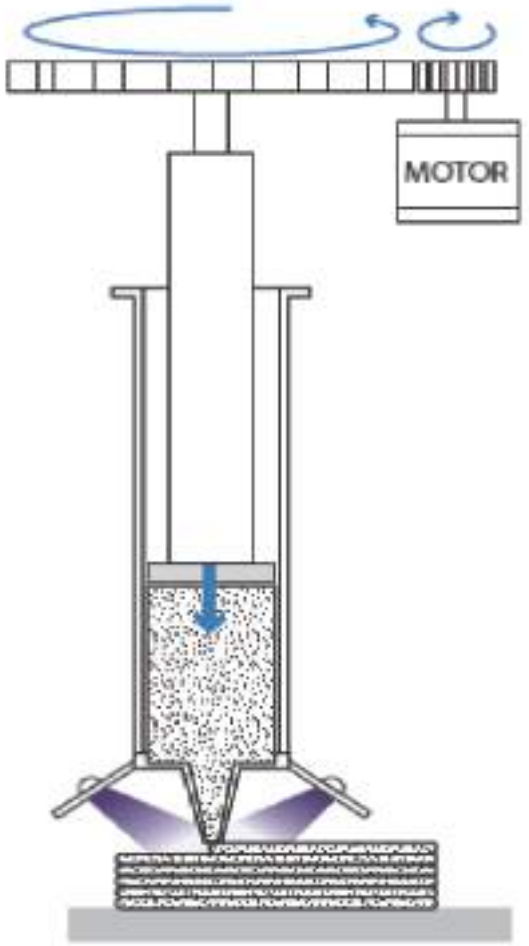


compositi a fibra corta e nanocompositi...

Liquid Deposition Modelling

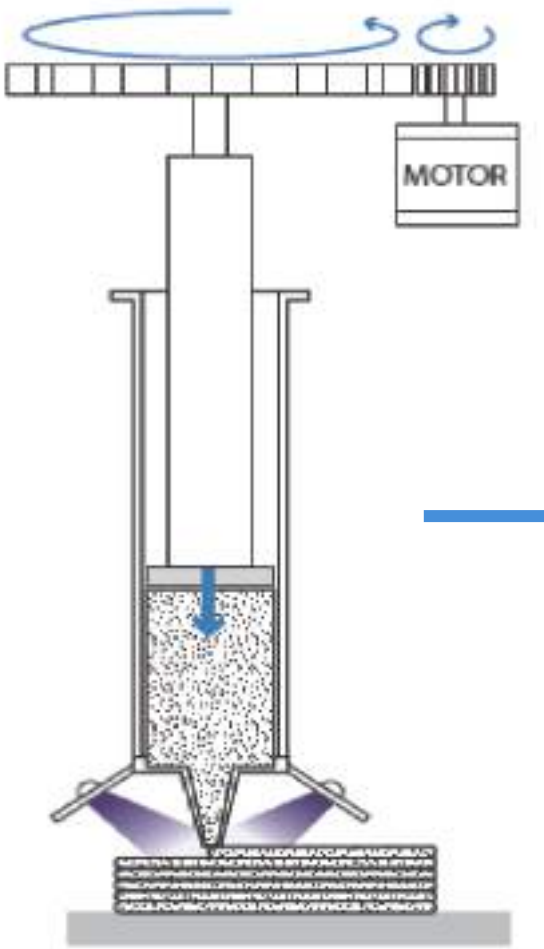
LDM

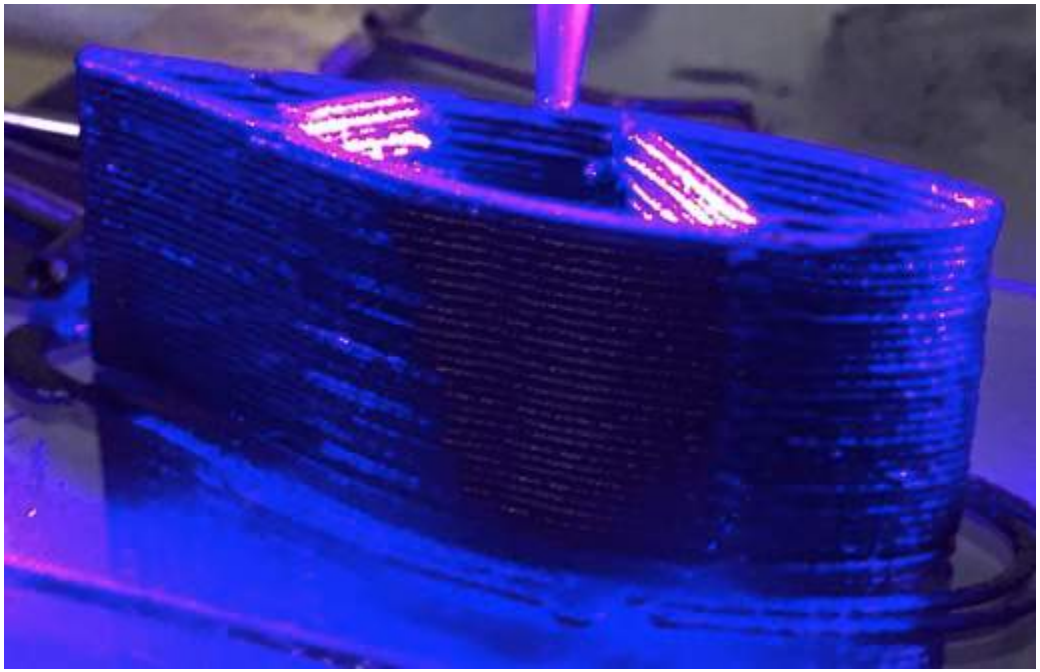
- materiale allo stato liquido
- sistema di estrusione a pistone
- apparato di polimerizzazione



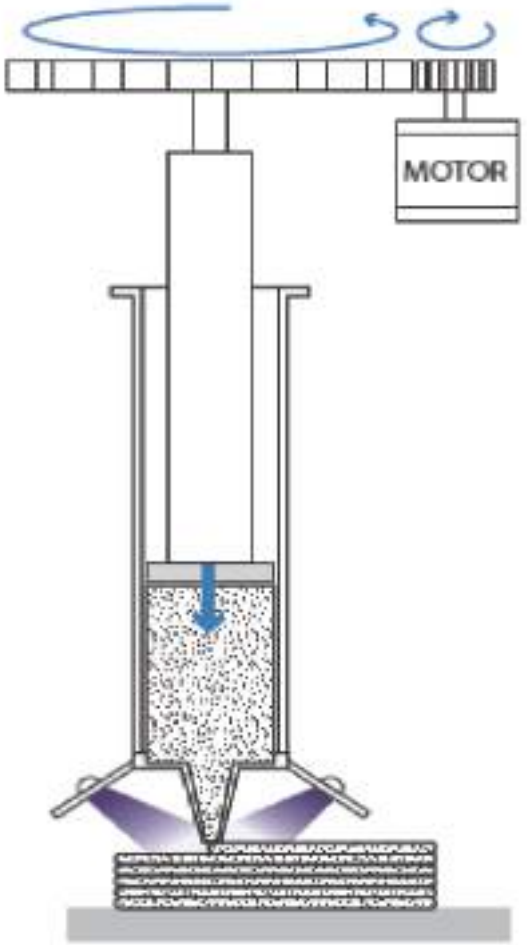
Liquid Deposition Modelling

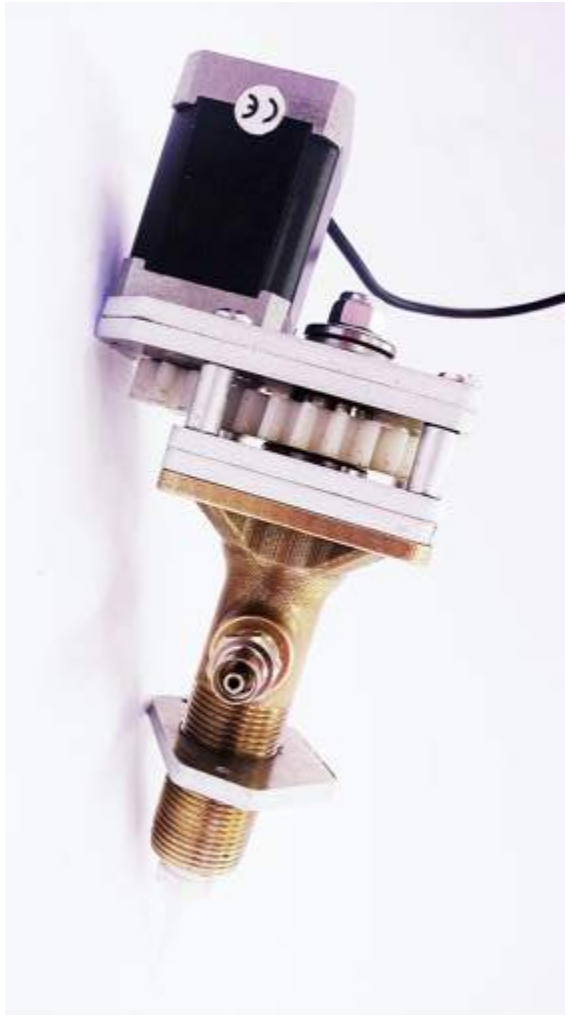
LDM

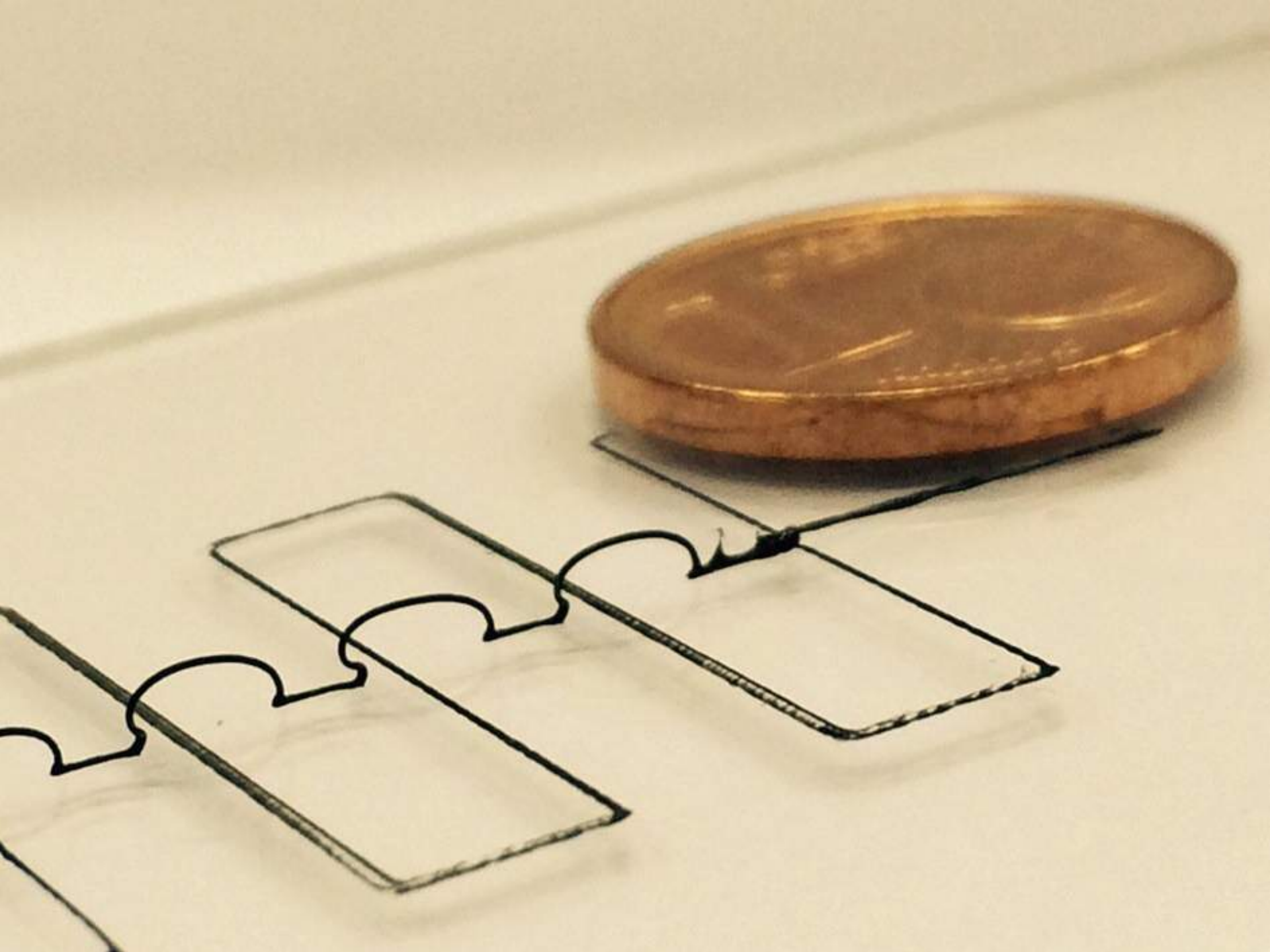




Estrusore a siringa / Estrusore a vite senza fine LDM





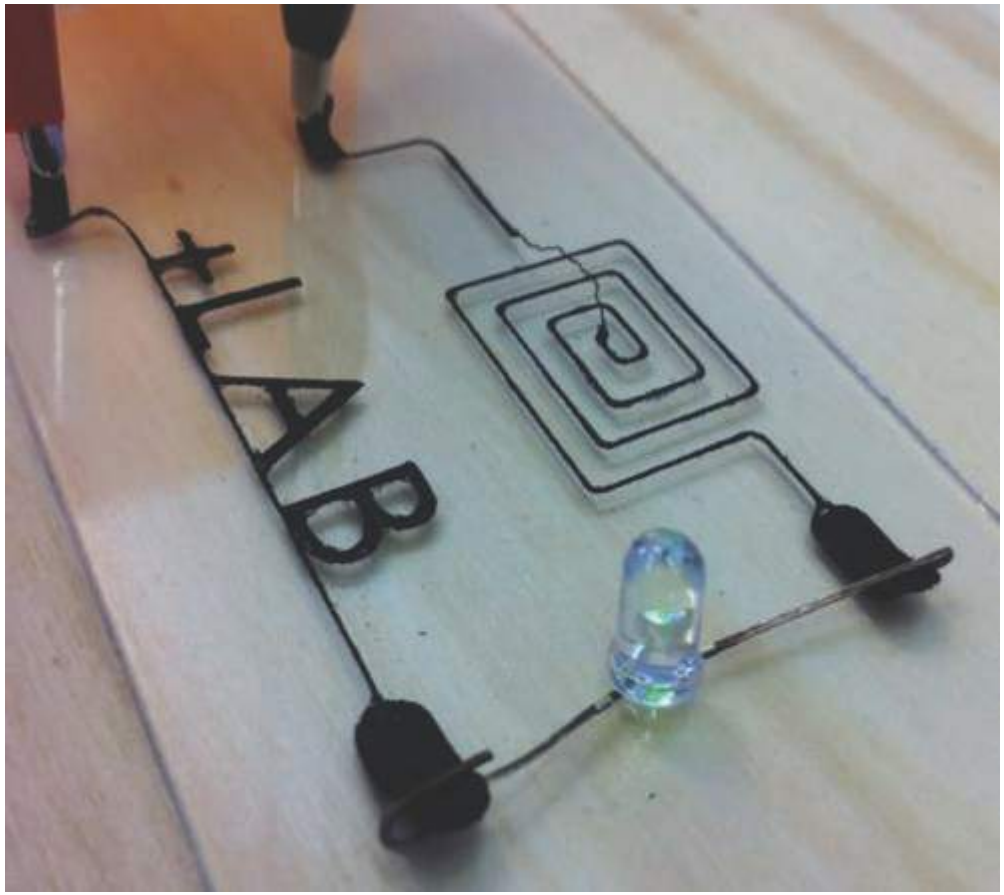


nanocompositi conduttivi a base di nanotubi di carbonio

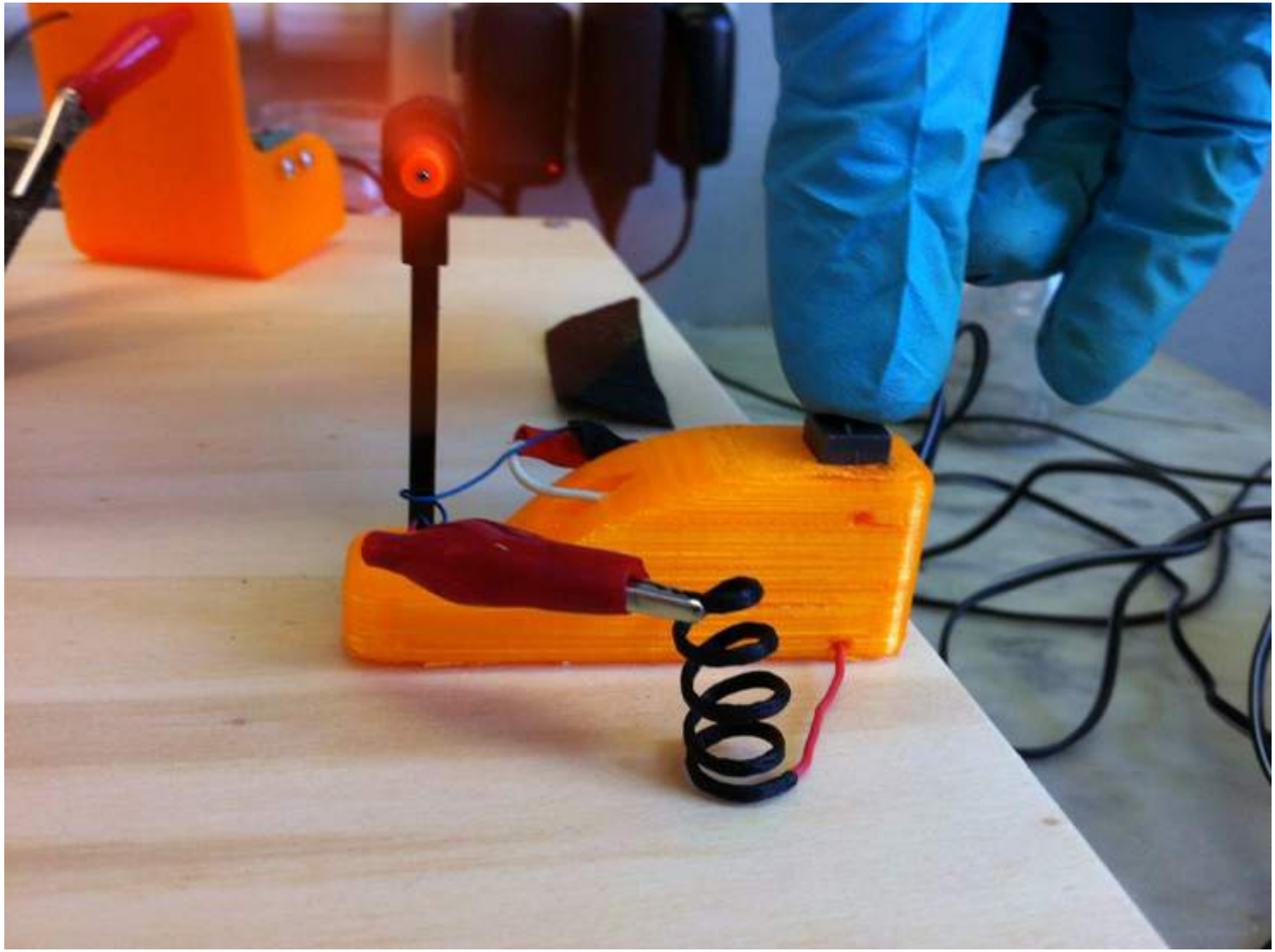
Nanotubi di Carbonio

Grafene

- proprietà meccaniche
- conducibilità elettrica
- conducibilità termica



nanocompositi conduttivi



Compositi a fibra corta..

compositi a fibra corta

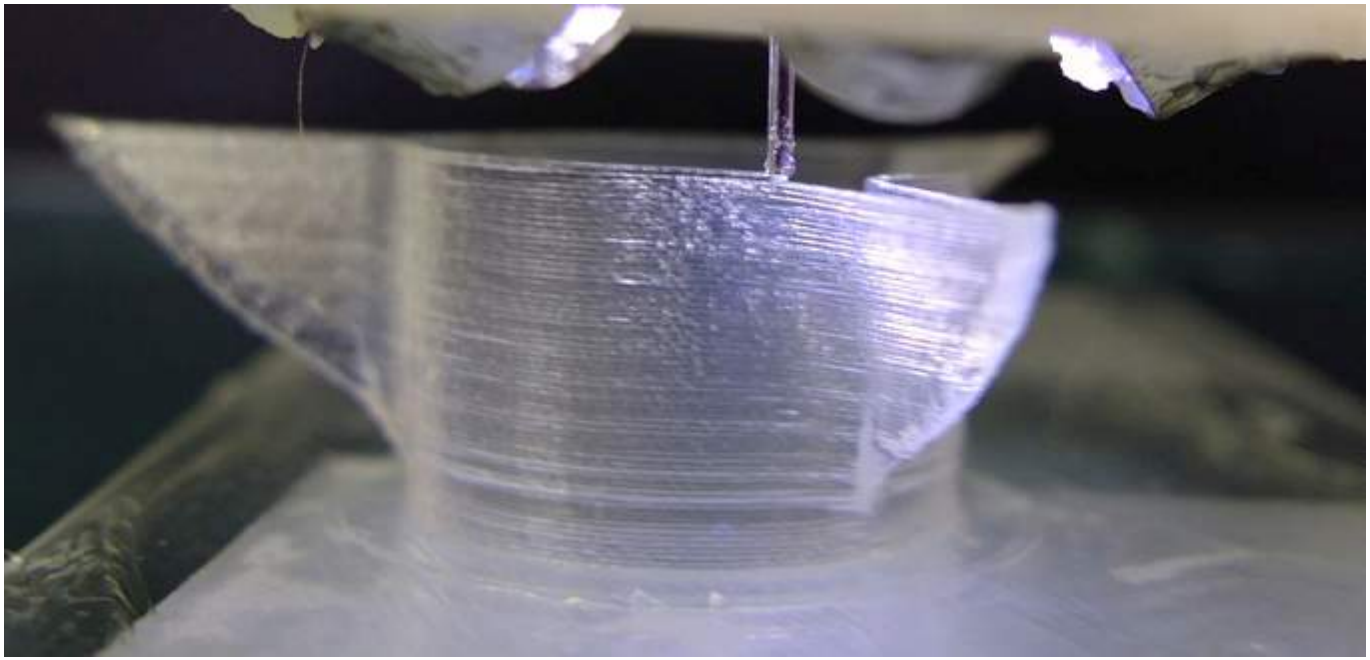
Matrice

- Epossidica
- Acrilica
- Poliuretanica
- Poliestere

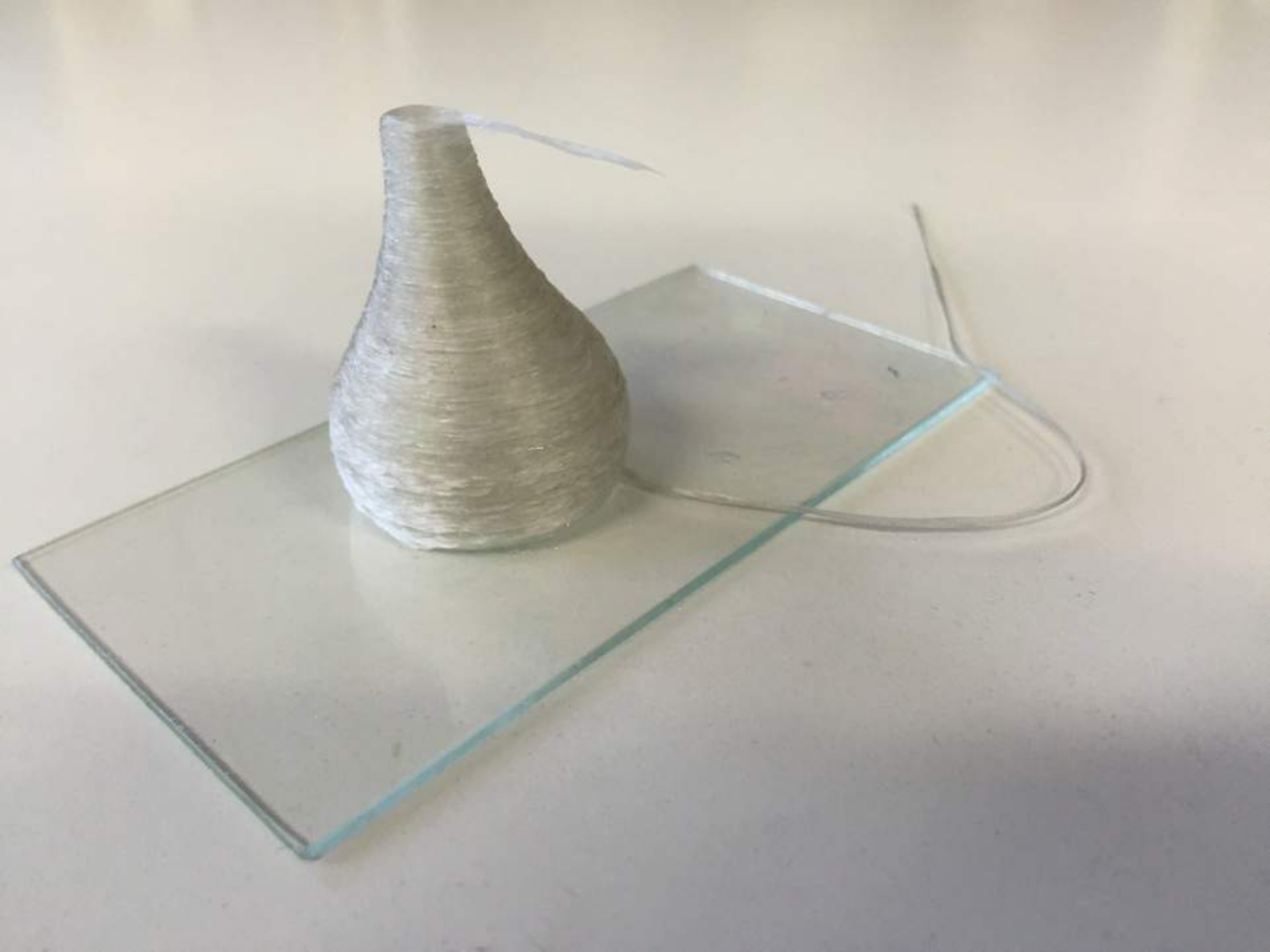
+

Fibre

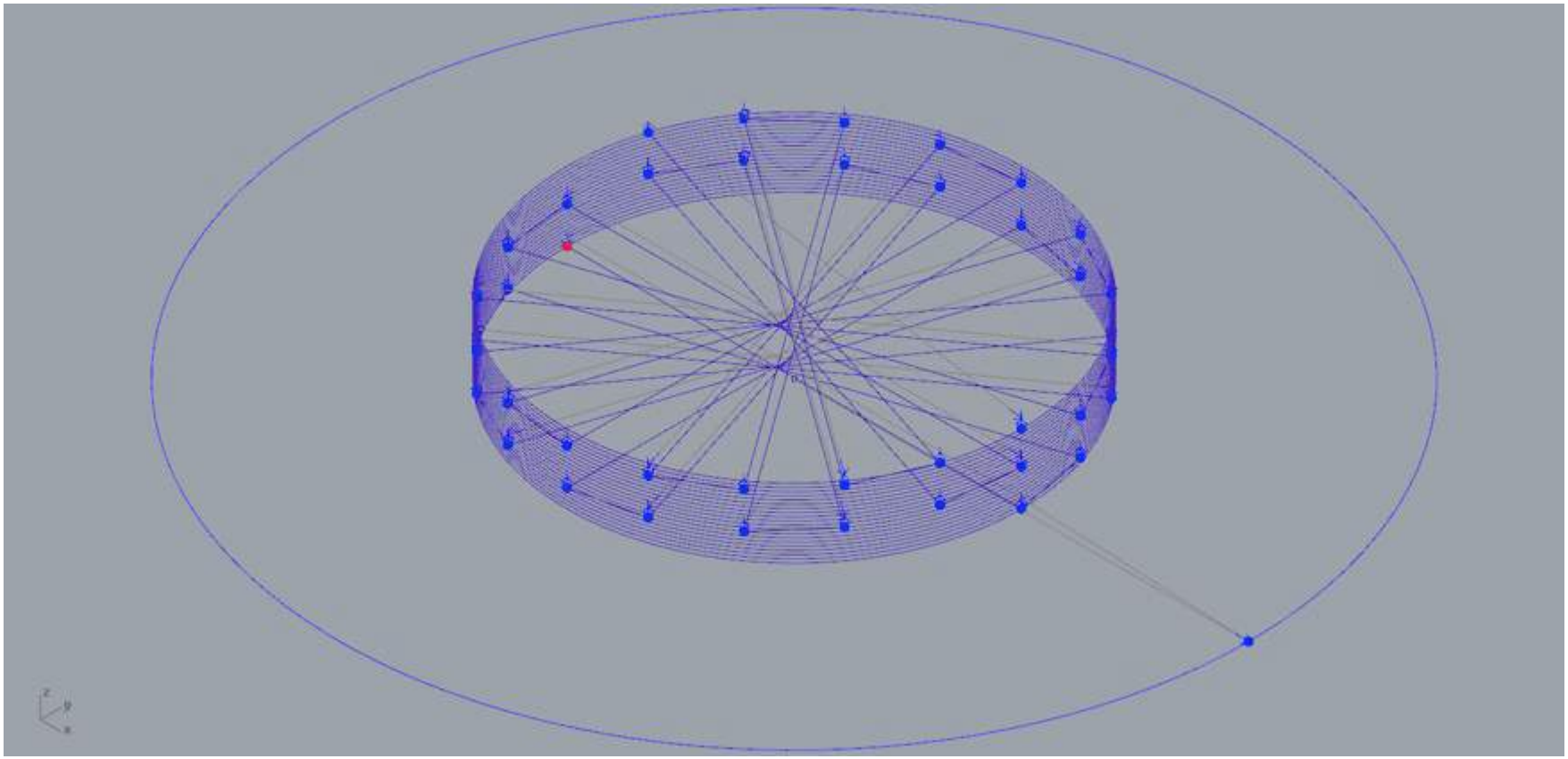
- Carbonio
- Vetro
- Kevlar
- Fibre naturali



Compositi a fibra corta

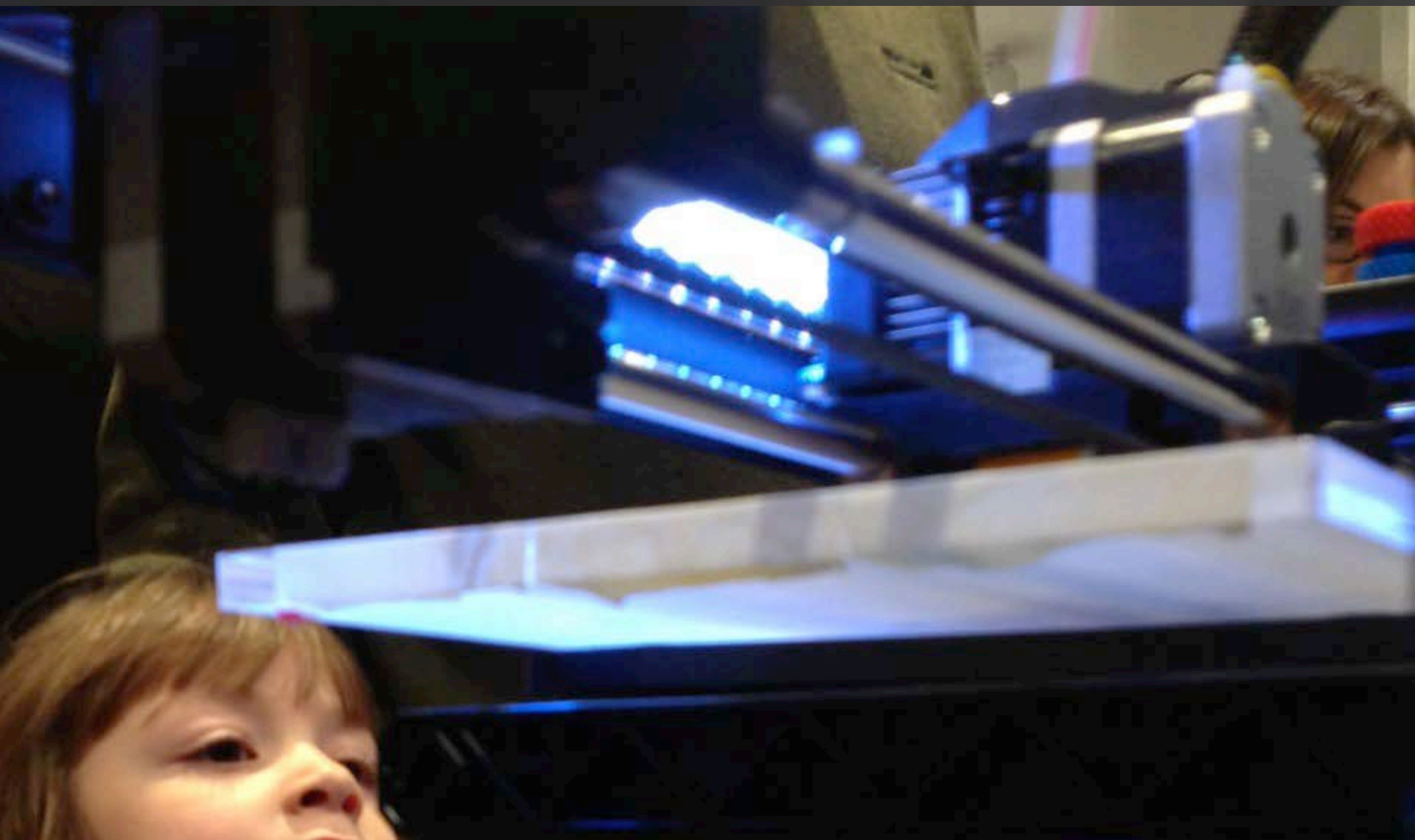


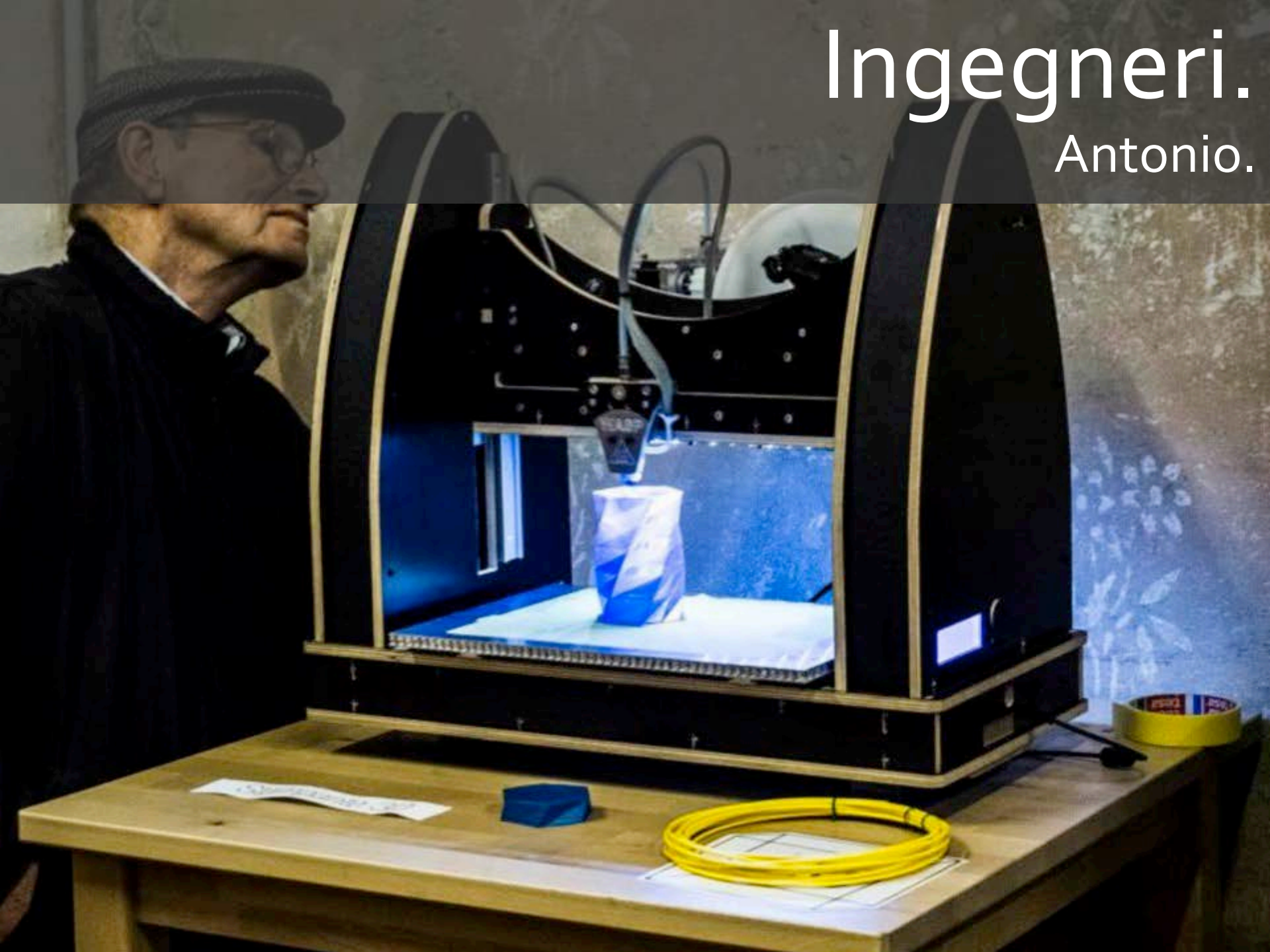
Grasshopper e lo Slicing NON lineare.



Architetti.

Chiara.



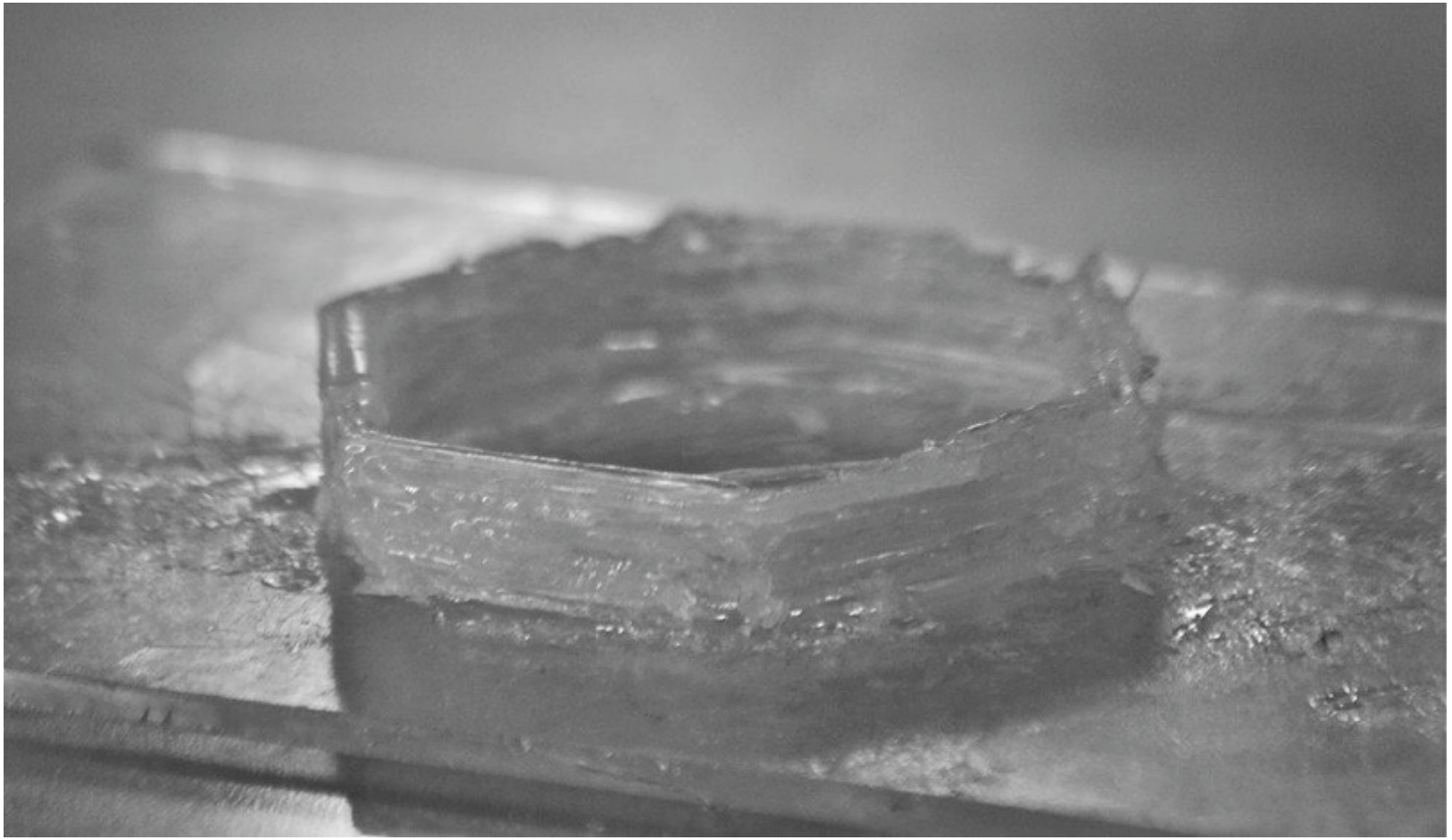

Ingegneri.
Antonio.

Piccole grandi persone.

La scuola elementare di Brozzo.

12/12/2014 **Hello World!.gcode**

Il primo pezzo stampato in 3D con resina termoindurente a fibra continua



Compositi a fibra continua

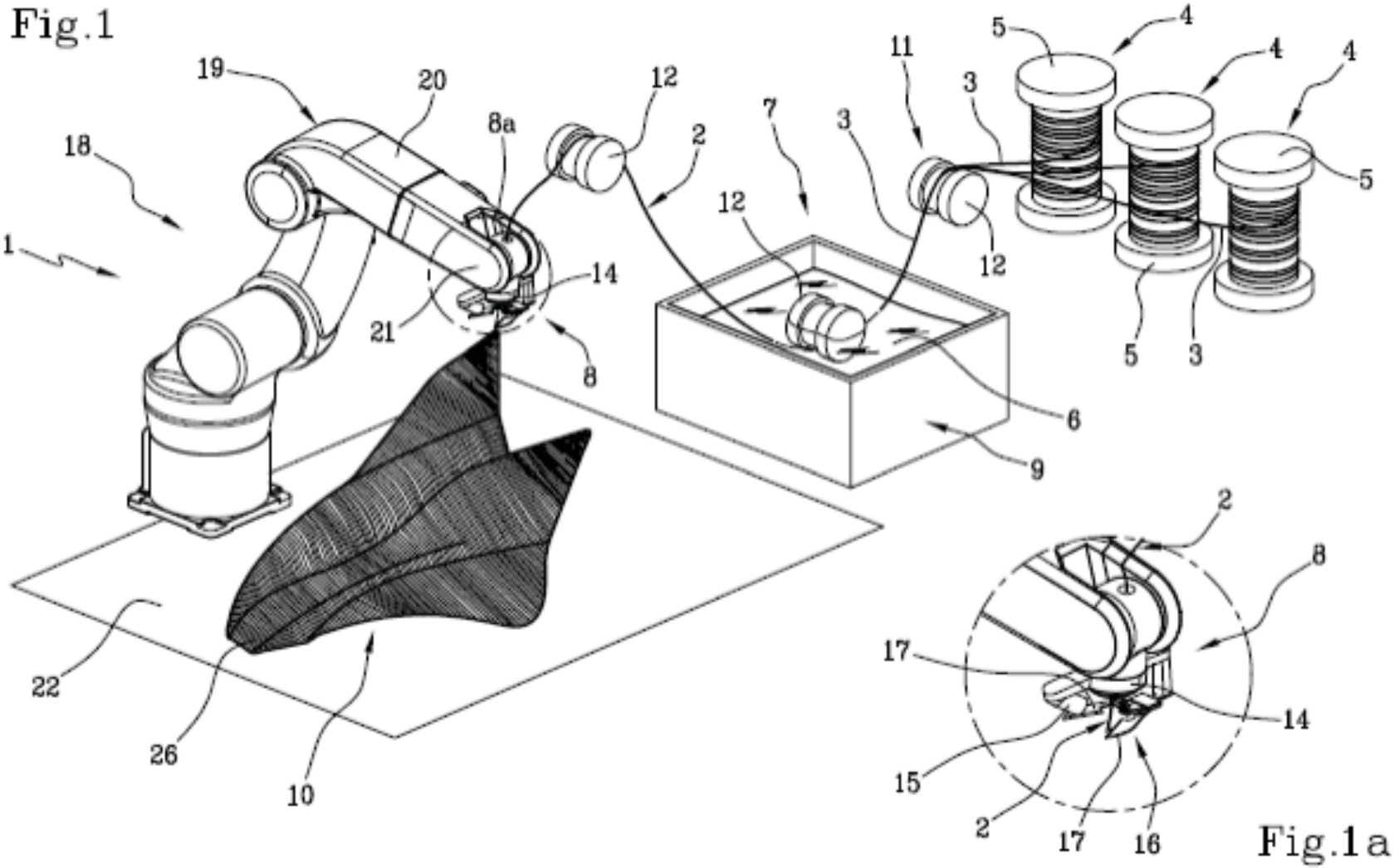
Il sistema di stampa 3D di materiali compositi a matrice termoindurente caricati a fibra continua è stato depositato come

brevetto

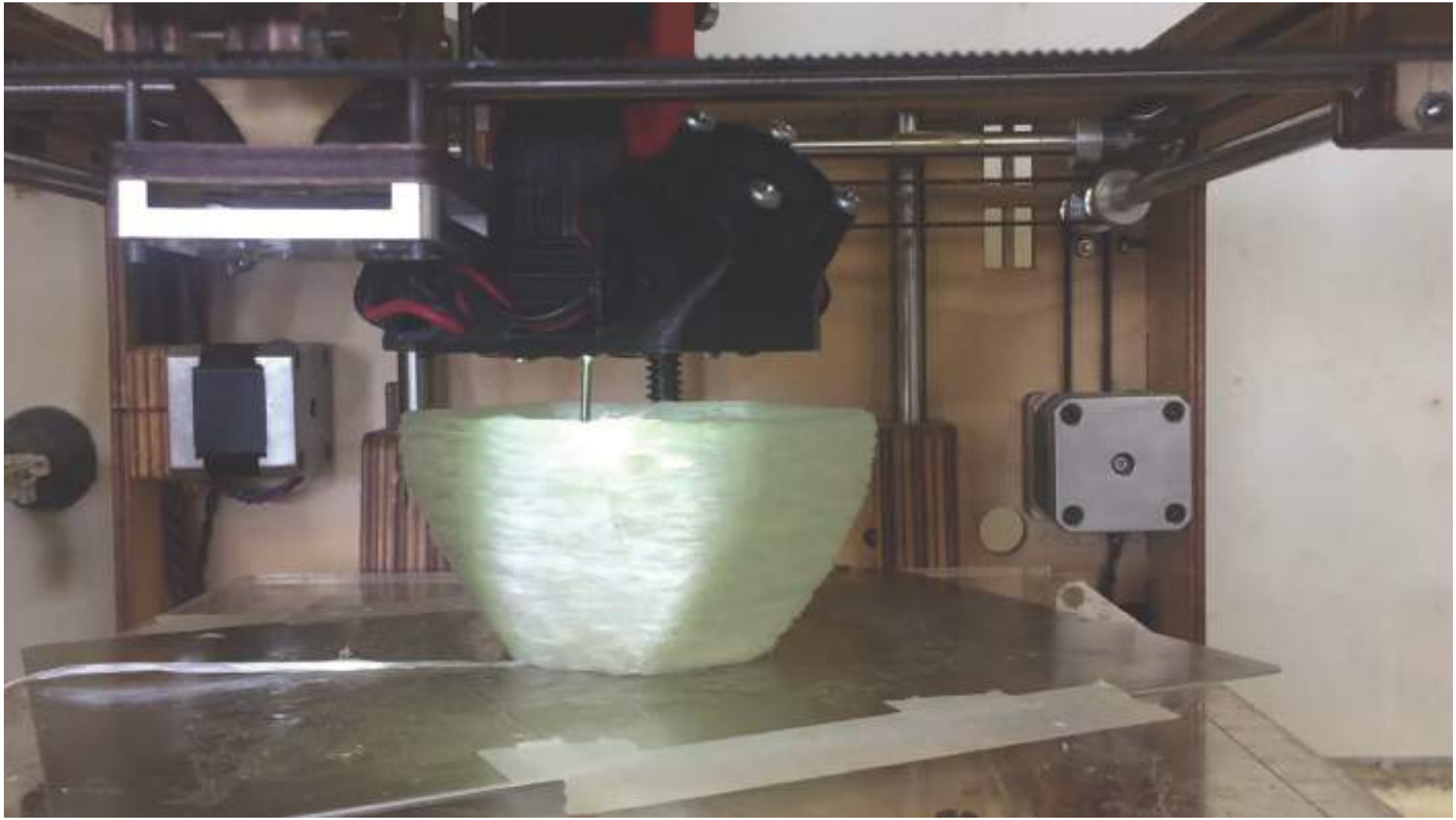
Apparecchiatura e metodo per la stampa tridimensionale di materiali compositi a fibra continua

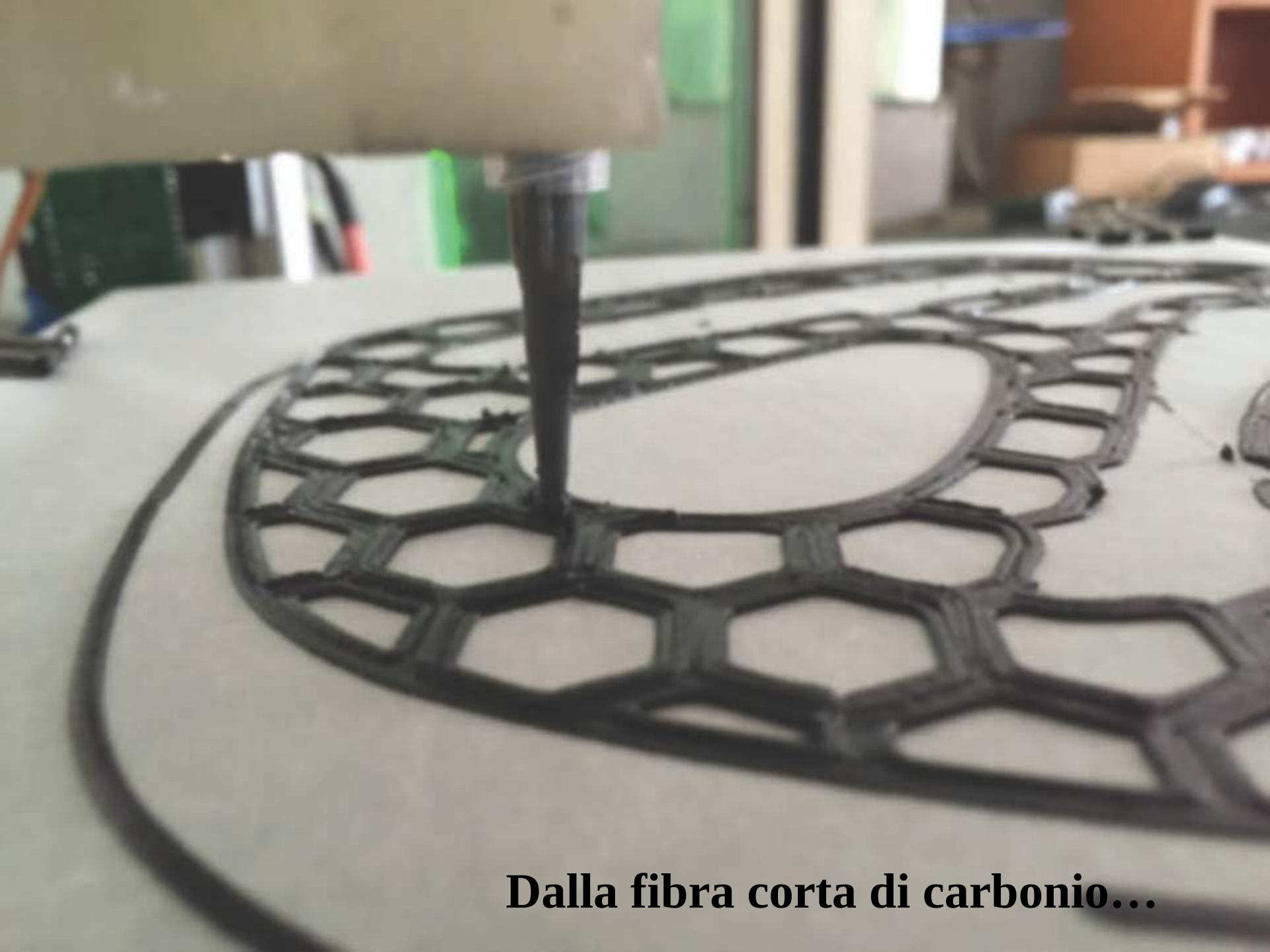
Domanda numero: 102015000073191

la tecnologia: AM di compositi fibra continua



Il prototipo



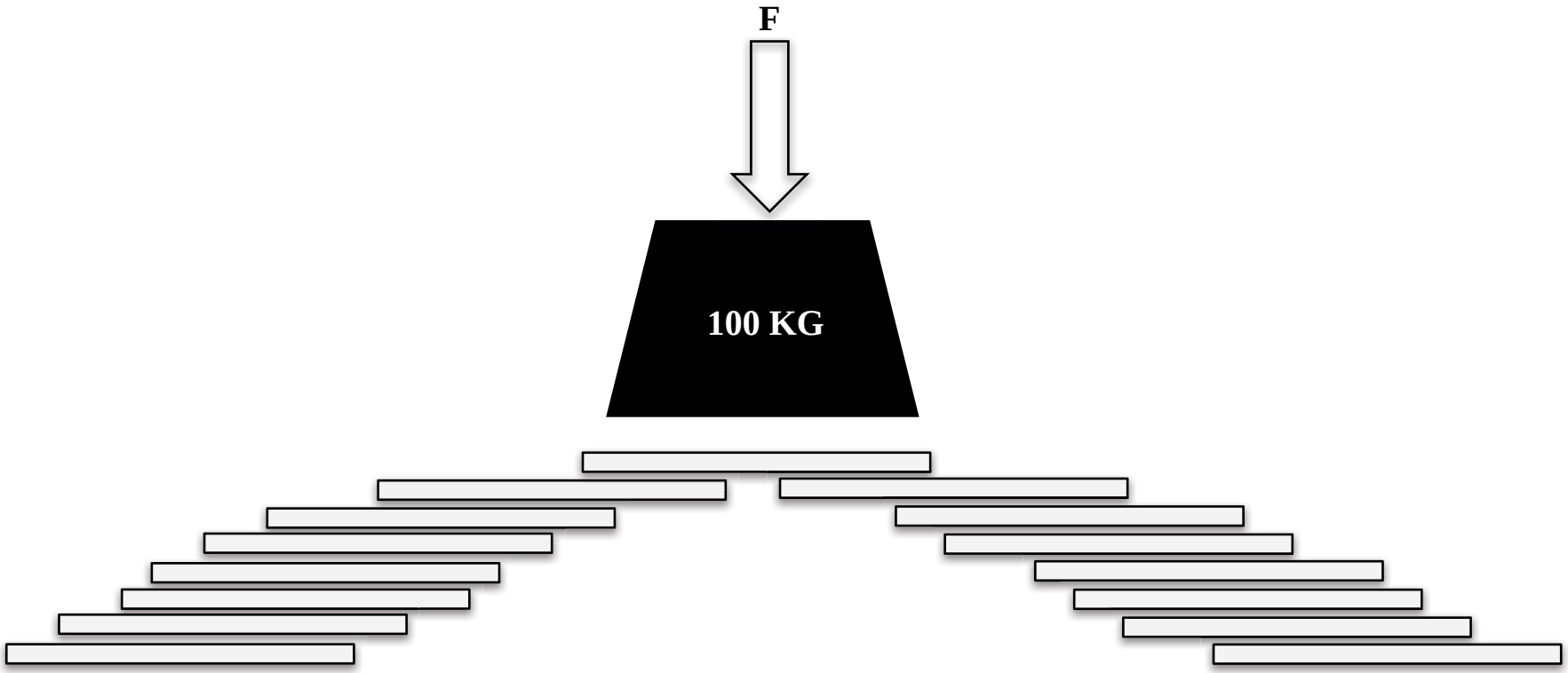


Dalla fibra corta di carbonio…

Alla fibra lunga mista di vetro e carbonio….

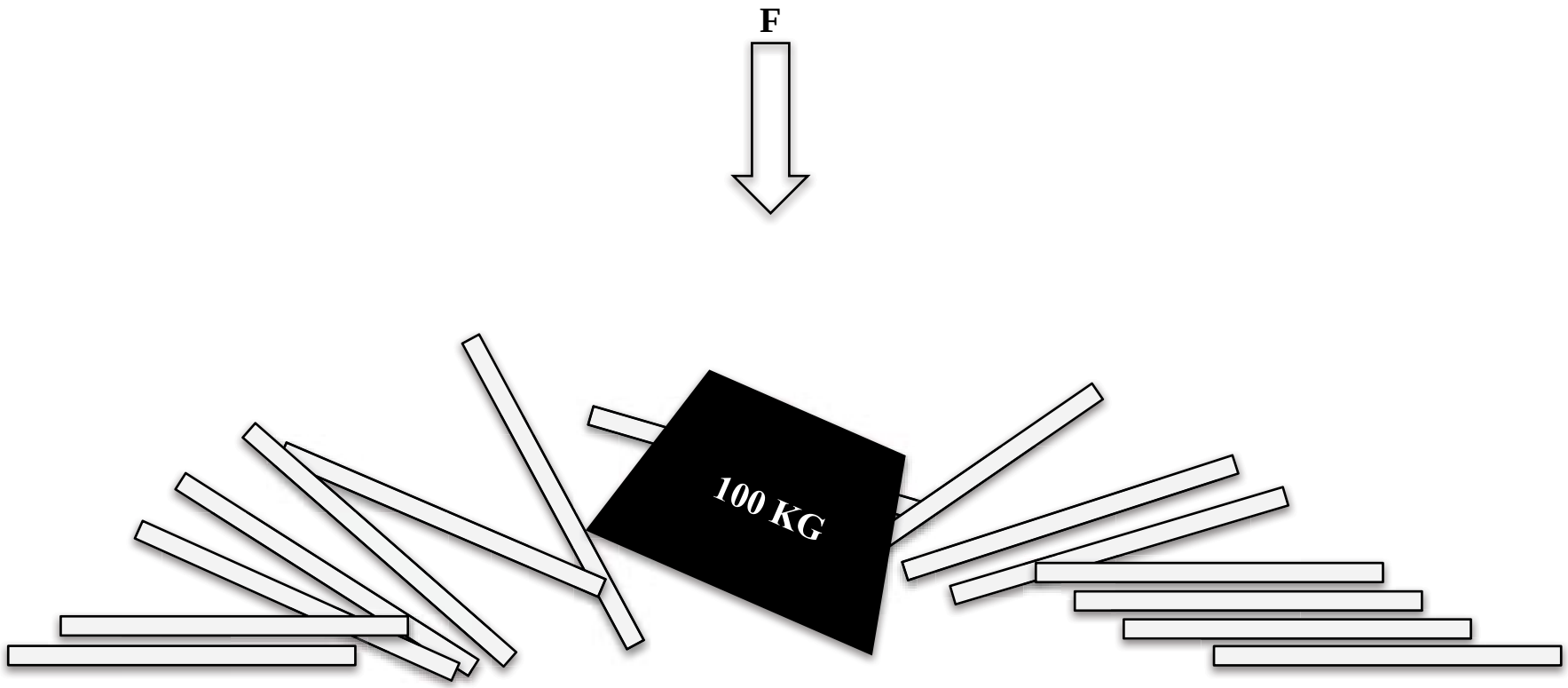
La stampa 3d layer by layer sfrutta un sistema di deposizione di materiale a strati paralleli alla superficie di costruzione.

linear slicing vs smart slicing



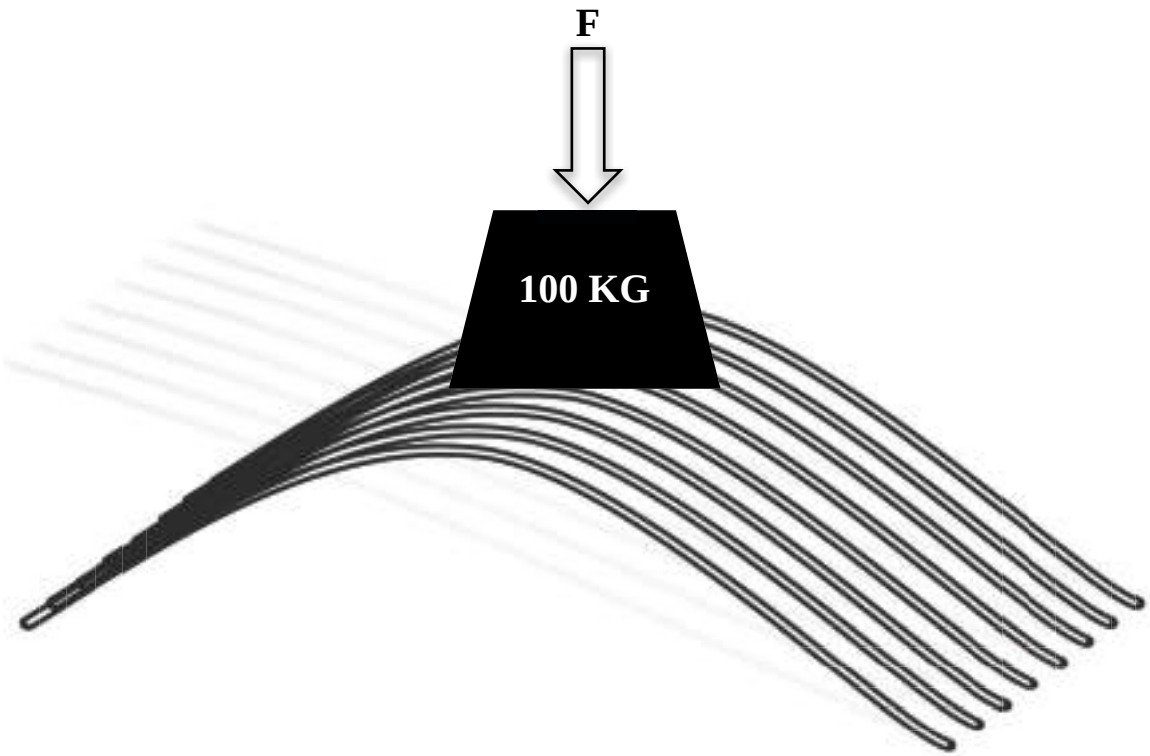
Un sistema di deposizione tradizionale
non è ottimizzato per aumentare le proprietà meccaniche.

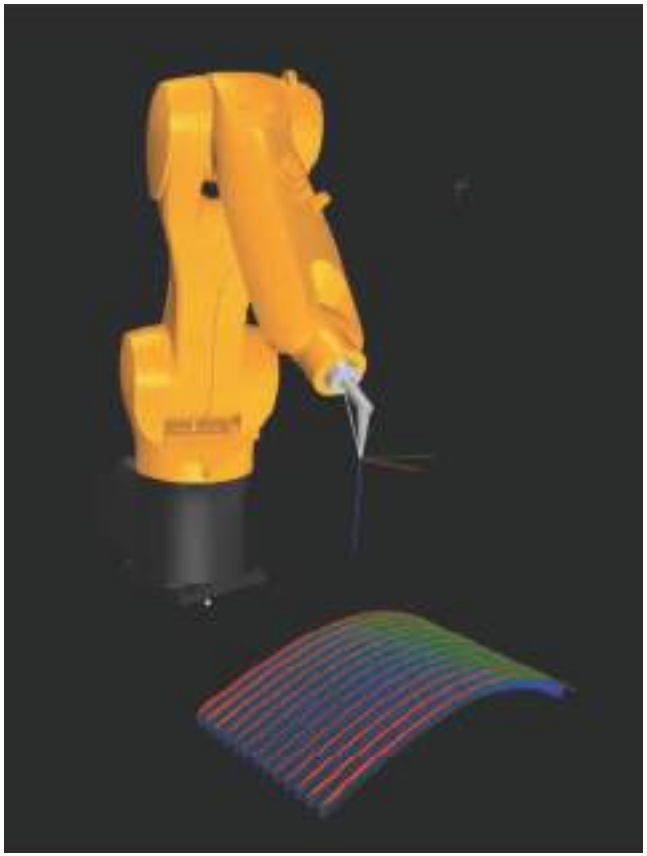
linear slicing



Uno slicing intelligente permette di orientare le fibre in funzione del carico partendo dal FEM.

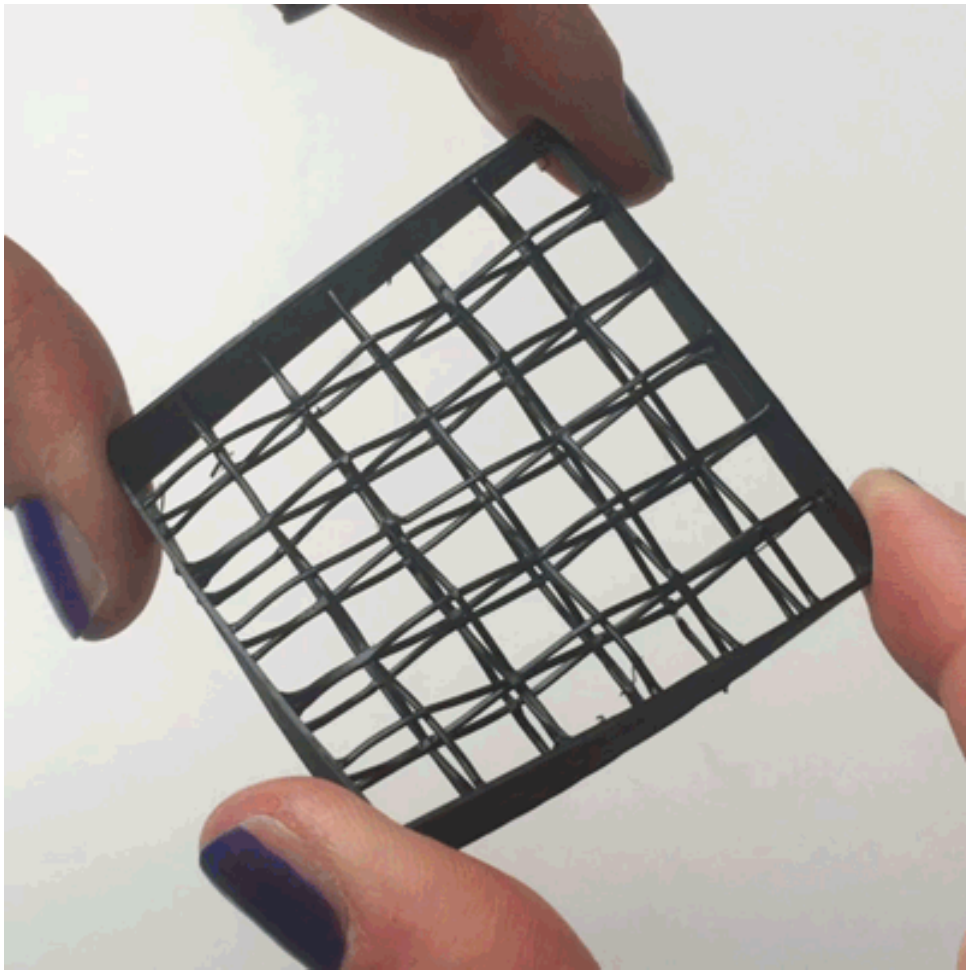
smart slicing

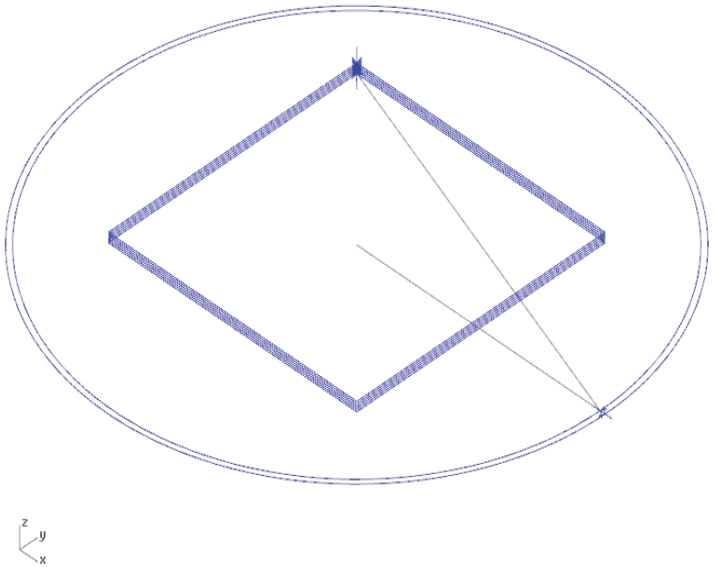




smart slicing

Deposizione superficiale e infil



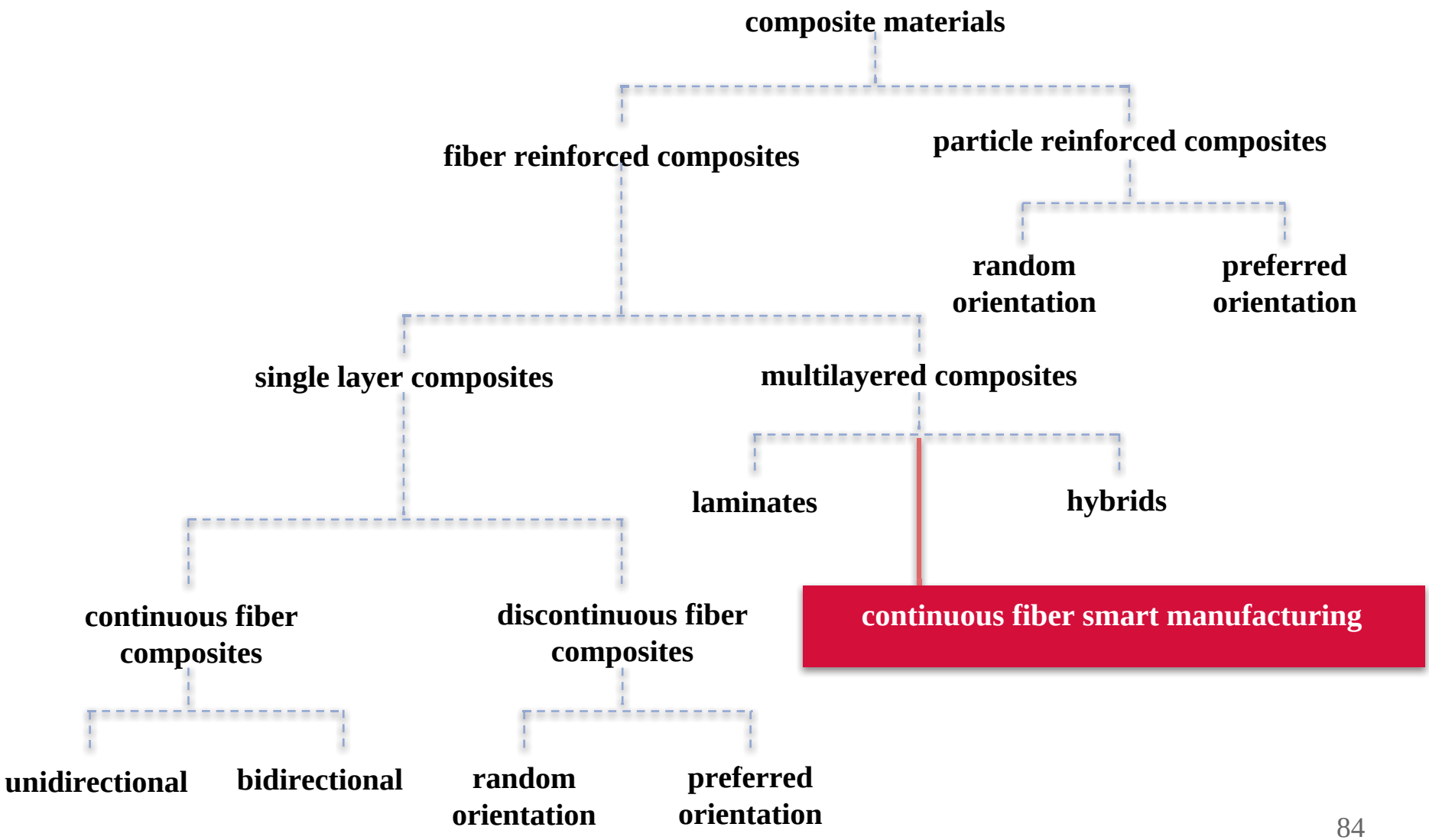


Test fibre di vetro + resina acrilica, peso 88 gr.

smart slicin

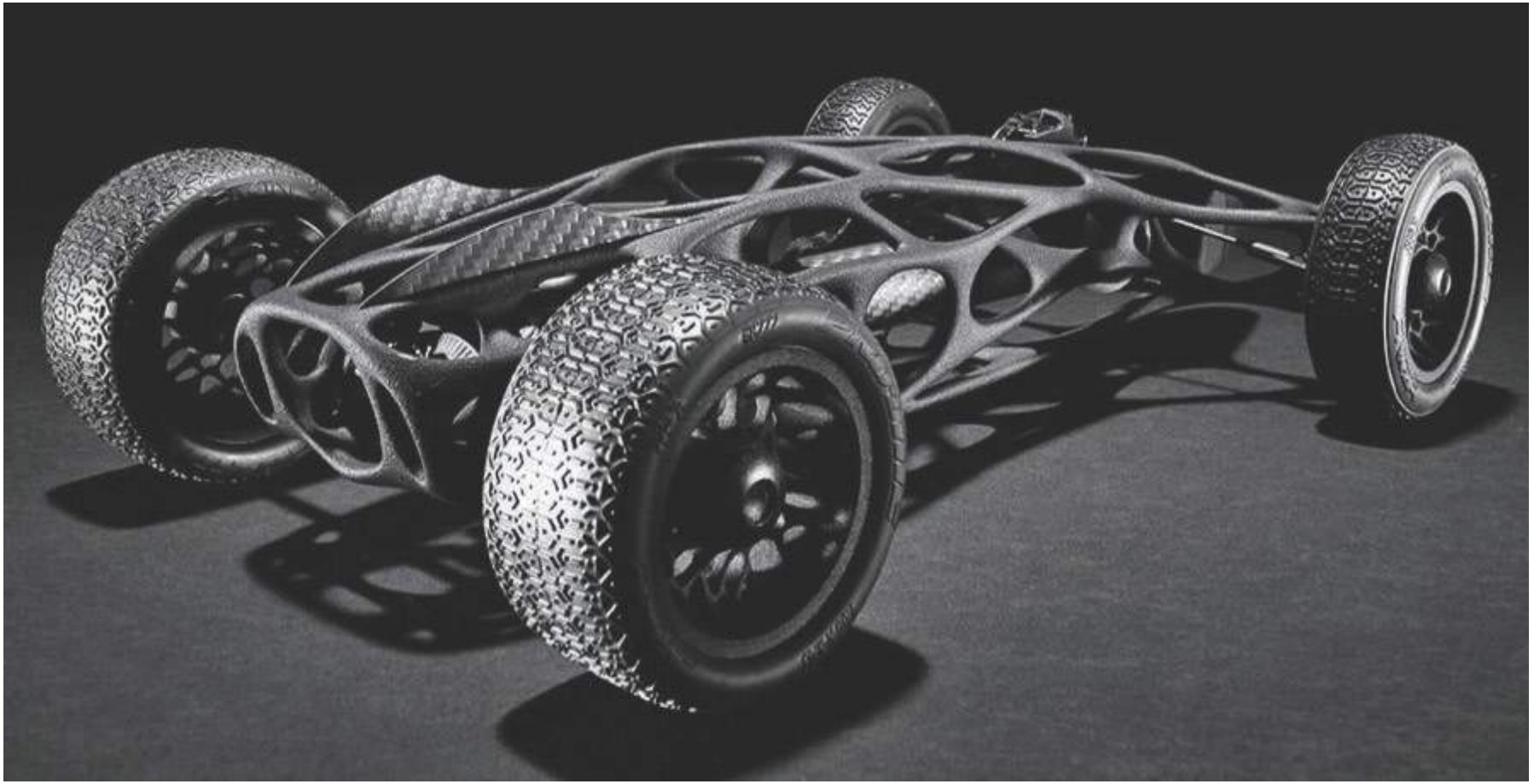
dov’è la novelty?

Come classificare questo processo?



Forme complesse fin ora impossibili da realizzare.

La libertà della lavorazione SENZA STAMPI



Elevate prestazioni derivanti dal utilizzo di materiali performanti con un processo di deposizione controllata.

Prestazioni

La manifattura additiva produce 100 oggetti uguali o cento oggetti differenti con lo stesso costo di impianto.

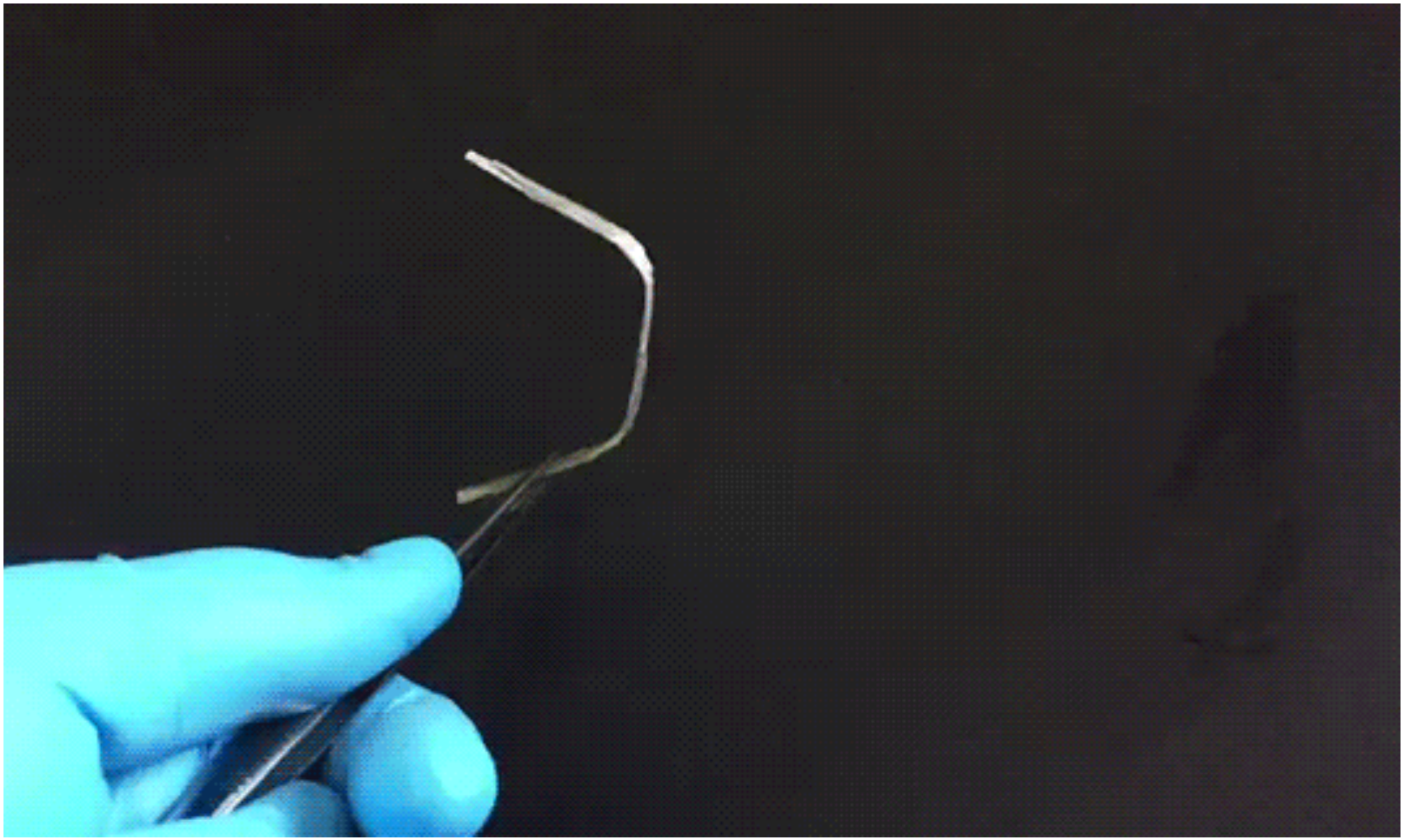
Personalizzazione estrema

Dall’idea al prodotto in breve tempo.

velocità di produzione

Possibilità di creare materiali ibridi e modulare le proprietà delle strutture.

Strutture adattive e materiali intelligenti



l’interesse nel mondo

il mondo della stampa 3d di compositi

The Boston Globe	03/07/2014
www.3ders.org	16/12/2014
Fortune	23/06/2015
www.3ders.org	27/04/2016
TCT Magazine	17/05/2016
3Dprint.com	27/06/2016

il mondo della stampa 3d di compositi

With $1.1 million in bank, MarkForged prepares to deliver first-of-its-kind 3D printer

New startup raised $2.8 million for developing a reinforced composite 3D printer

Why Ford is partnering with a hot 3D printing startup

South Korea to set up $20M research project for 3D printed ship development in Ulsan

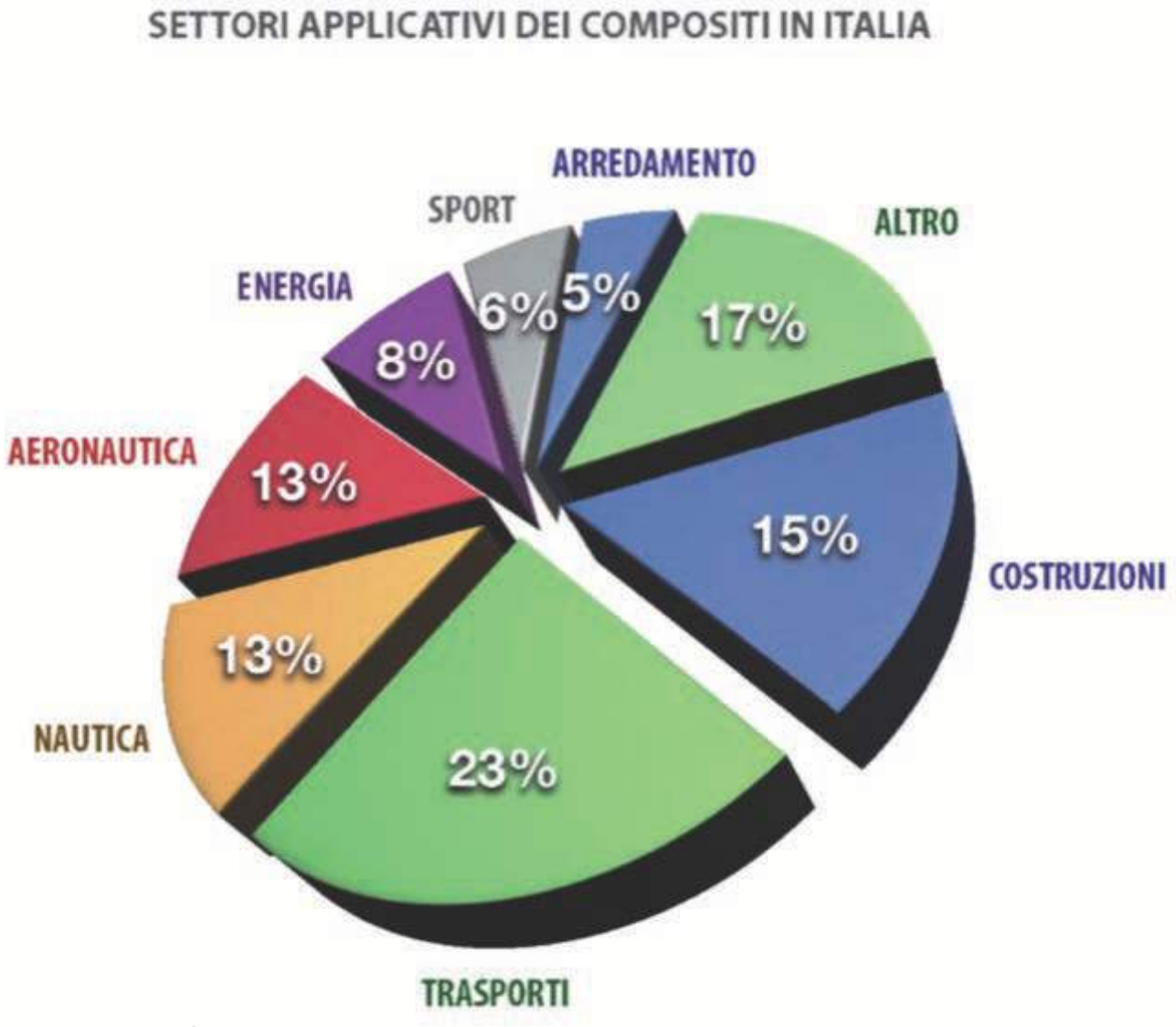
ENVISIONTEC REVEALS SLCOM 1 FOR 3D PRINTING COMPOSITES AT RAPID 2016

AREVO announces $7M series A funding round led by Khosla Ventures


dov’è il goal?

Un grande mercato potenziale

Settori applicativi dei **compositi in Italia**



I GOL

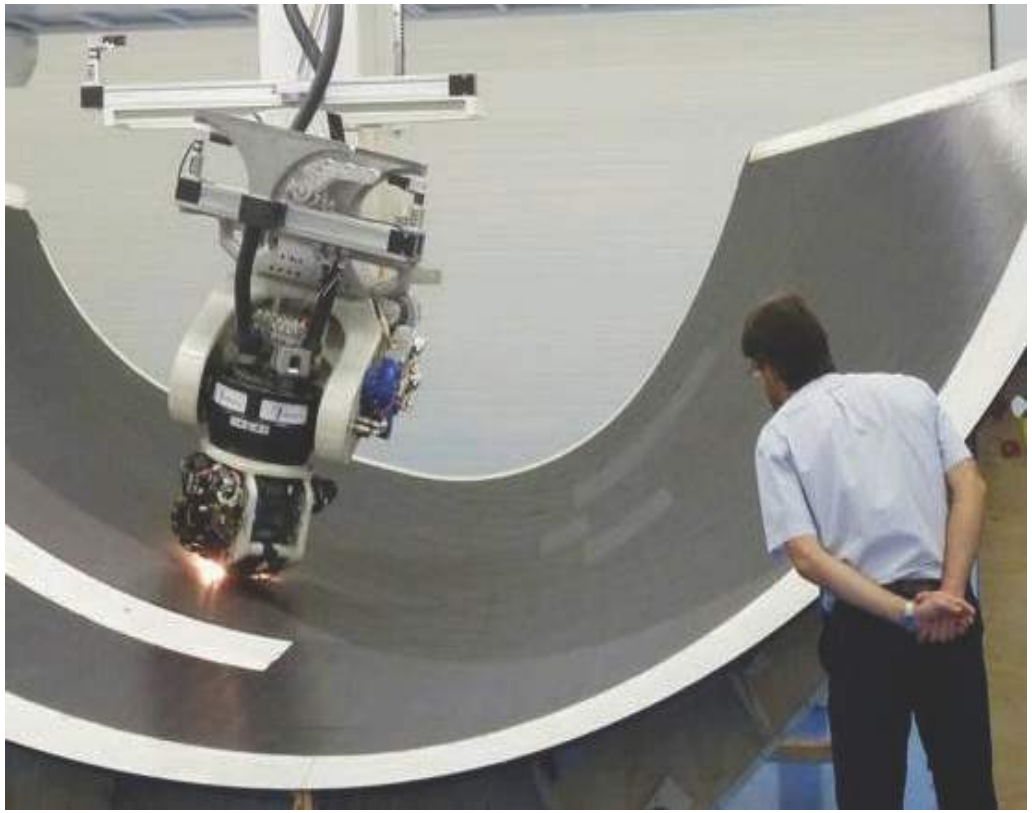
Elevate Prestazioni

Grandi Dimensioni

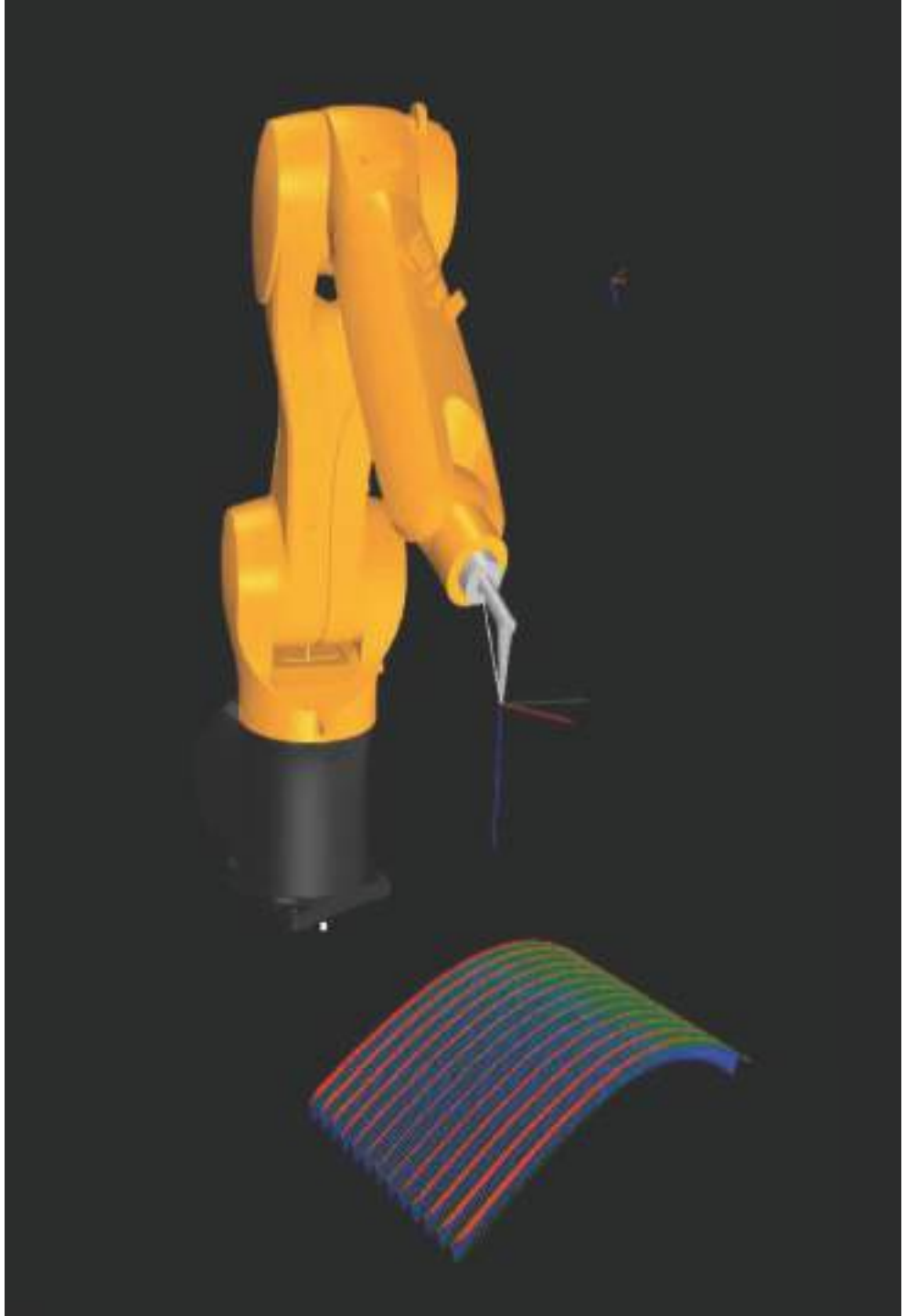
→ **ALTO VALORE AGGIUNTO**

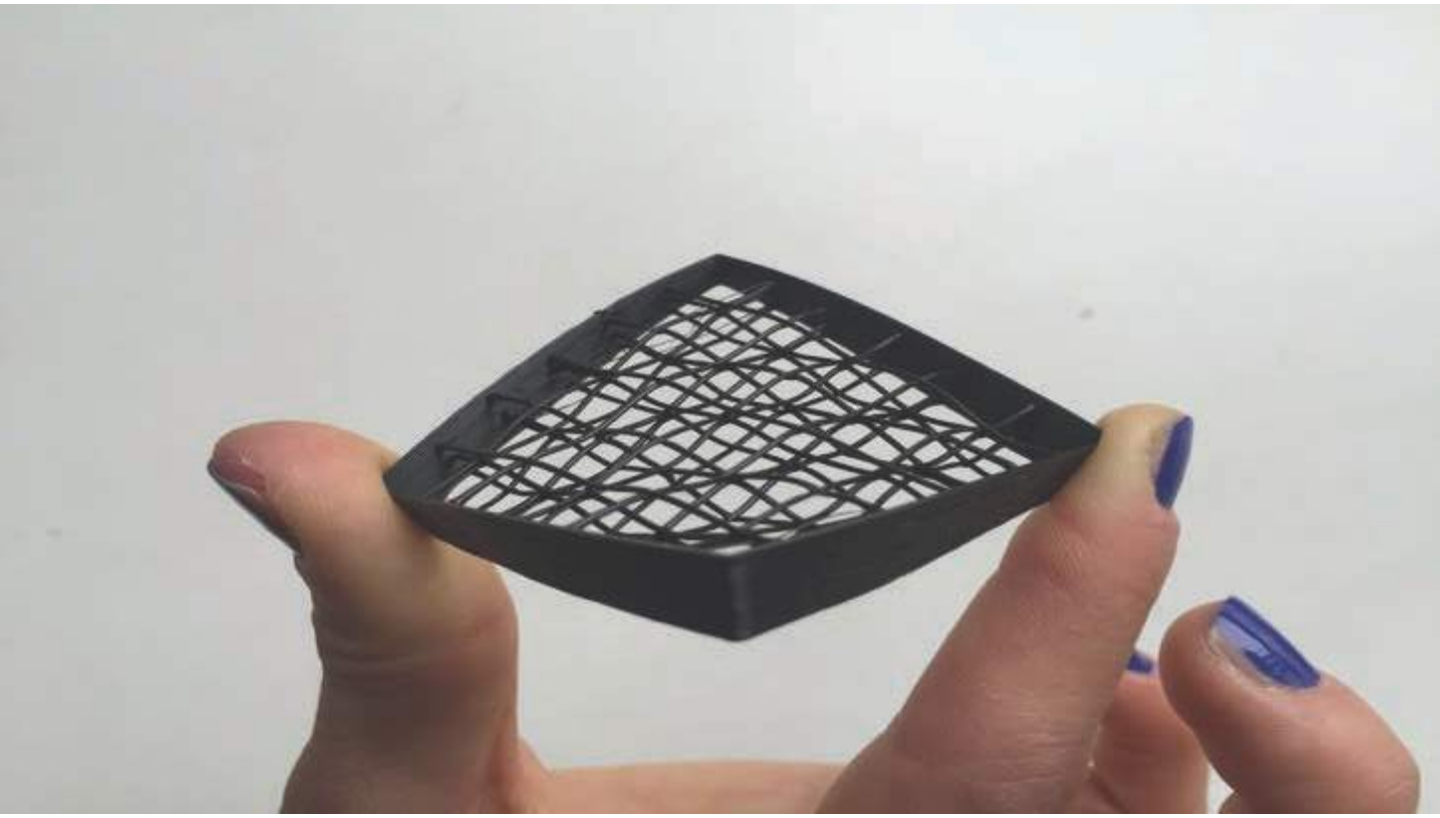
Adattare la tecnologia CFSM ad una macchina di grandi dimensioni simile a quelle utilizzate nei sistemi di Fiber Placement Manufacturing.

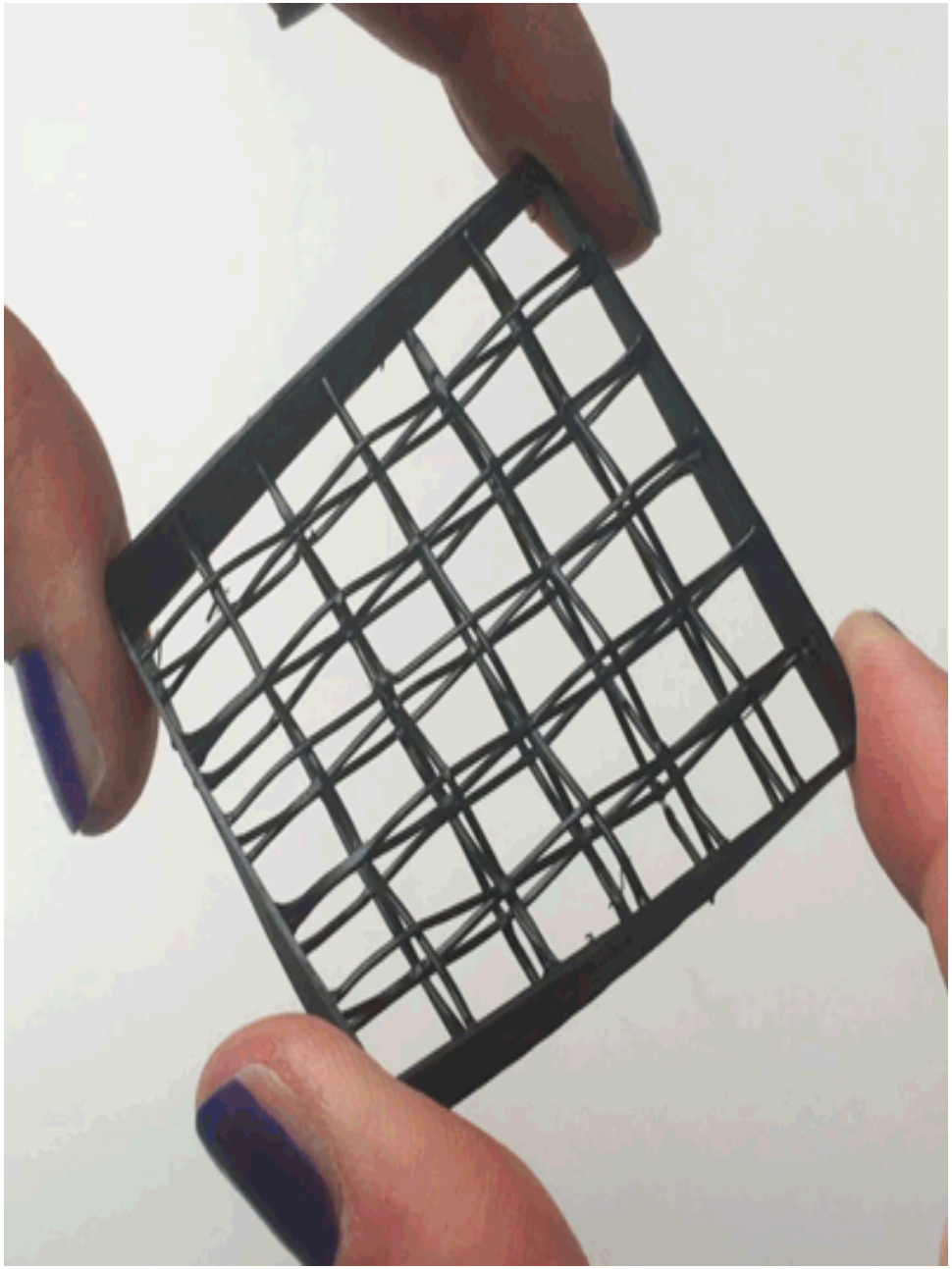
GRANDI MACCHINE

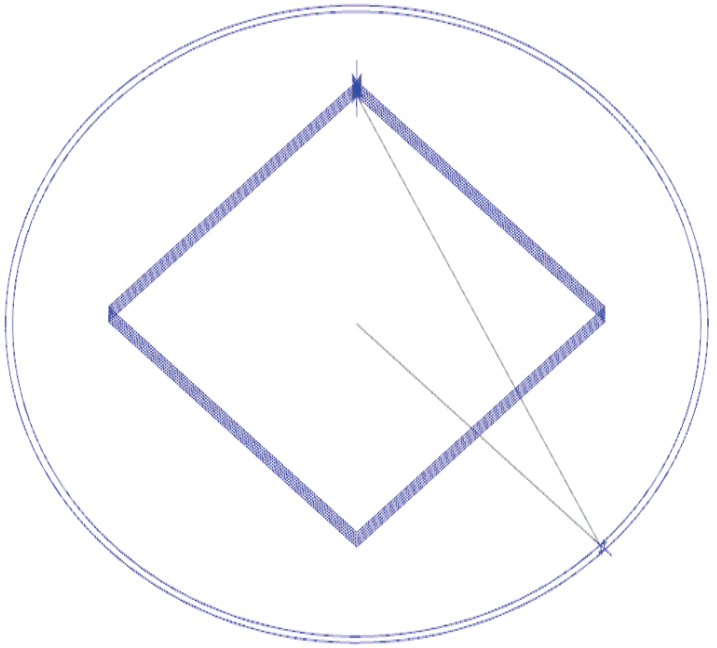


Andare oltre i 3 assi…
l’incontro con la robotica.





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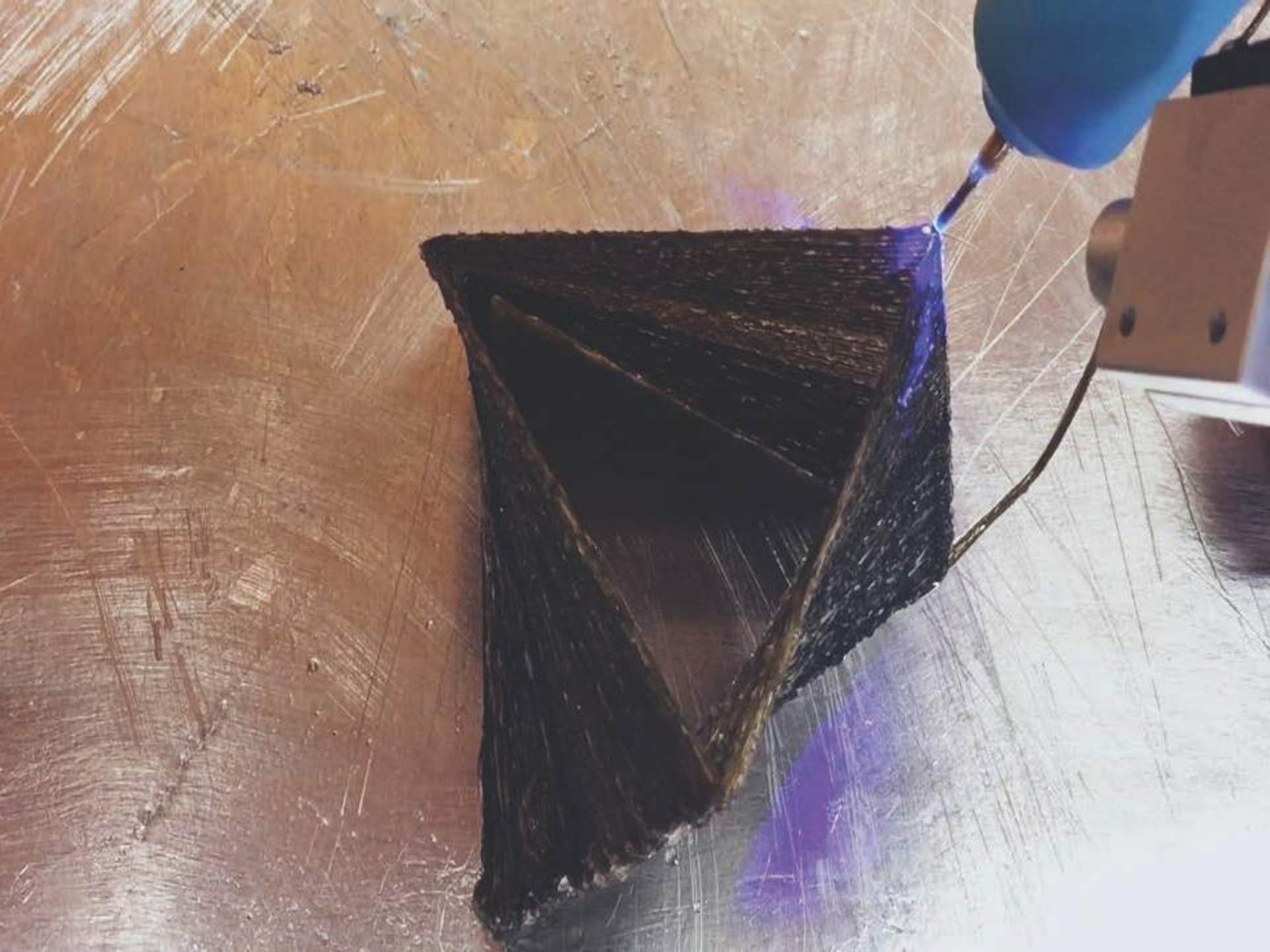
ATROPOS

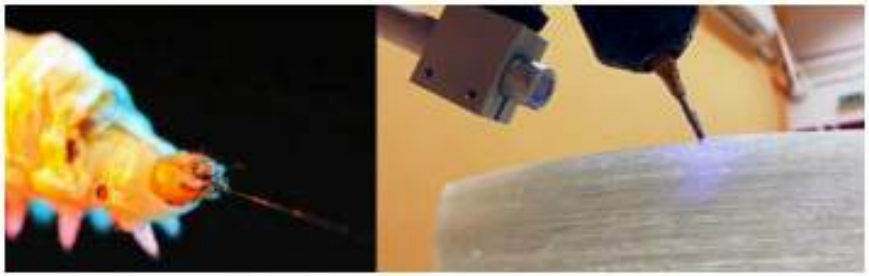



KUKA

3D PRINT.COM
The Voice of 3D Printing Technologies

Thermosetting Composite Materials: Atropos Creates New Relationship Between 3D Printing & Robotics

by Bridget Butler Millsaps | Sep 23, 2016 | 3D Printers, 3D Printing, 3D Printing Materials, Robotics |



www.3ders.org
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+LAB's Atropos robotic arm offers silkworm-style 3D printing that could change the industry

Sep 23, 2016 | By Nick

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Siemens' VP Vynce Paradise Speaks About "Infinite Extrusion" 3D Printing of Continuous Composites

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Davide Sher | 3 weeks ago | 3D Printing, Materials, NEWS, Robotics | Leave a comment | 358 Views

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Presented to a material or process that best contributes to efficient manufacturing and product sustainability.

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3D Printing of High Temperature Thermoplastic Molds
Oak Ridge National Lab (ORNL)

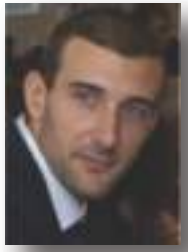
Continuous Fiber Composites Smart Manufacturing
+LAB - Politecnico di Milano

Development of Cocured Integral Wing Interspar Box using VERITy Process
Advanced Composites Division, NAL

Thermoplastic Resistive Welding Fabric
T Plates Global, LLC.

GRAZIE.

Alla Z, e…

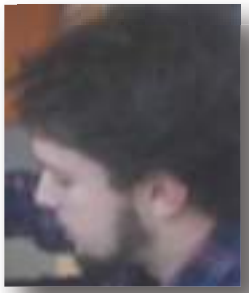



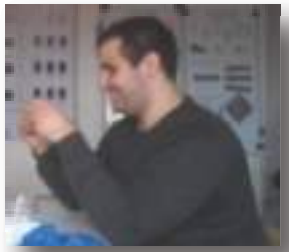


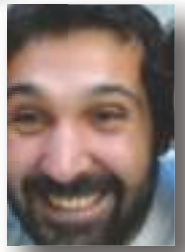
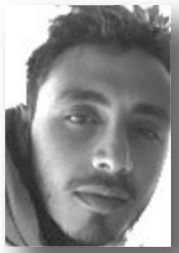


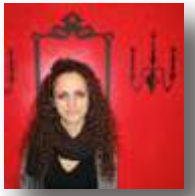









Fare o non fare.
Non esiste provare.
Cosa e perché stampare in 3D

Grazie a voi tutti
per la cortese attenzione.

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