



Stampa 3D di compositi a fibra corta e continua. La manifattura additiva incontra la robotica

Marinella Levi

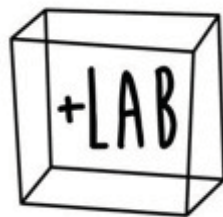
Dipartimento di Chimica, Materiali e Ingegneria Chimica
'Giulio Natta'

12 ottobre 2016

+LAB

la ricerca sulla stampa 3D

Applicazioni



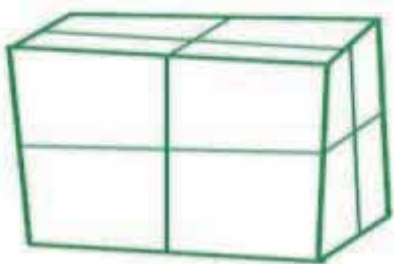
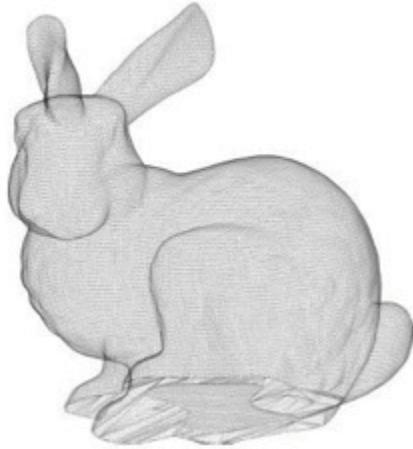
Materiali



Processi

la stampa 3D

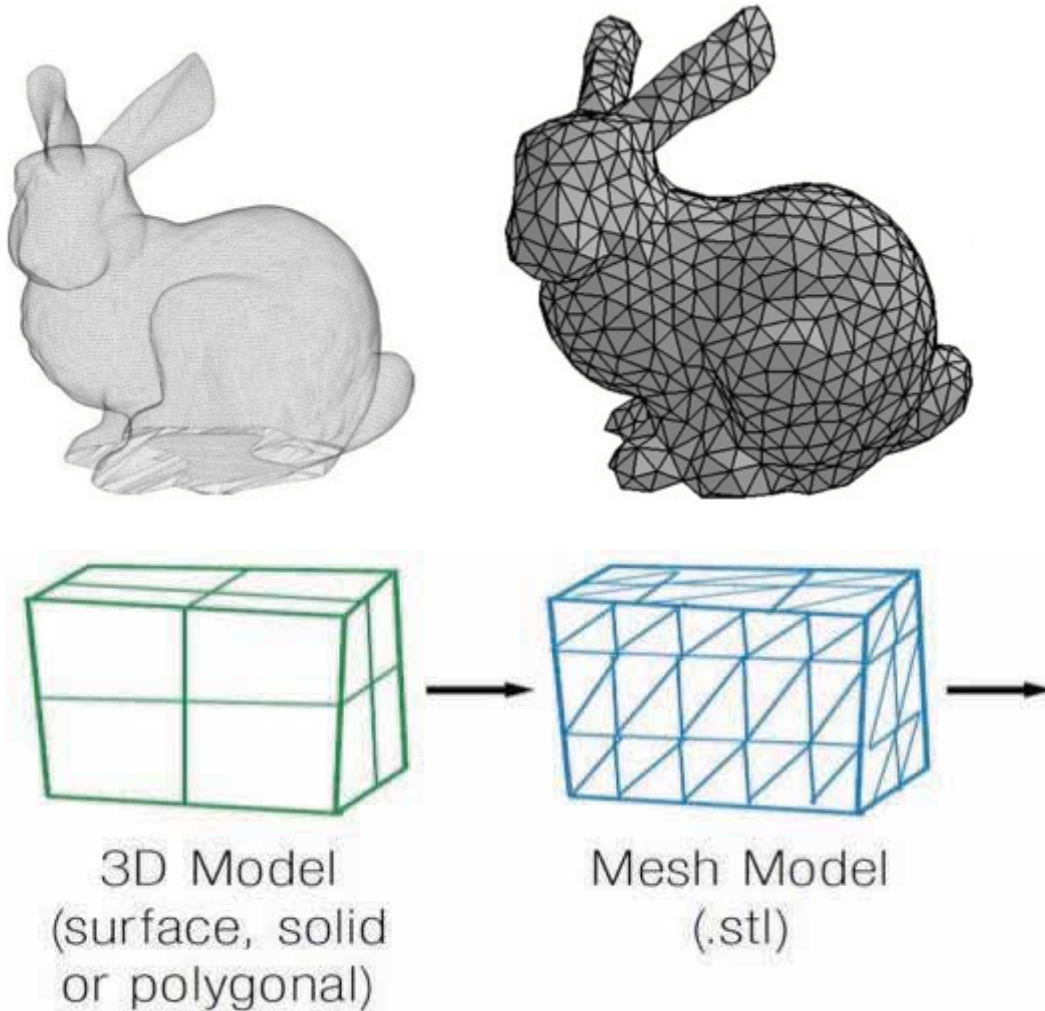
dal CAD alla macchina CNC layer by layer



3D Model
(surface, solid
or polygonal)

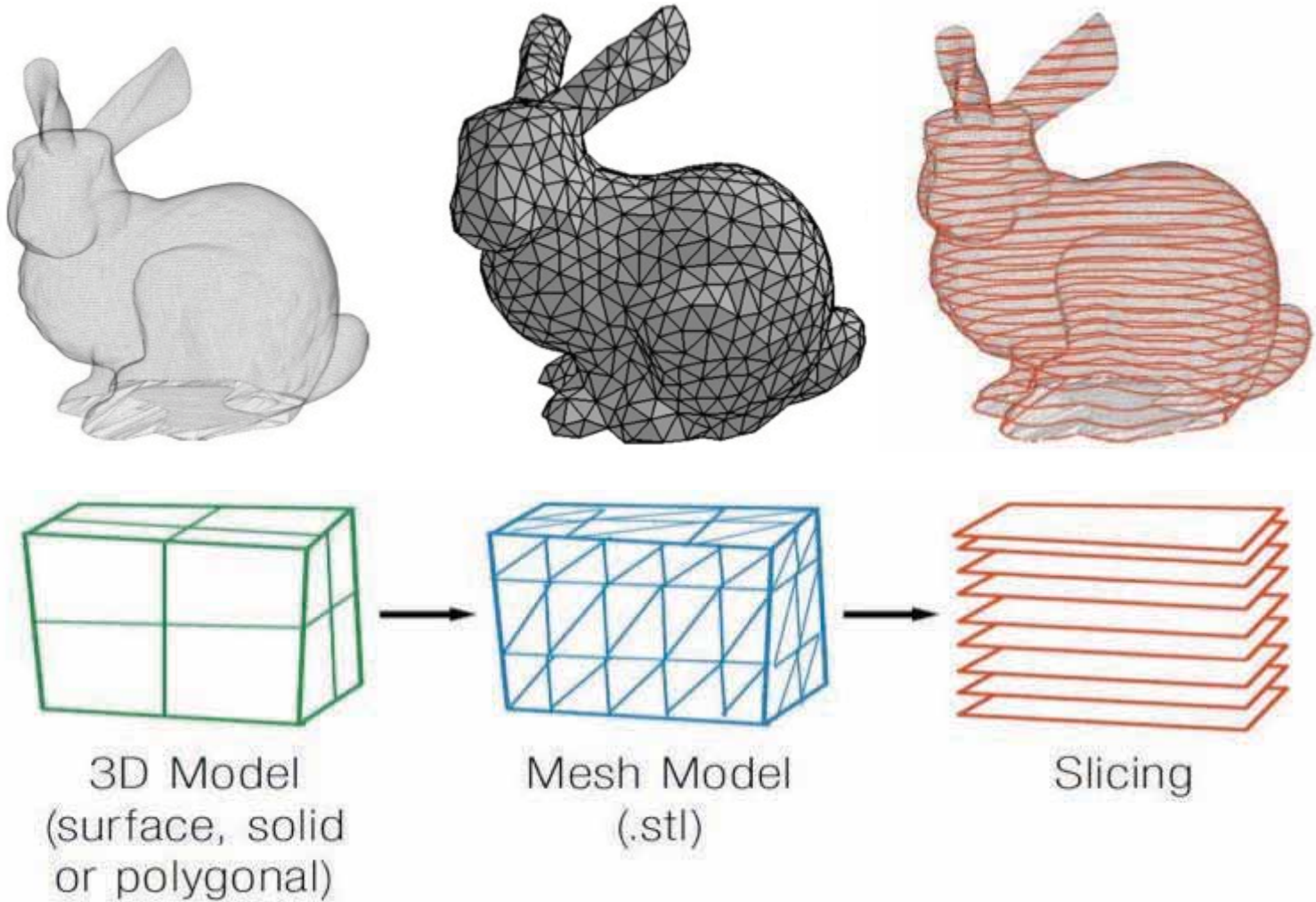
la stampa 3D

dal CAD alla macchina CNC layer by layer

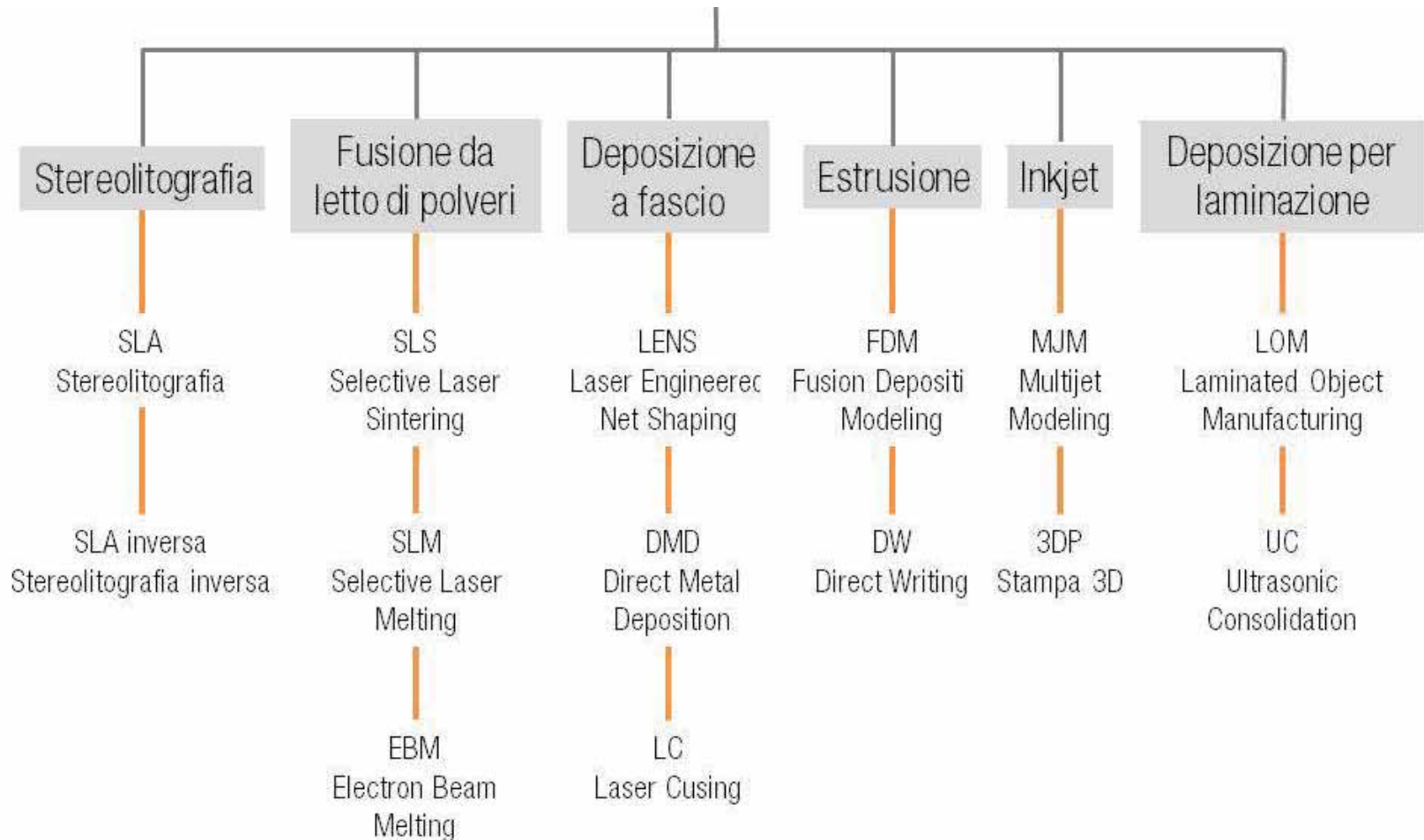


la stampa 3D

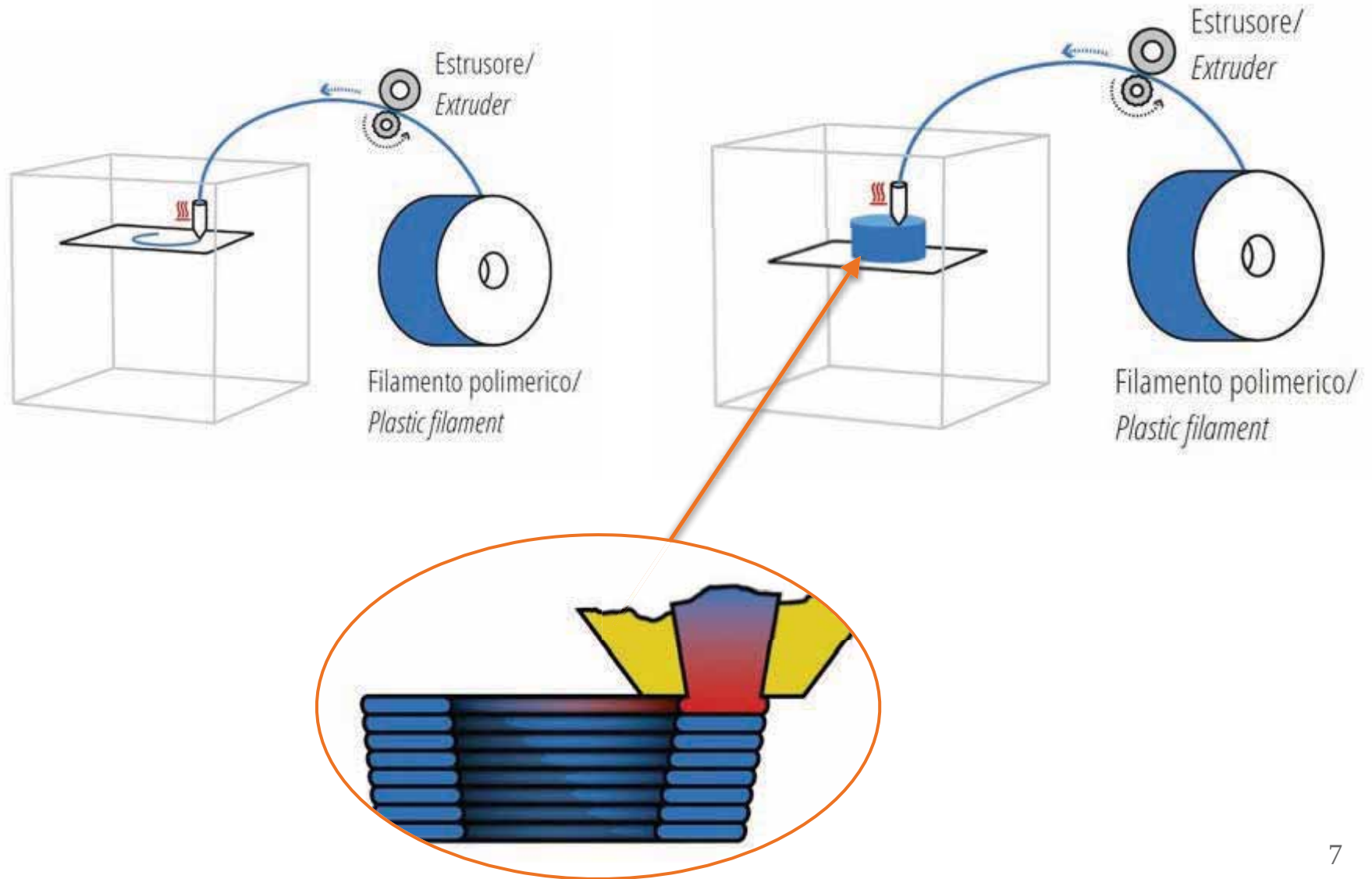
dal CAD alla macchina CNC layer by layer

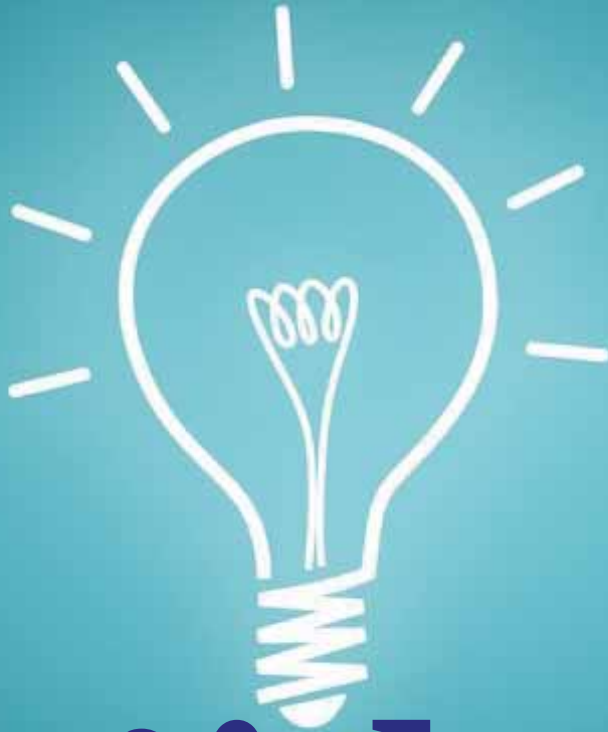


La manifattura additiva



layer by layer process





L'idea

L'idea

E' possibile ottenere materiali compositi da tecnologie additive?

FILAMENTI FIBRORINZORZATI VETRO/CARBONIO PER FDM

CARBON FIBER PEEK

CARBON FIBER NYLON

CARBON FIBER PLA

CARBON FIBER ABS

CARBON FIBER PETG

GLASS FIBER PETG

GLASS FIBER ABS

<http://www.3dxtech.com/carbon-fiber-filament/>
<http://zoltek.com/applications/3d-printing/>
<http://www.filoprint.it/>



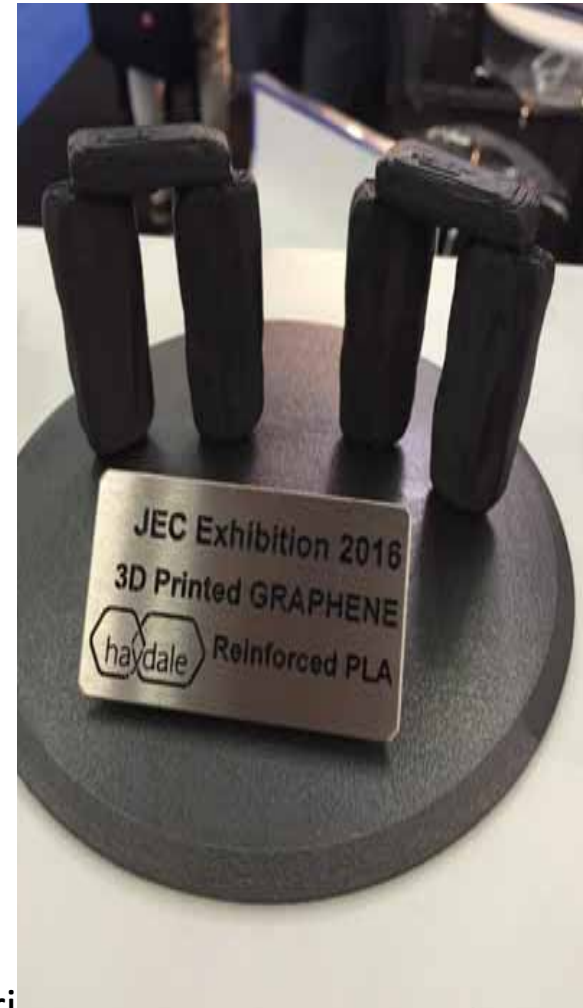
FILAMENTI CON RINFORZI SPECIALI PER FDM

GRAPHENE PLA

CNT'S ABS

CNT'S PETG

CNT'S PLA



<http://www.haydale.com>

<http://www.3dxtech.com/3dxnano-esd-abs-cnt-3d-printing-filaments/>

FILAMENTI CON RINFORZI NATURALI

BAMBOO FIBERS PLA FILAMENT

FLAX PLA FILAMENT

WOOD FIBERS PLA FILAMENT

HEMP FILAMENT



<http://colorfabb.com/bamboofill>

<http://www.nanovia-technologies.com/filaments.php>

<http://www.formfutura.com/175mm-wood-filament-laywoo-d3.html>

http://kanesis.eu/bio_plastic.html

BAAMCI

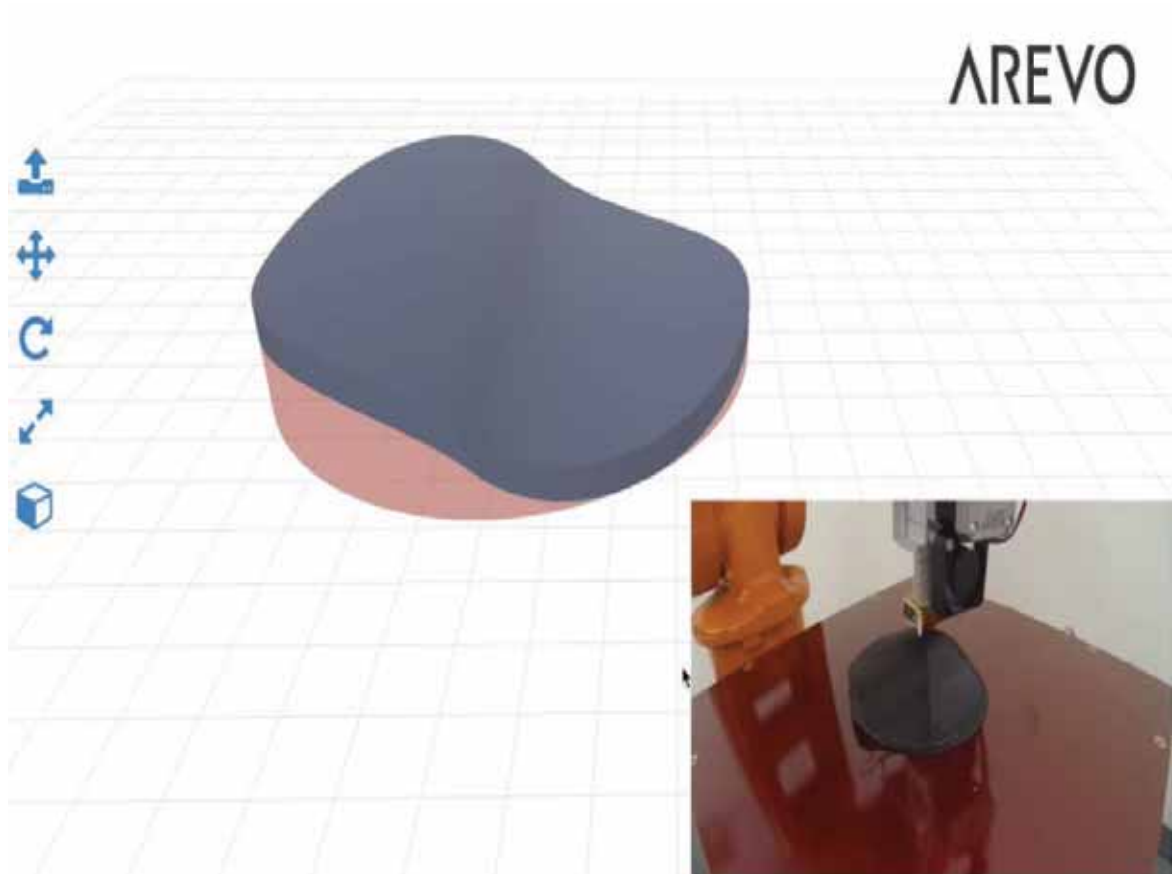
BIG AREA ADDITIVE MANUFACTURING 3D PRINTED SHELBY COBRA



<http://www.e-ci.com/baam/>

AREVOLABS

***SOFTWARE DI ANALISI FEM
ESTRUSIONE CON BRACCIO
ROBOTICO A 6 ASSI***



<http://arevolabs.com/>

COMPOSITI CON TECNOLOGIE POWDER BED

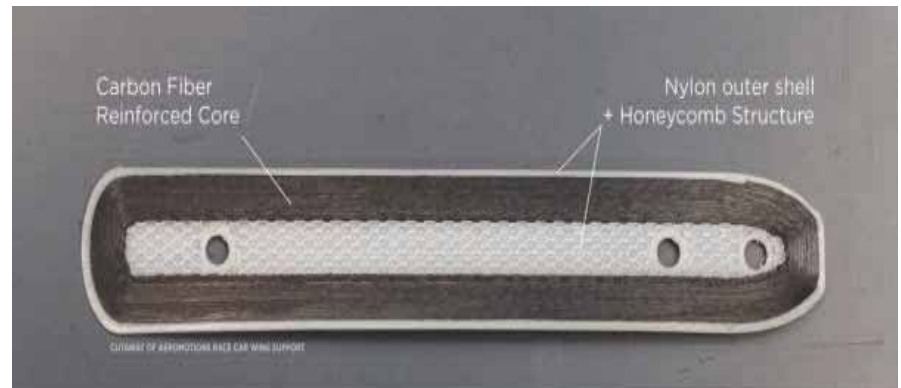
***SINTERIZZAZIONE
LASER SELETTIVA
MATRICE
TERMOPLASTICA
RINFORZI
PARTICELLARI
(CARBONIO, VETRO
E/O METALLI)***



<http://www.windform.it/documenti-per-download.html>

COMPOSITI A MATRICE TERMOPLASTICA E FIBRA LUNGA

CARBON FIBER NYLON
GLASS FIBER NYLON
KEVLAR FIBER NYLON



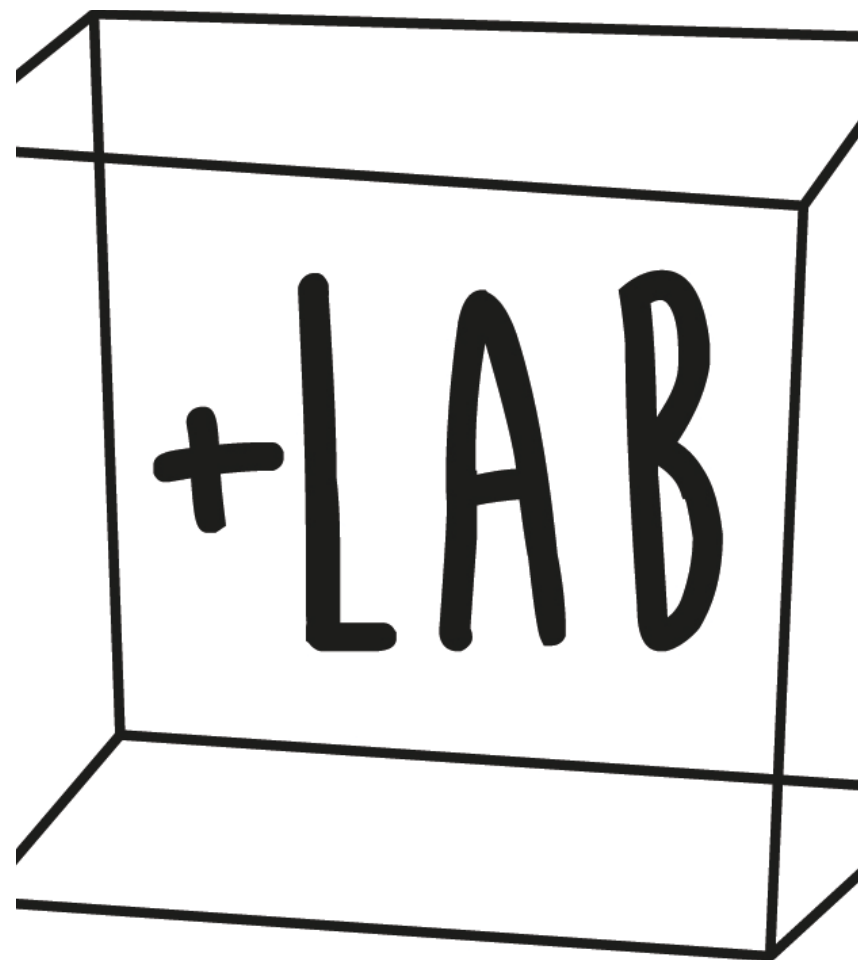
<https://markforged.com>

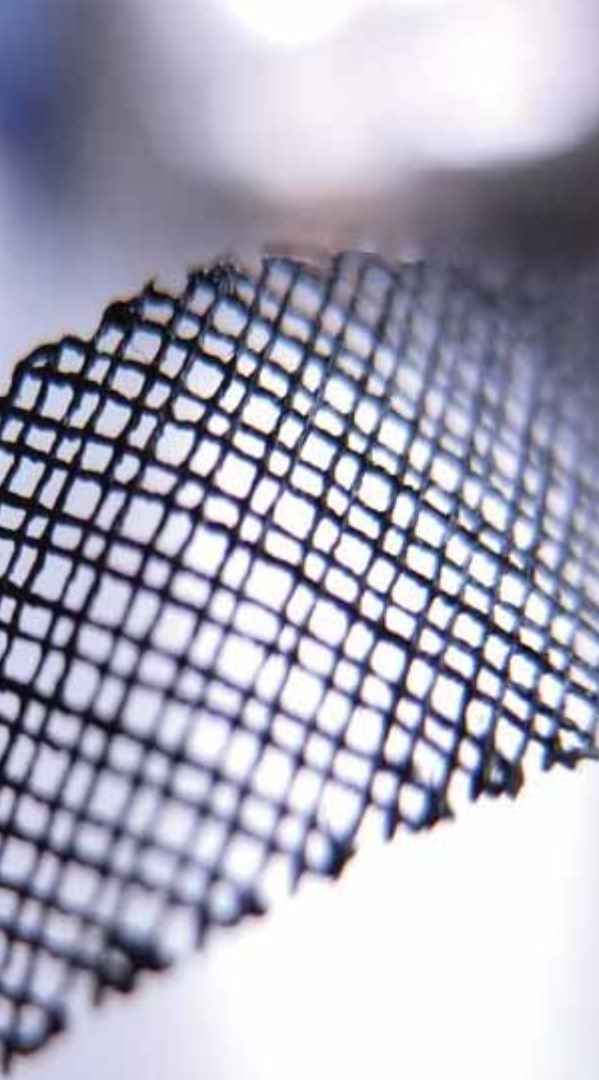
<http://anisoprint.ru/en/main-page/>

IDEAS 2 CYCLES

- STAMPARE IN 3D LO
STAMPO E
LAMINAZ
TRADIZIO



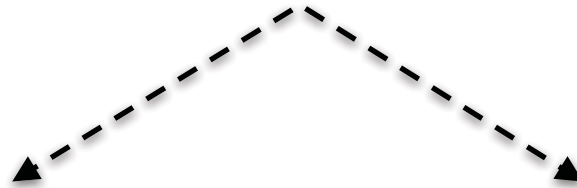




le 3 linee di ricerca

Quale matrice per la manifattura additiva di compositi

MATRICE

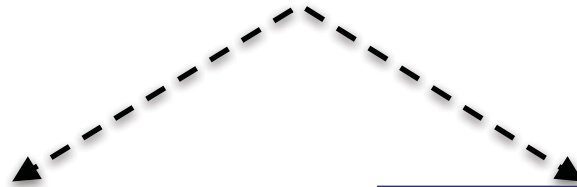


Matrice Termoplastica

Matrice Termoindurente

Quale matrice per la manifattura additiva di compositi

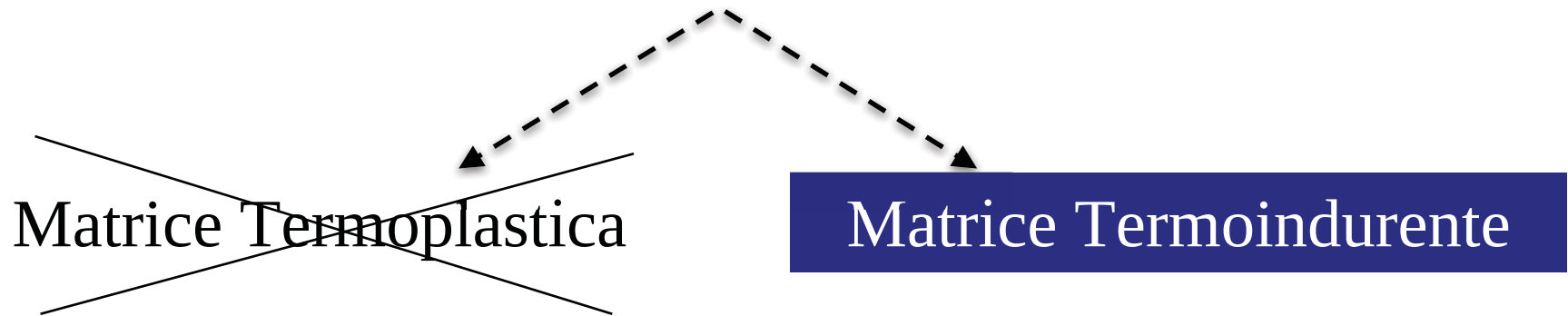
MATRICE



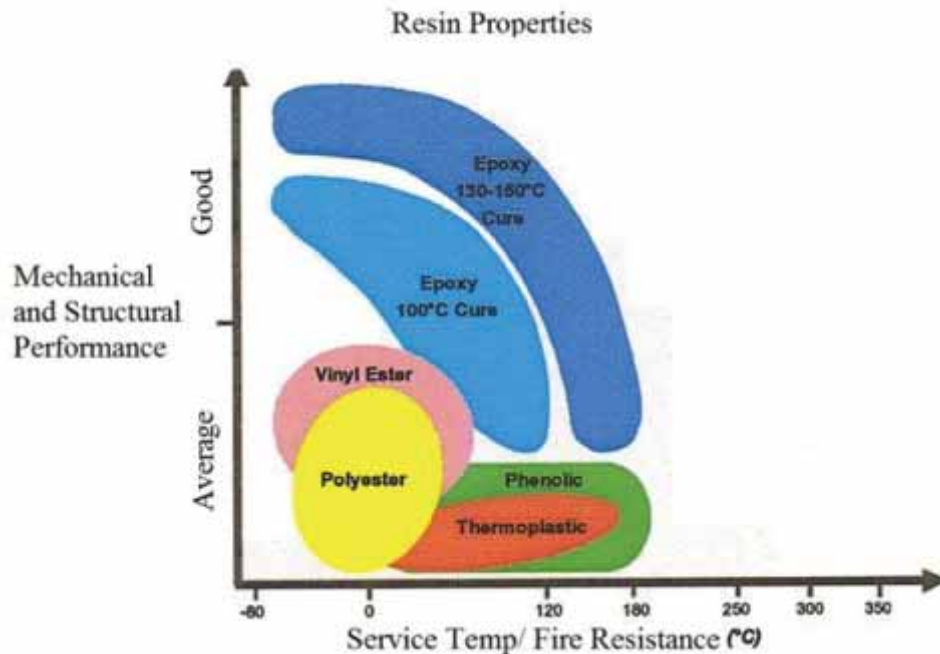
Matrice Termoplastica

Matrice Termoindurente

MATRICE Quale matrice per la manifattura additiva di compositi



L'importanza della matrice



ORTHOTIC COMPOSITES

Matrice Termoindurente

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

L'importanza della matrice

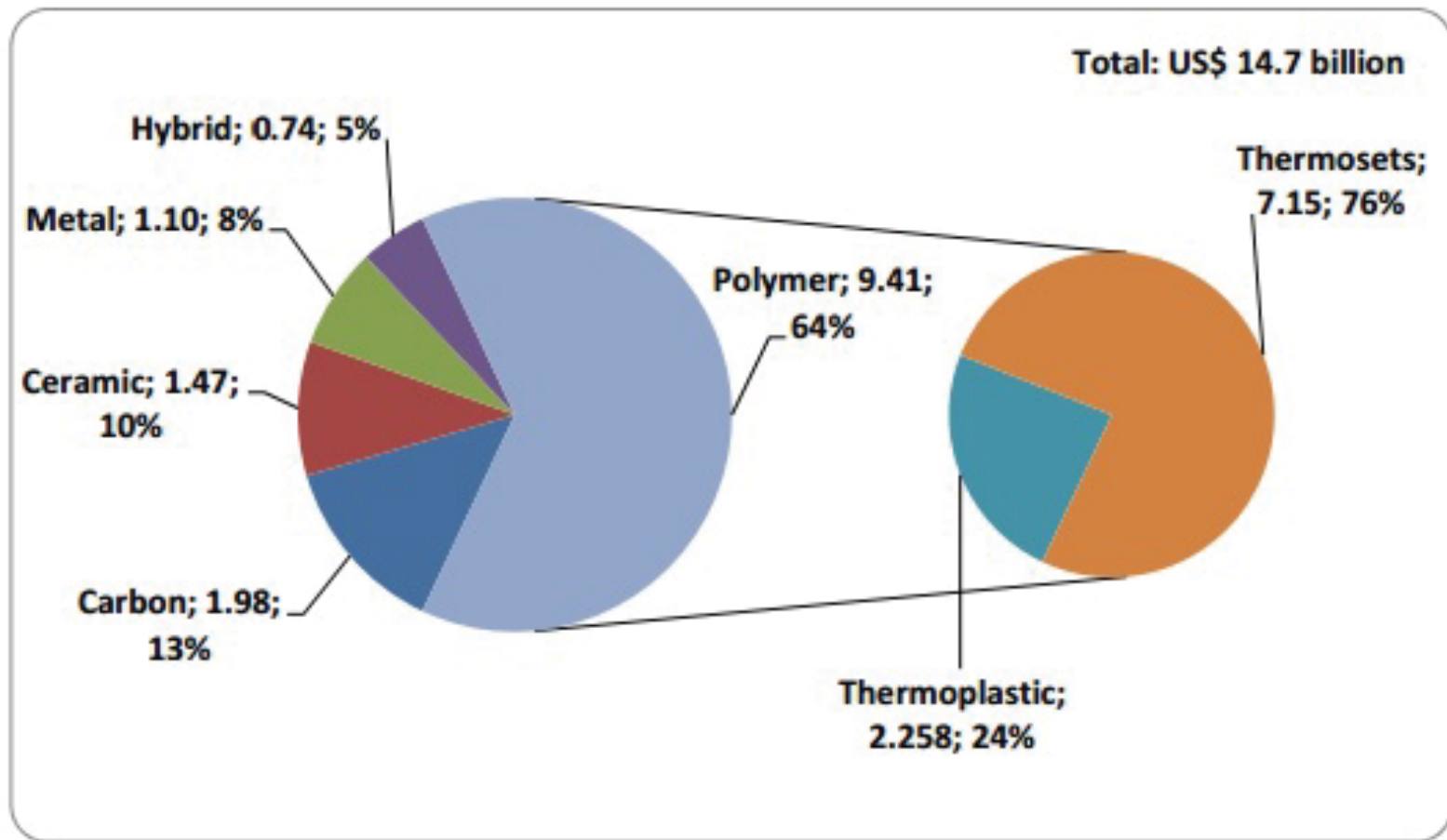
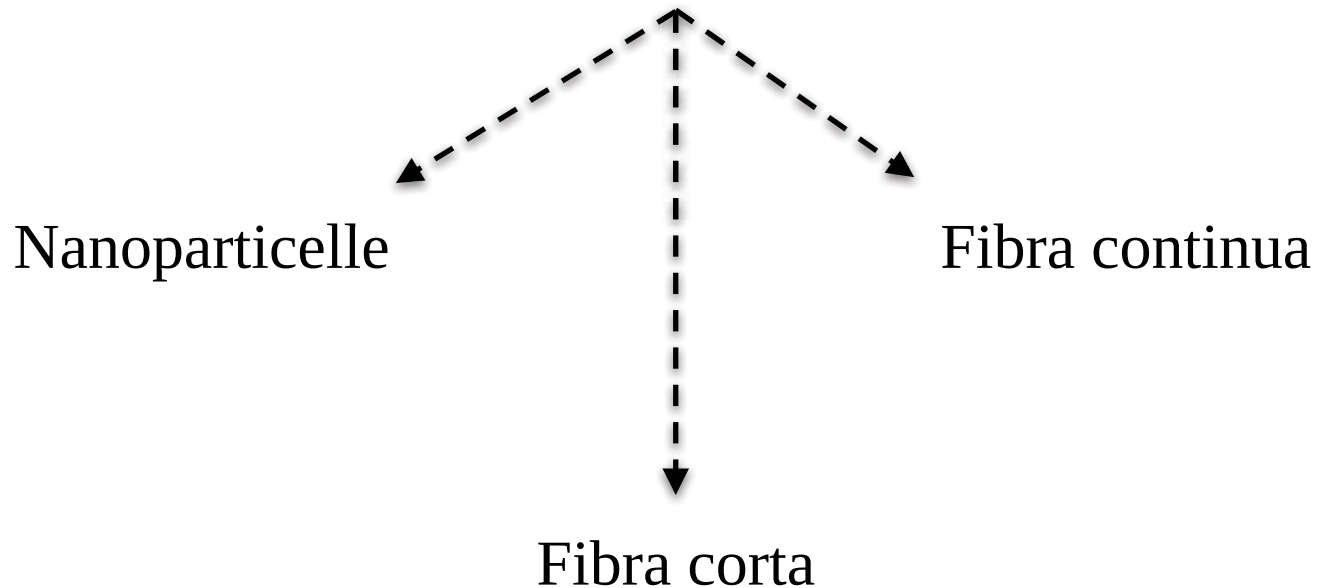


Fig. 7: Carbon composite revenues in US\$ billion by matrix material (2013). [2]

MATERIALI COMPOSITI a matrice termoisolante

3 linee di ricerca



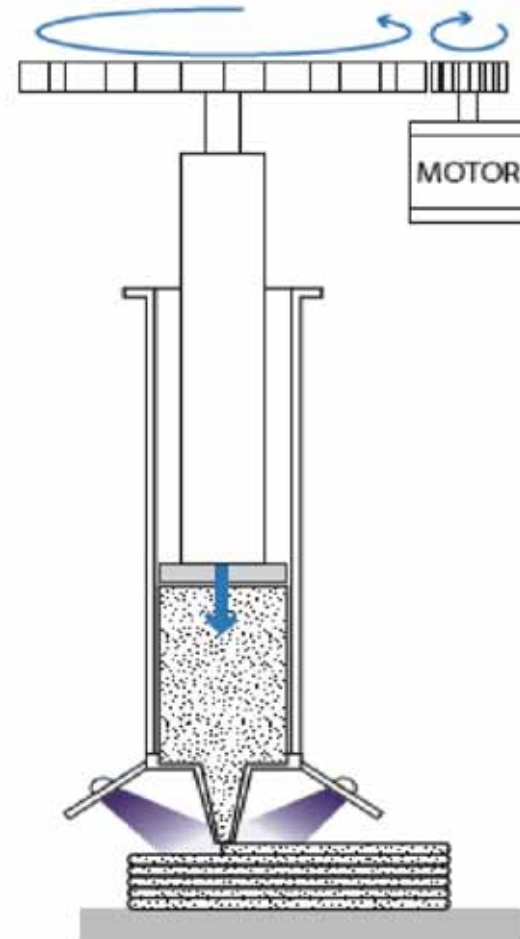


compositi a fibra corta e nanocompositi...

Liquid Deposition Modelling

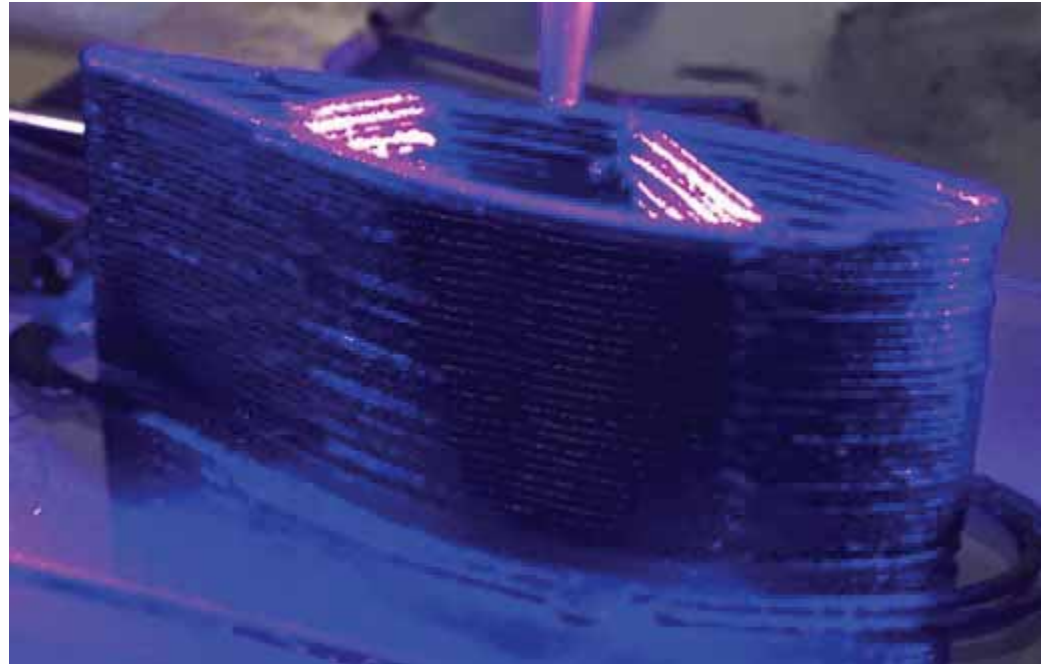
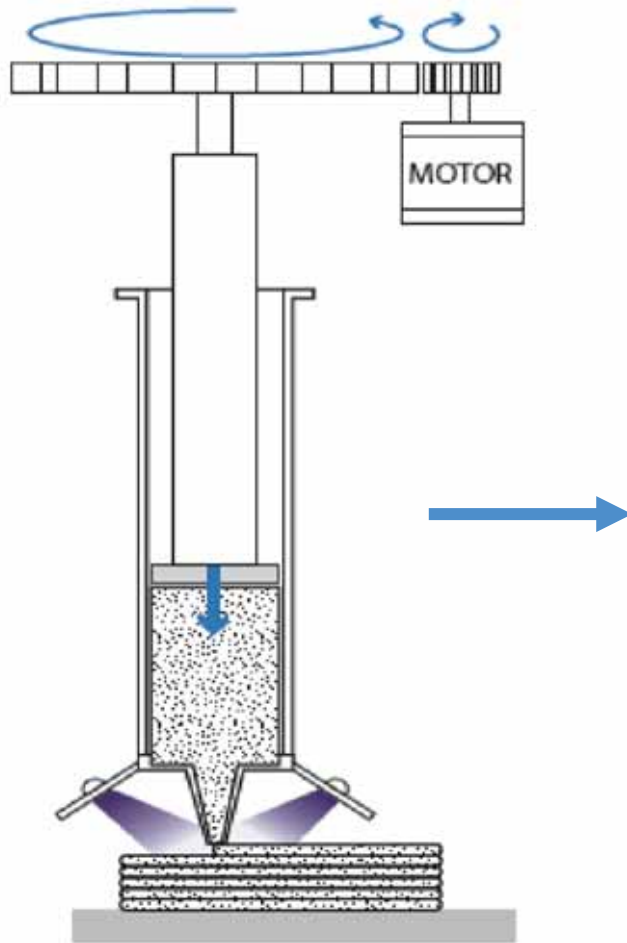
LDM

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

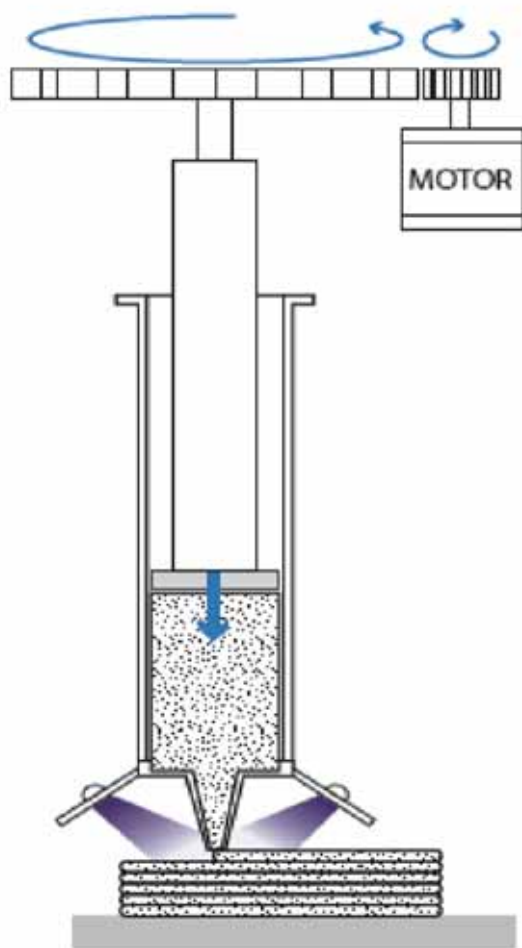


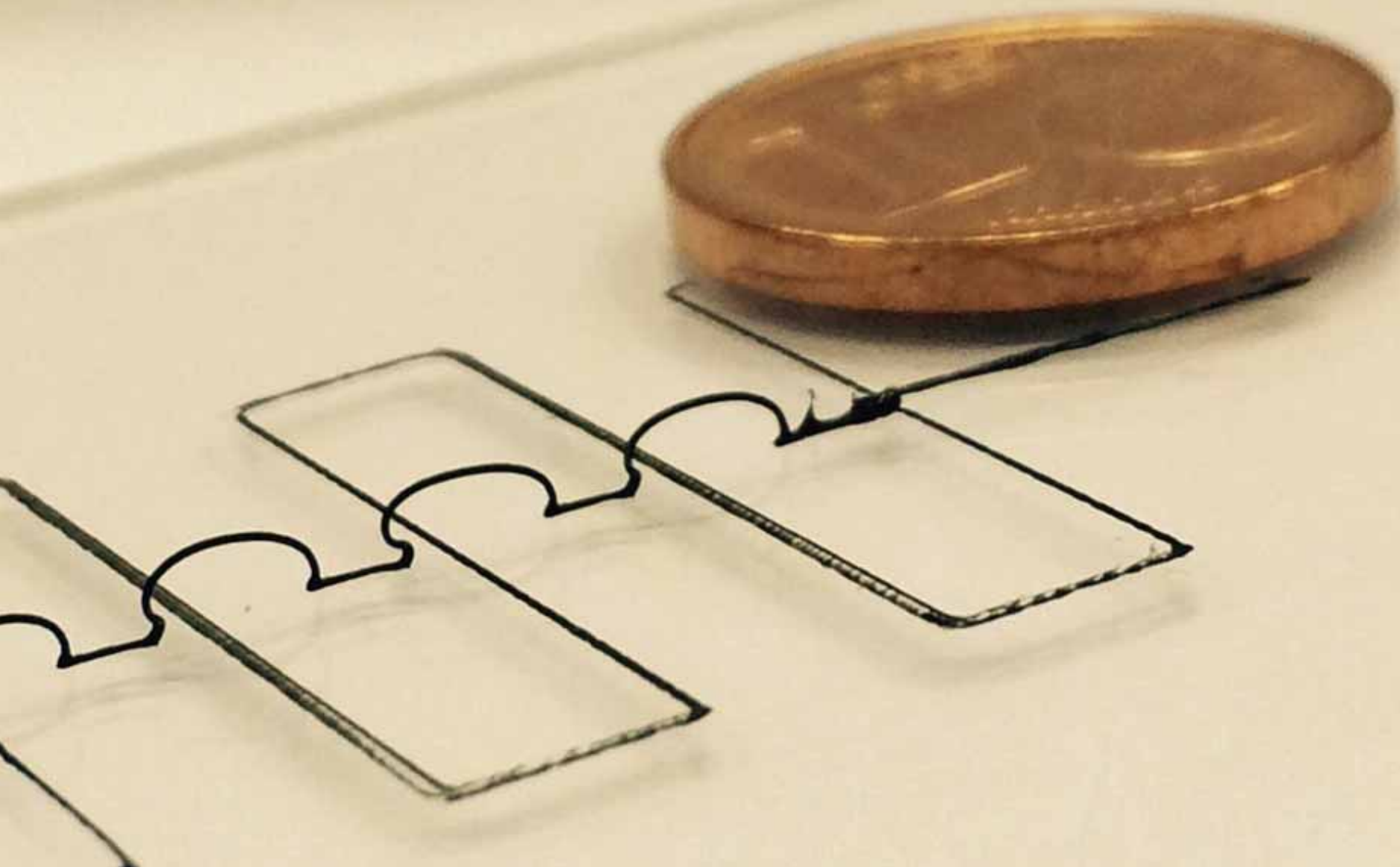
Liquid Deposition Modelling

LDM



Estrusore a siringa / Estrusore a vite senza fine LDM



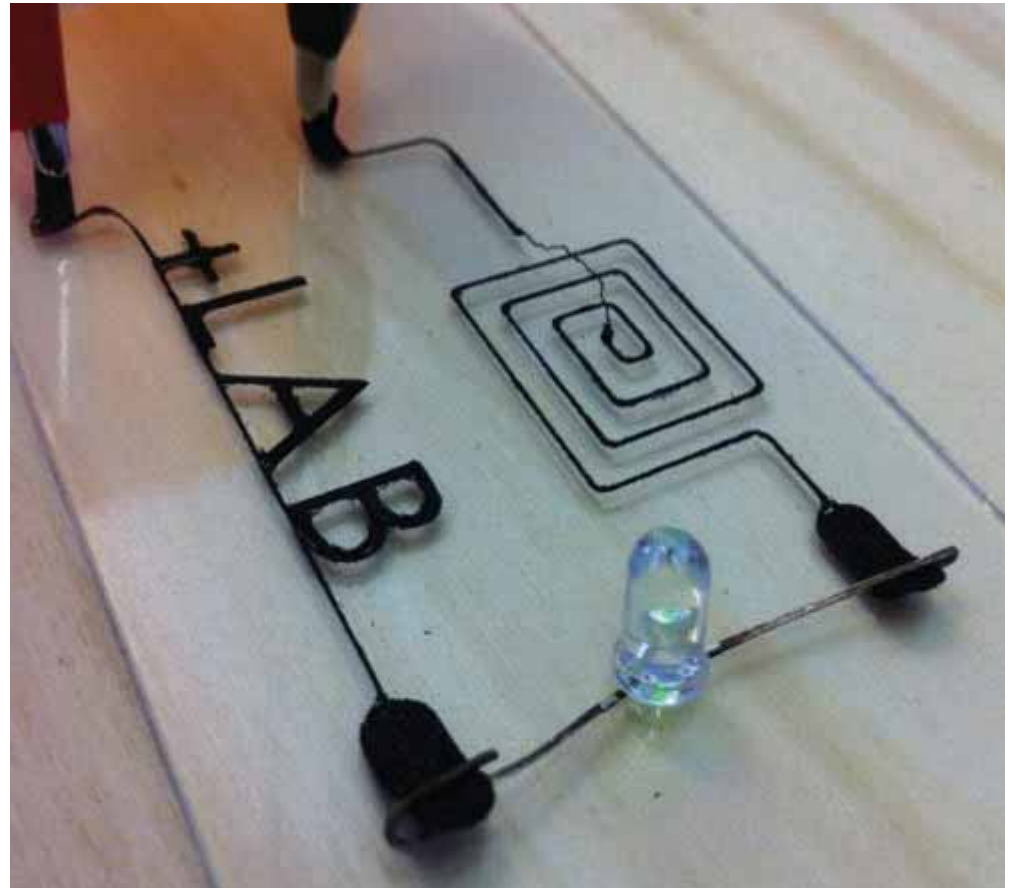


nanocompositi conduttivi a base di nanotubi di carbonio

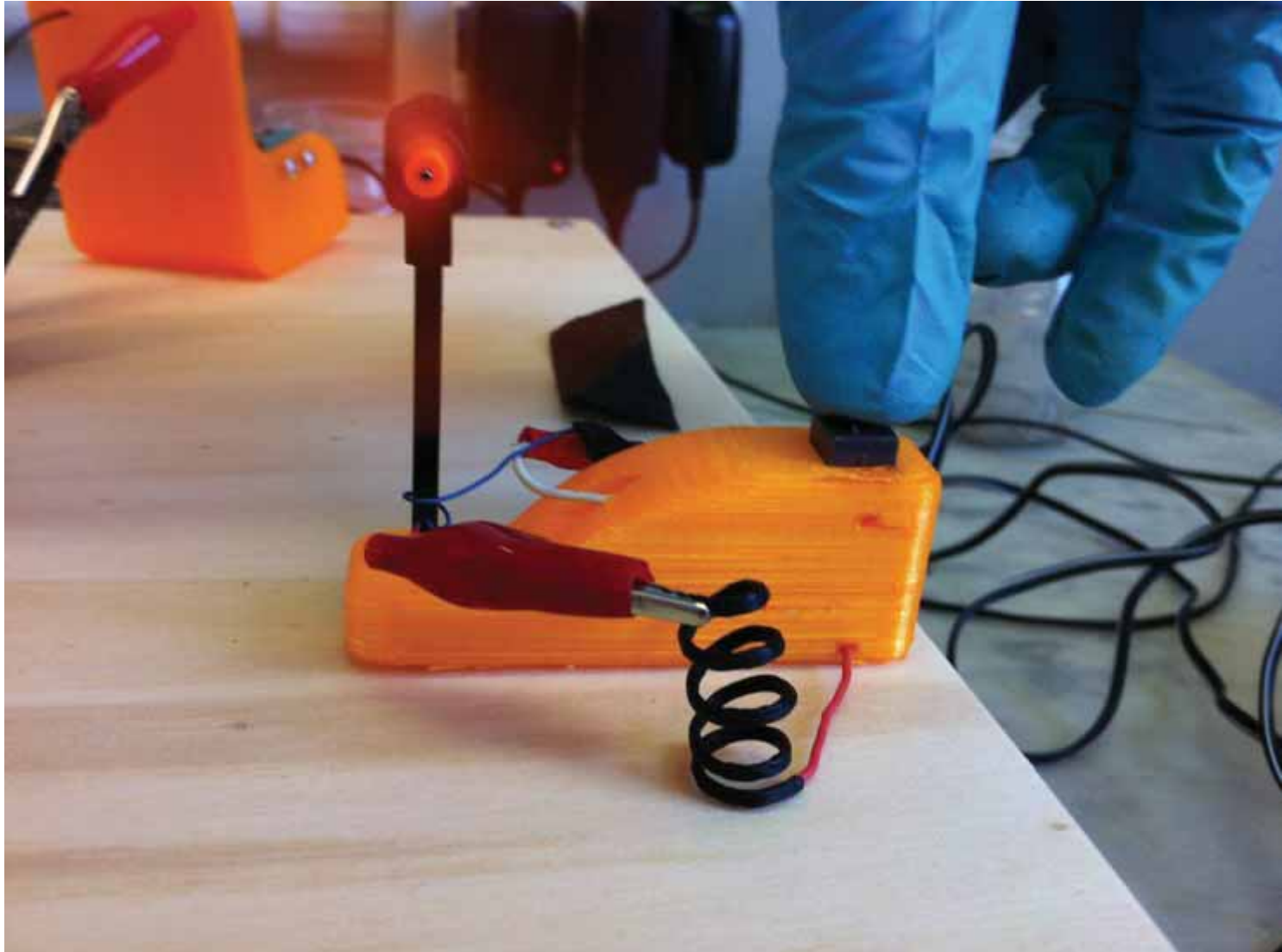
Nanotubi di Carbonio

Grafene

- proprietà meccaniche
- conducibilità elettrica
- conducibilità termica



nanocompositi conduttivi





Compositi a fibra corta..

compositi a fibra corta

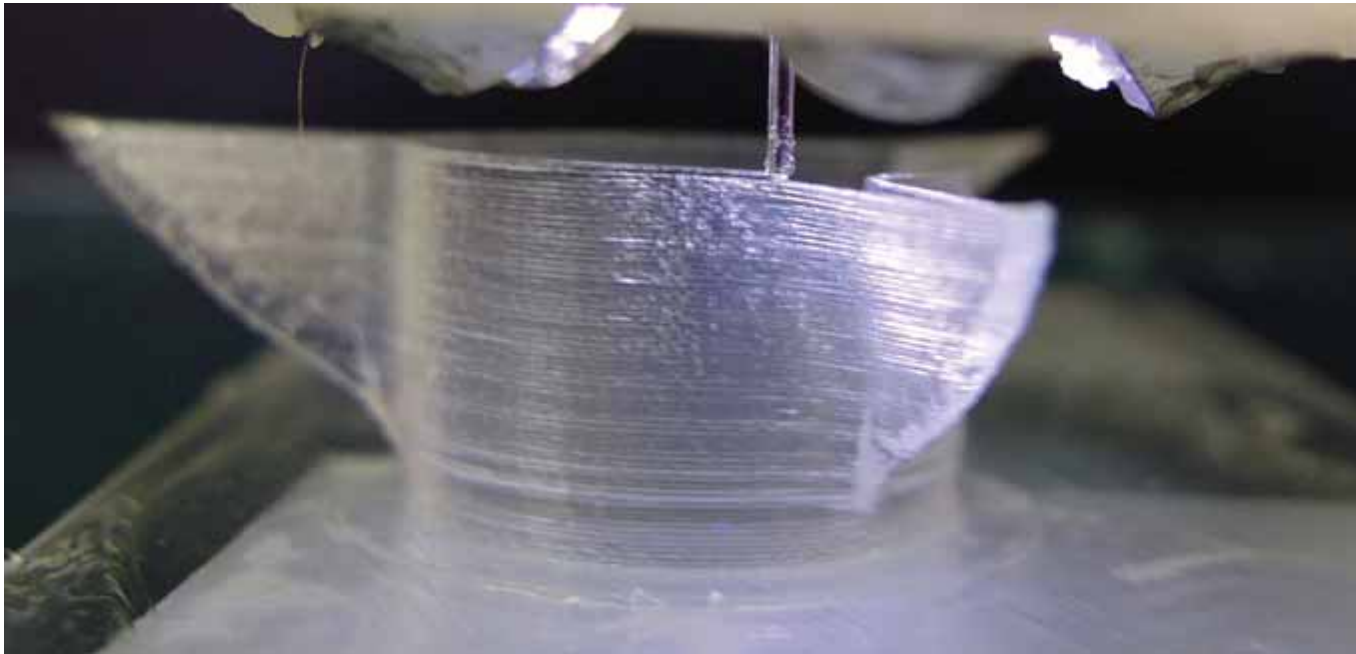
Matrice

- Epossidica
- Acrilica
- Poliuretana
- Poliestere

+

Fibre

- Carbonio
- Vetro
- Kevlar
- Fibre naturali



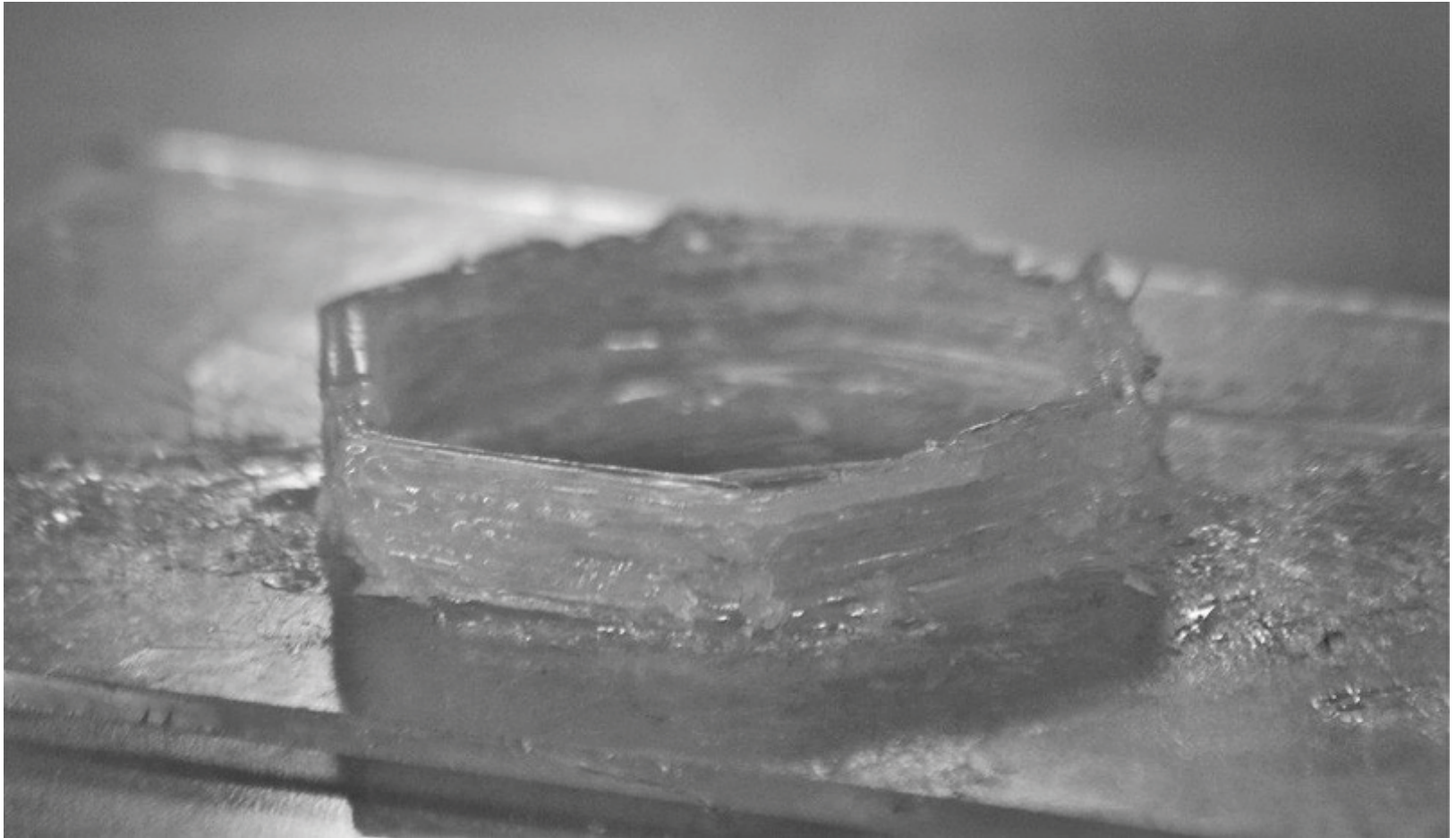
Compositi a fibra corta





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

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



A photograph of a conical structure made of continuous fibers, possibly a composite material. The structure is light-colored, with a visible texture of fine, parallel fibers. It has a wide base and tapers to a narrow neck at the top. The structure is standing on a flat, light-colored surface. The background is a plain, light-colored wall.

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

Fig.1

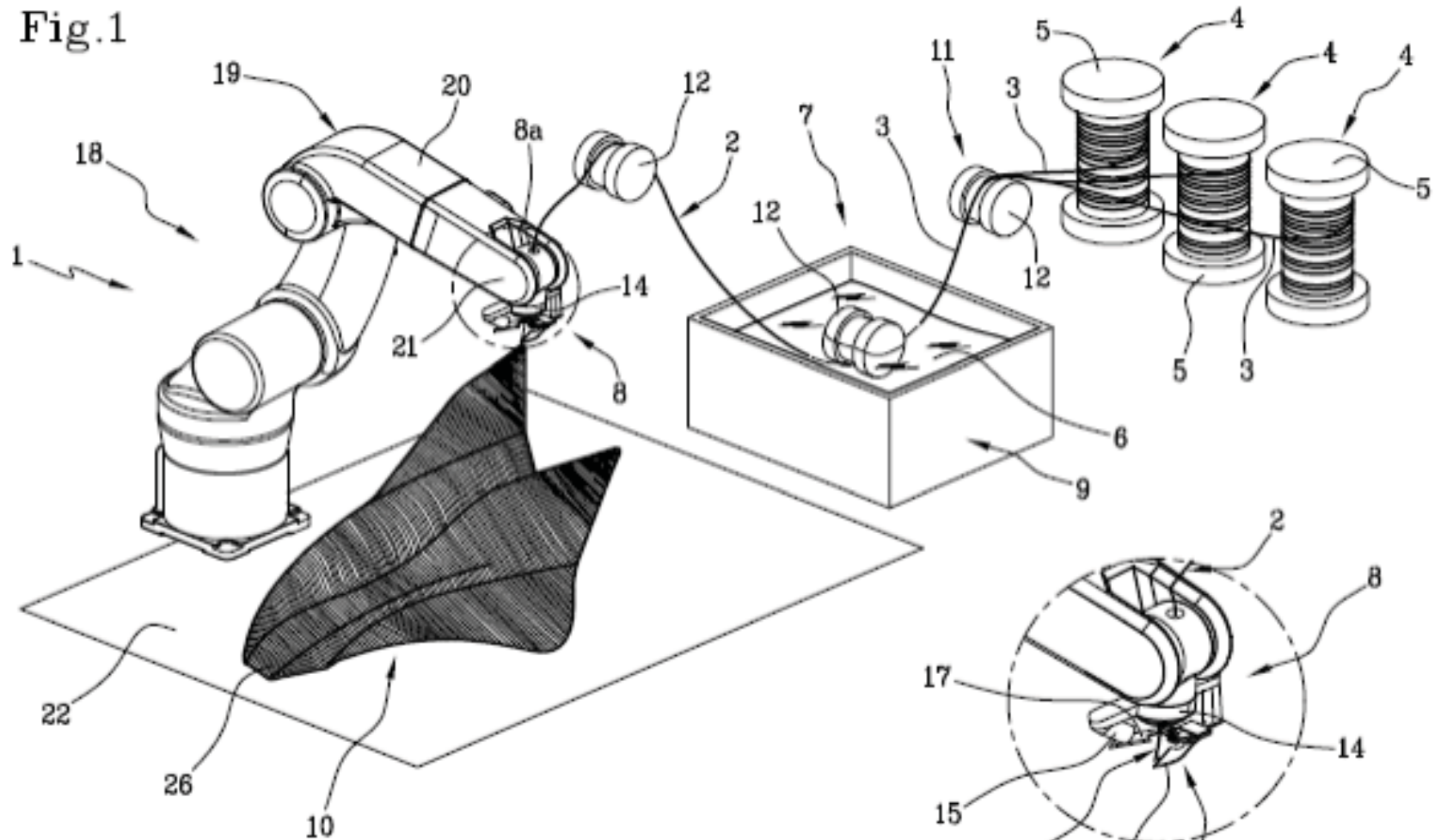
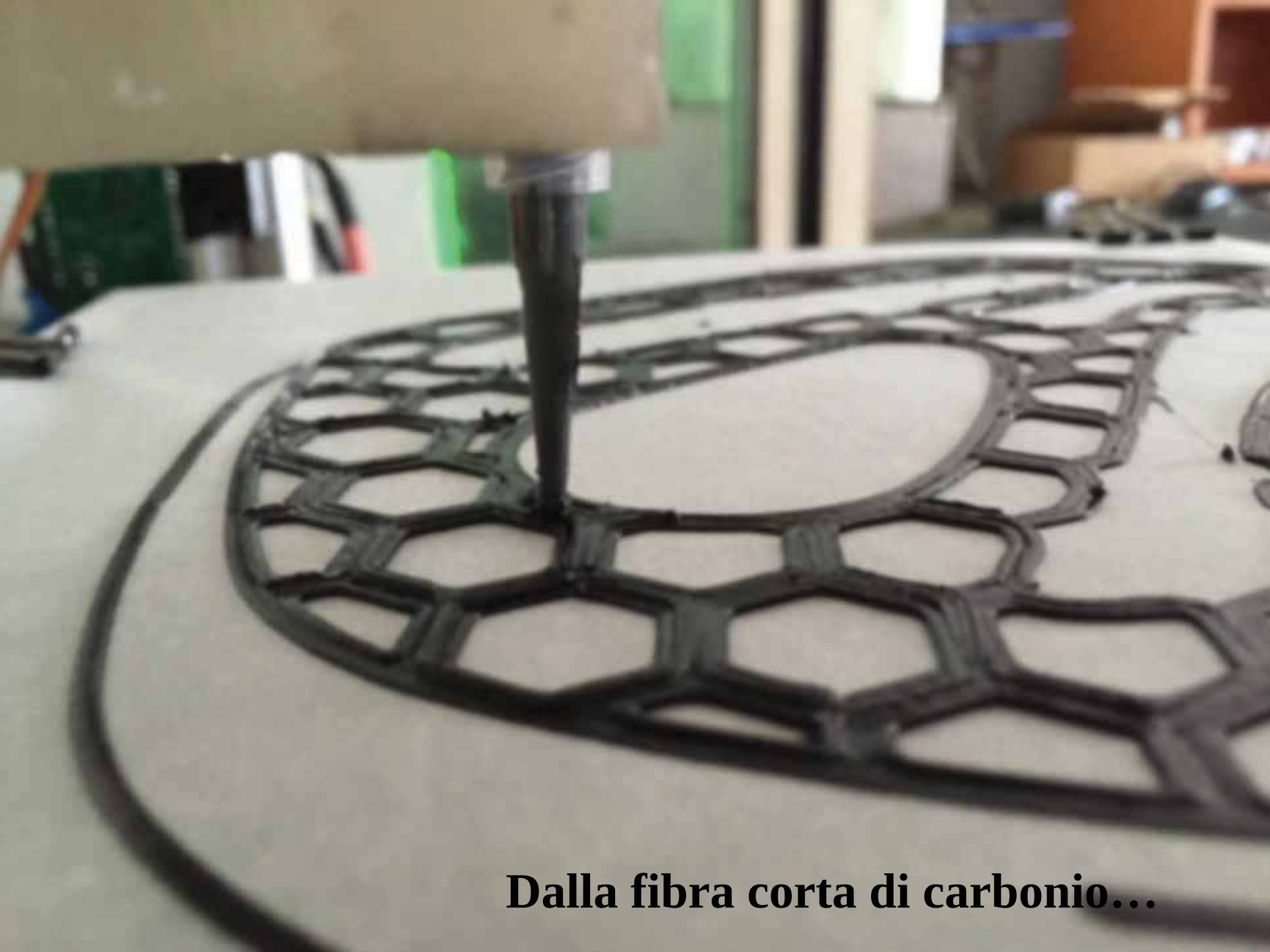


Fig.1a

Il prototipo





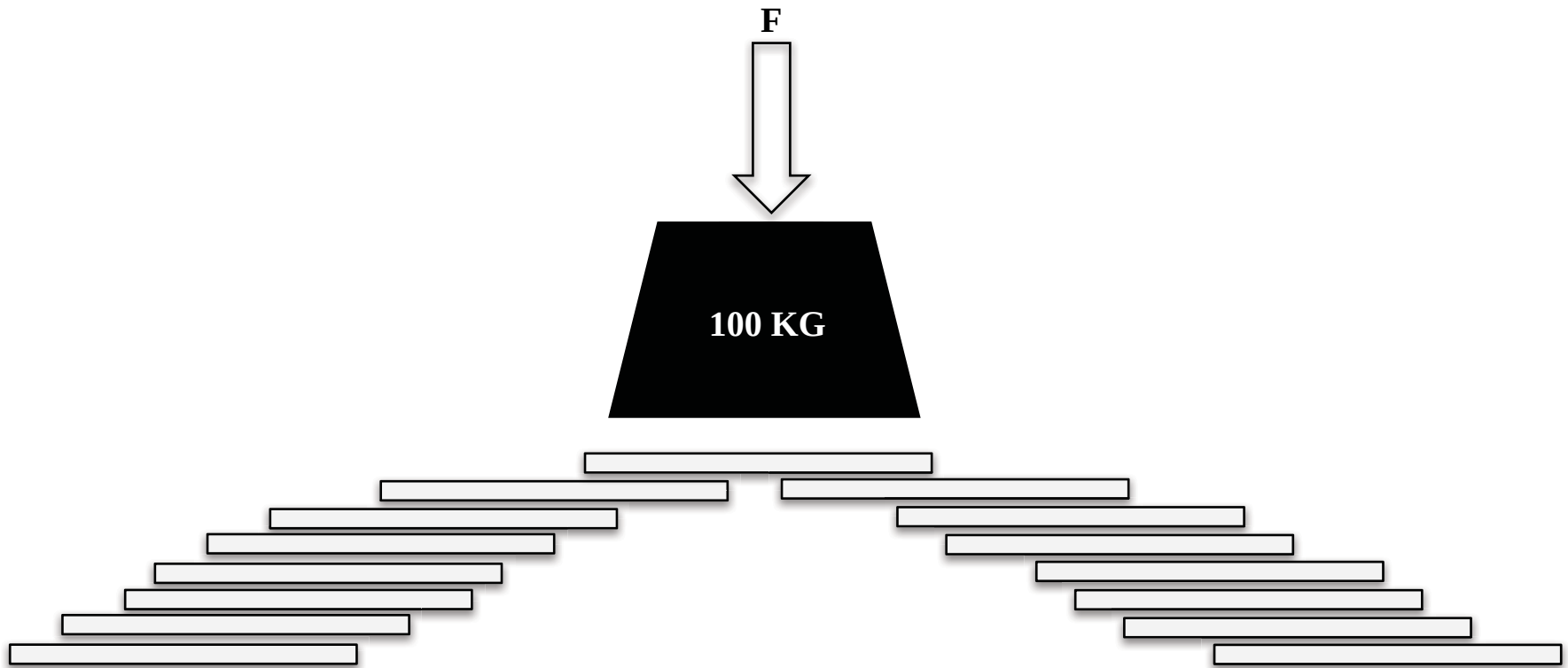
Dalla fibra corta di carbonio...



Alla fibra lunga mista di vetro e carbonio....

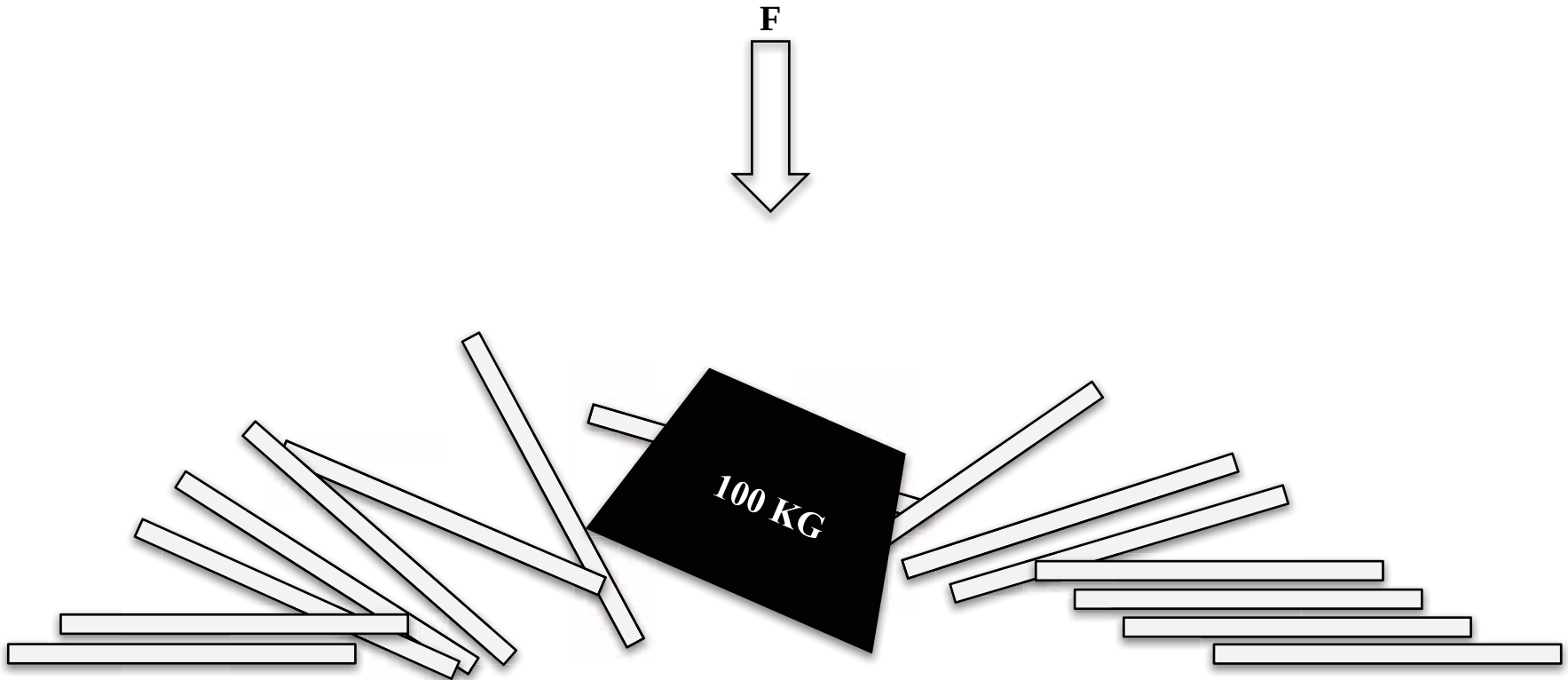
La stampa 3d layer by layer sfrutta un sistema di deposizione di materiale a strati paralleli alla superficie di costruzione.

linear slicing vs smart slicing



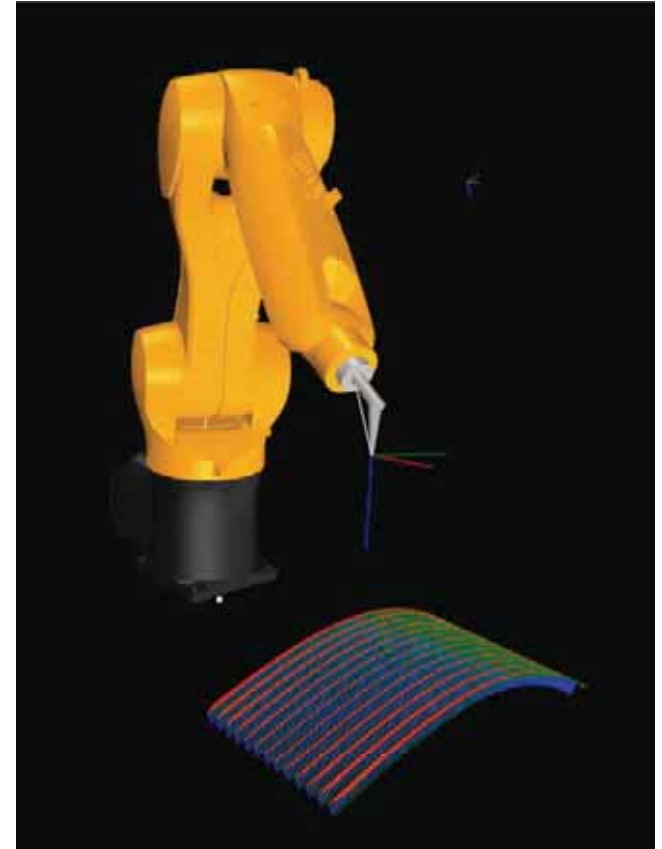
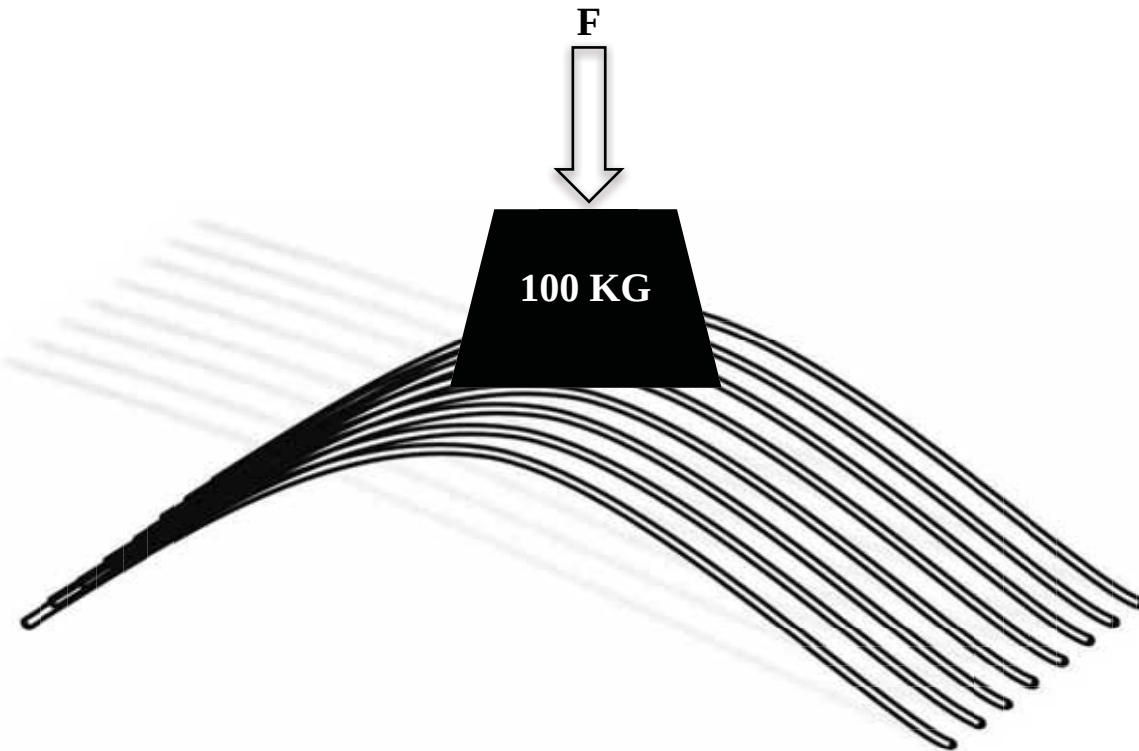
**Un sistema di deposizione tradizionale
non è ottimizzato per aumentare le proprietà meccaniche.**

linear slicing



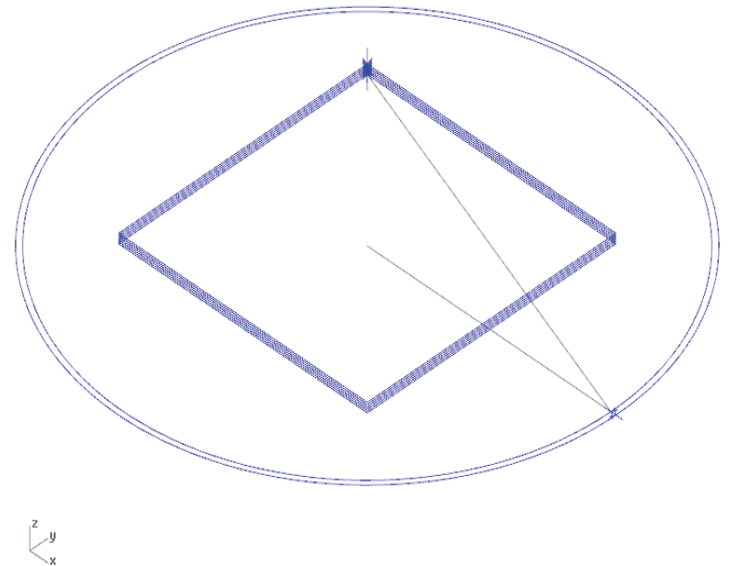
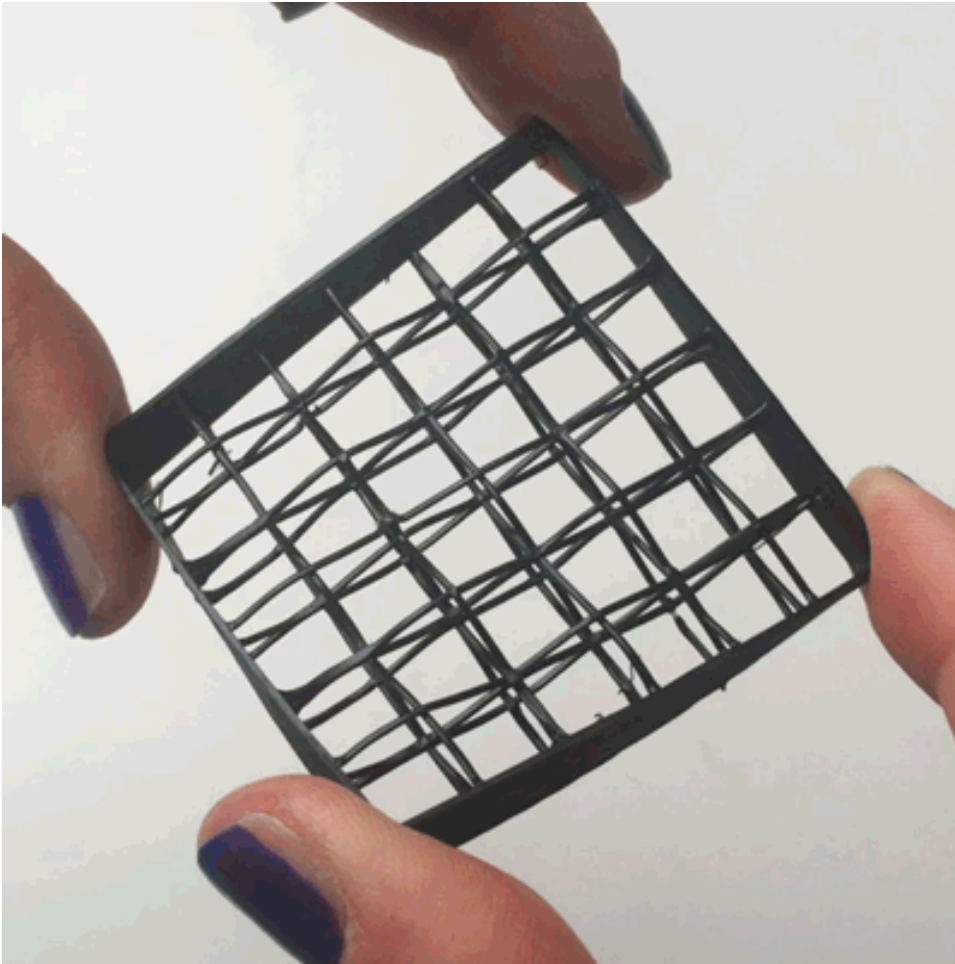
Uno slicing intelligente permette di orientare le fibre in funzione del carico partendo dal FEM.

smart slicing



smart slicing

Deposizione superficiale e infil



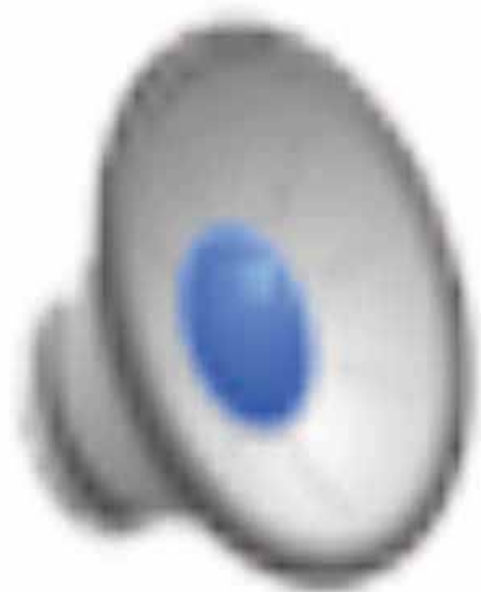
Test fibre di vetro + resina acrilica, peso 88 gr.

smart slicin

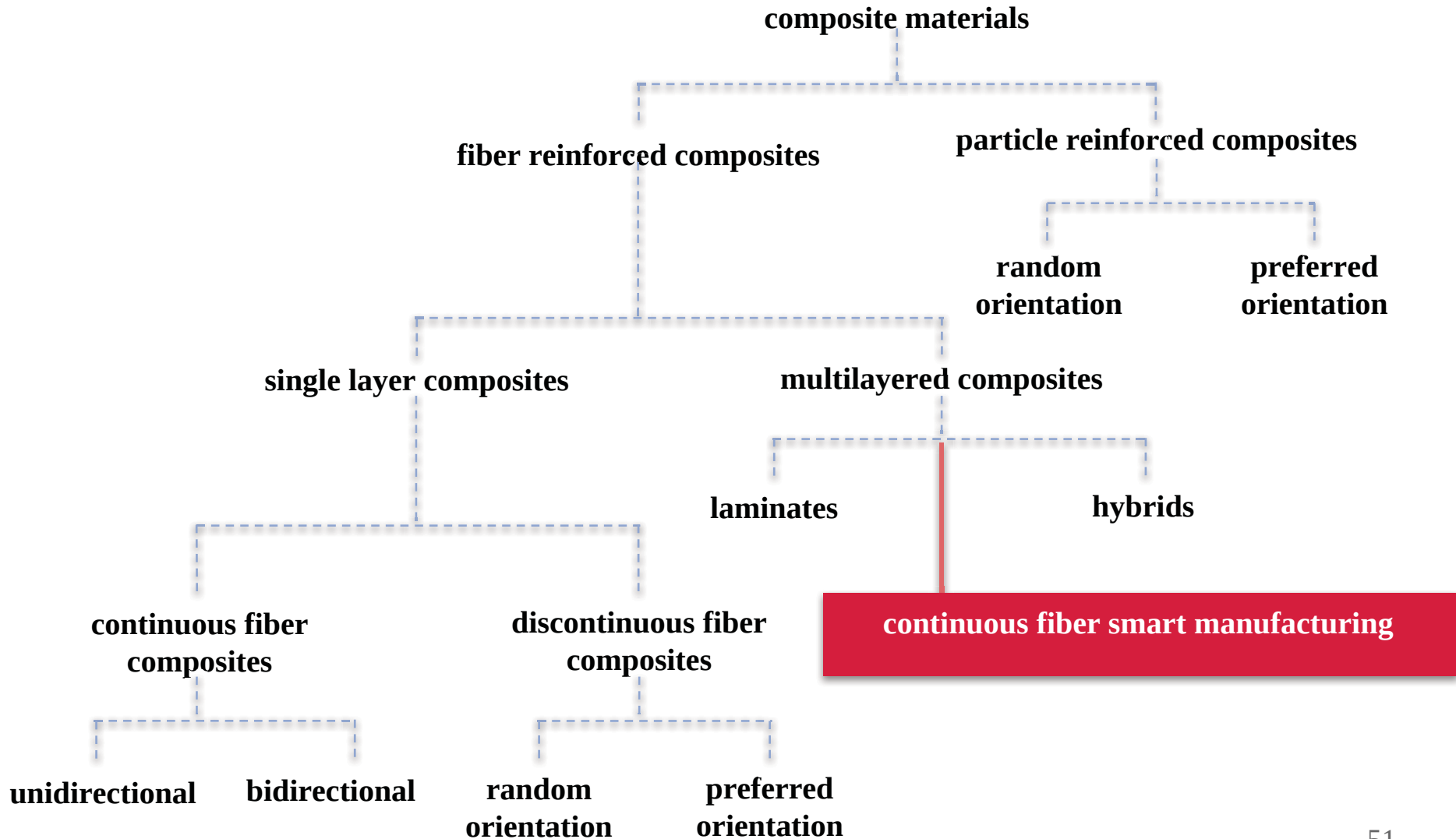




dov'è la novelty?



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



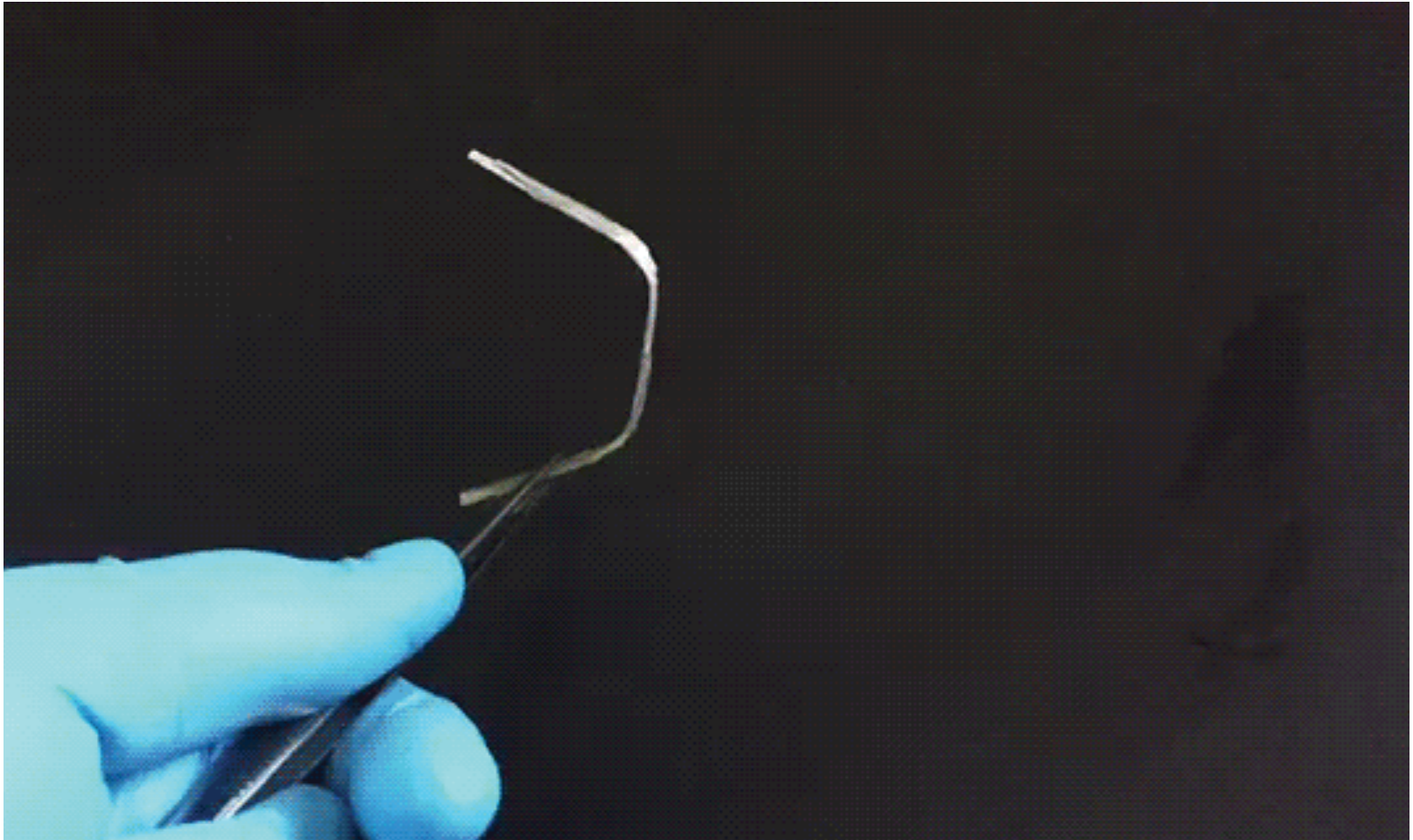
Dall'idea al prodotto in breve tempo.

velocità di produzione



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

Strutture adattive e materiali intelligenti



Cosa dice il mercato.

il mondo della stampa 3d di compositi

With \$1.1 million in bank, MarkForged prepares to deliver first-of-its-kind 3D printer
The Boston Globe 03/07/2014

New startup raised \$2.8 million for developing a reinforced composite 3D printer
www.3ders.org 16/12/2014

Why Ford is partnering with a hot 3D printing startup
Fortune 23/06/2015

South Korea to set up \$20M research project for 3D printed ship development in Ulsan
www.3ders.org 27/04/2016

ENVISIONTEC REVEALS SLCOM 1 FOR 3D PRINTING COMPETITION AT RAPID 2016
TCT Magazine 17/05/2016

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

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

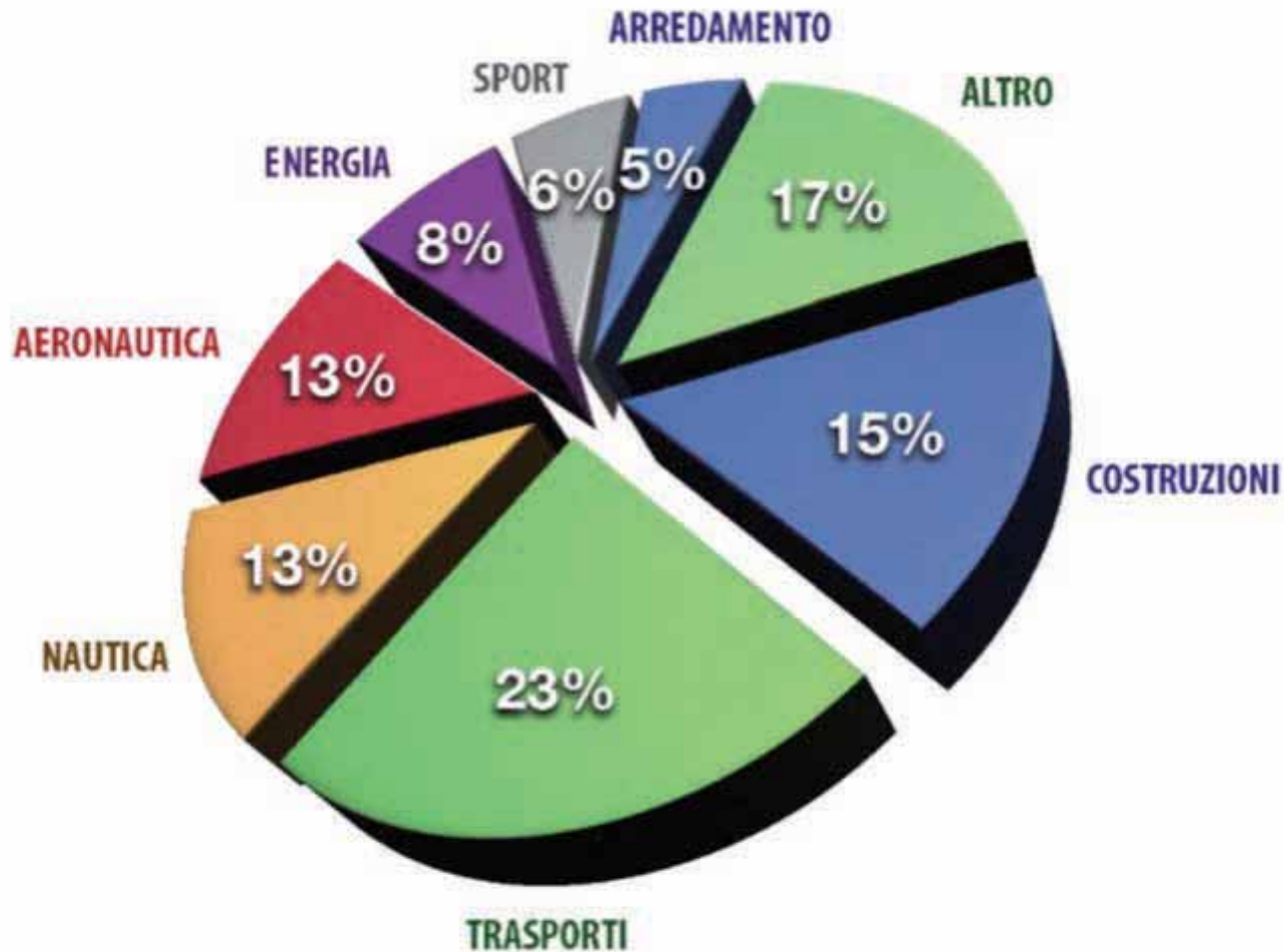
 **AREVO announces \$7M series A funding round led by Khosla Ventures**



dov'è il goal?

Un grande mercato potenziale

Settori applicativi dei compositi in Italia
SETTORI APPLICATIVI DEI COMPOSITI IN ITALIA



I GOL

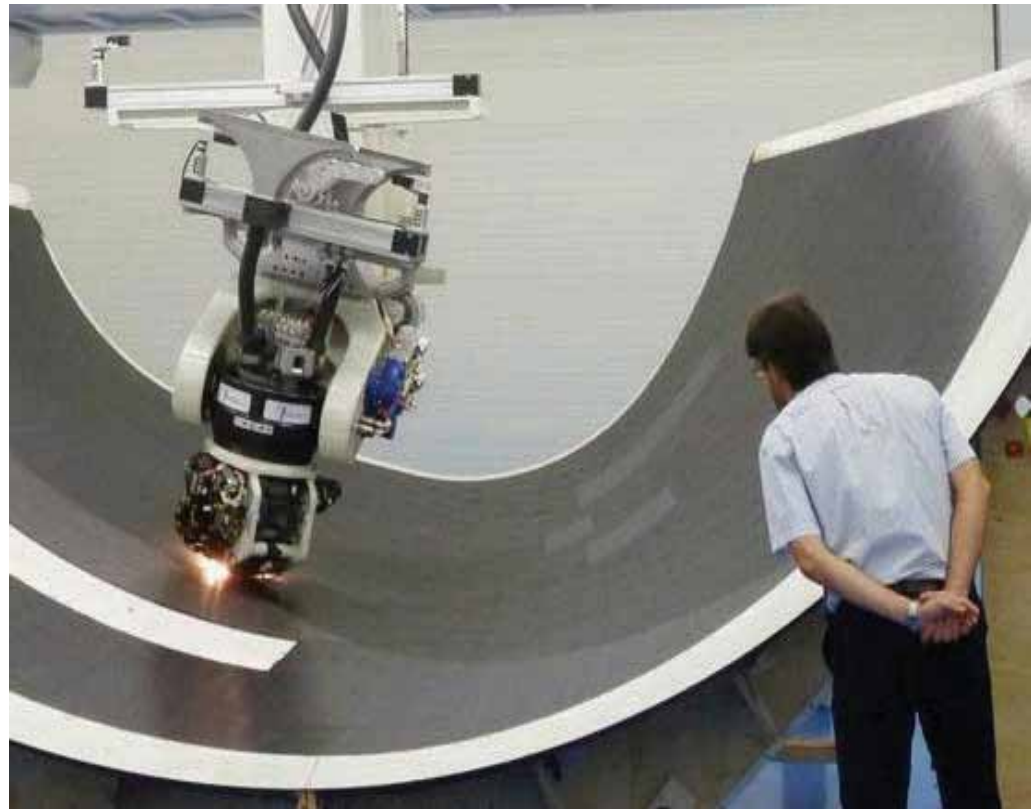
**Elevate Prestazioni
Grandi Dimensioni**



**ALTO VALORE
AGGIUNTO**

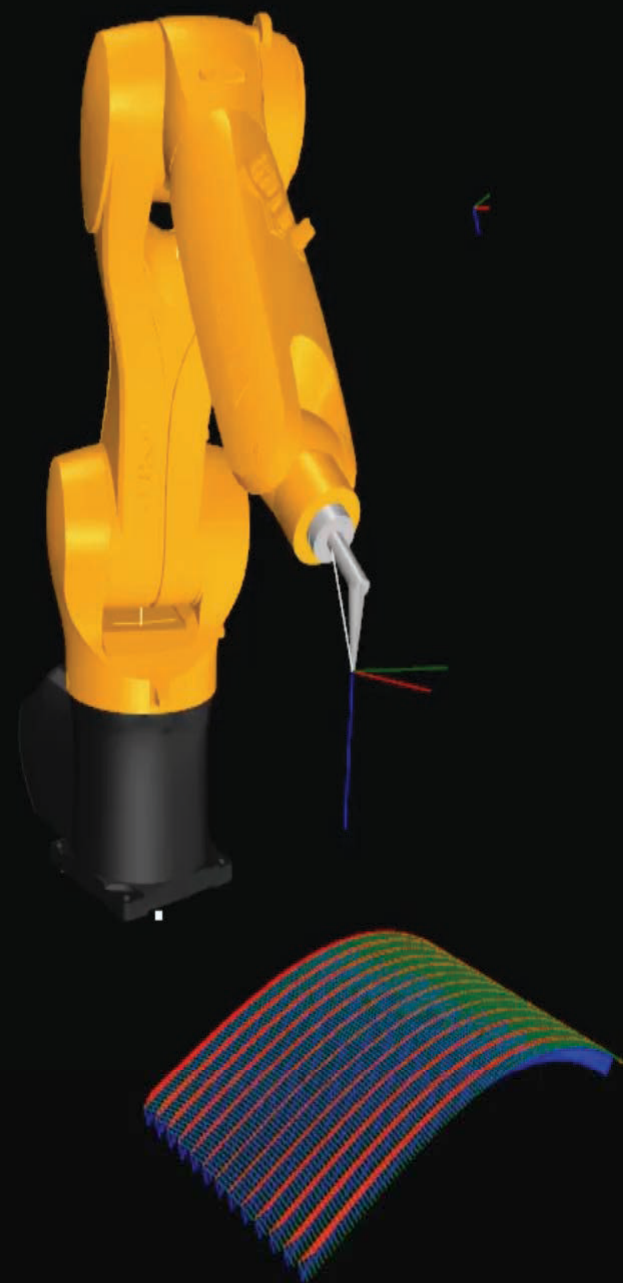
Adattare la tecnologia CFSM ad una macchina di grandi dimensioni simile a quelle utilizzate nei sistemi di Fiber Placement Manufacturing.

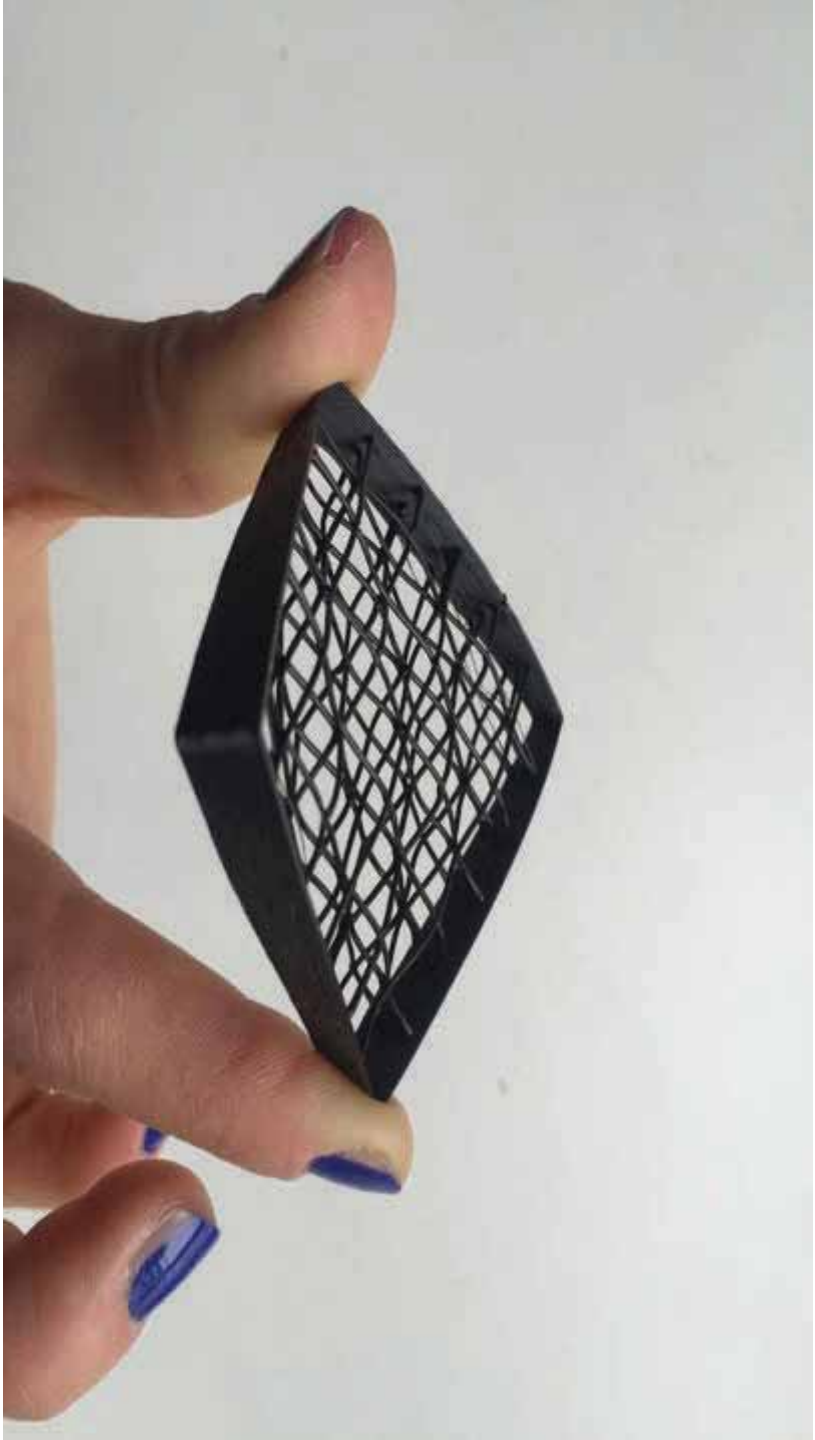
GRANDI MACCHINE

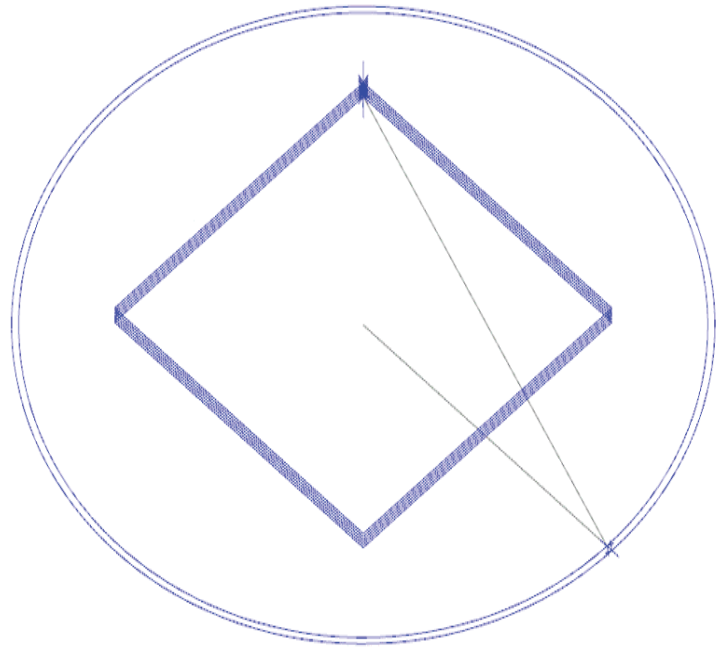
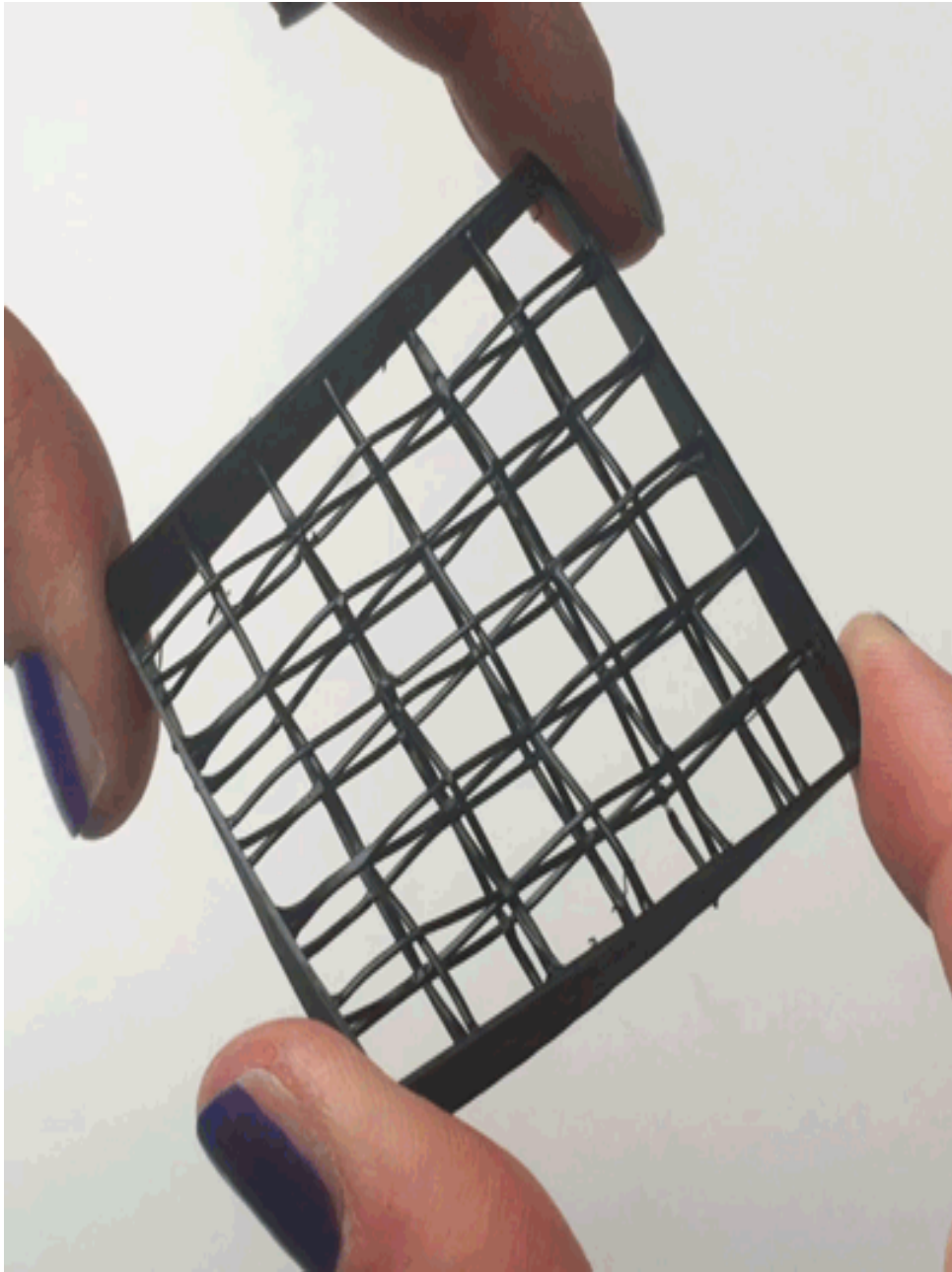


**Andare oltre i 3 assi...
l'incontro con la robotica.**







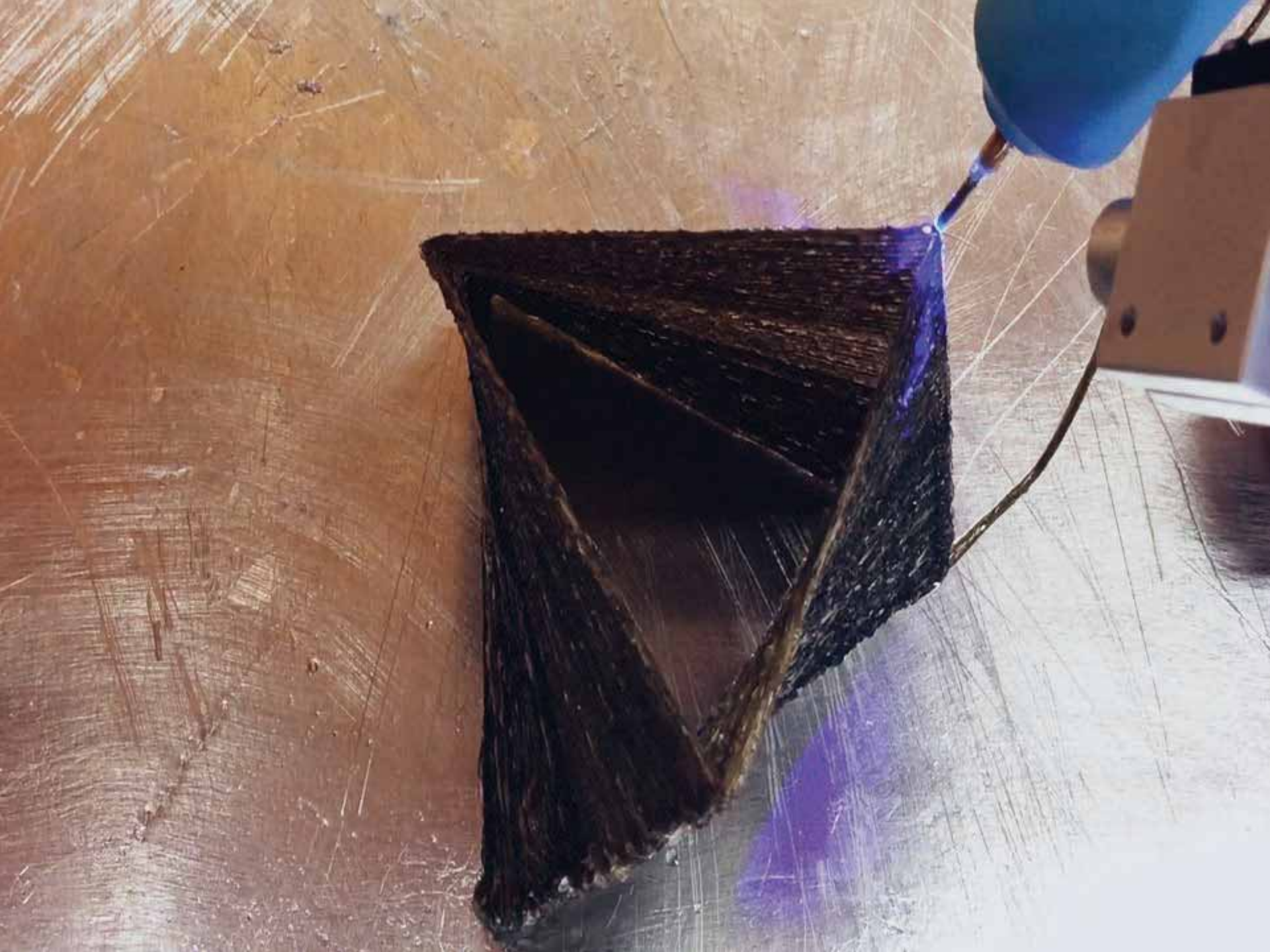


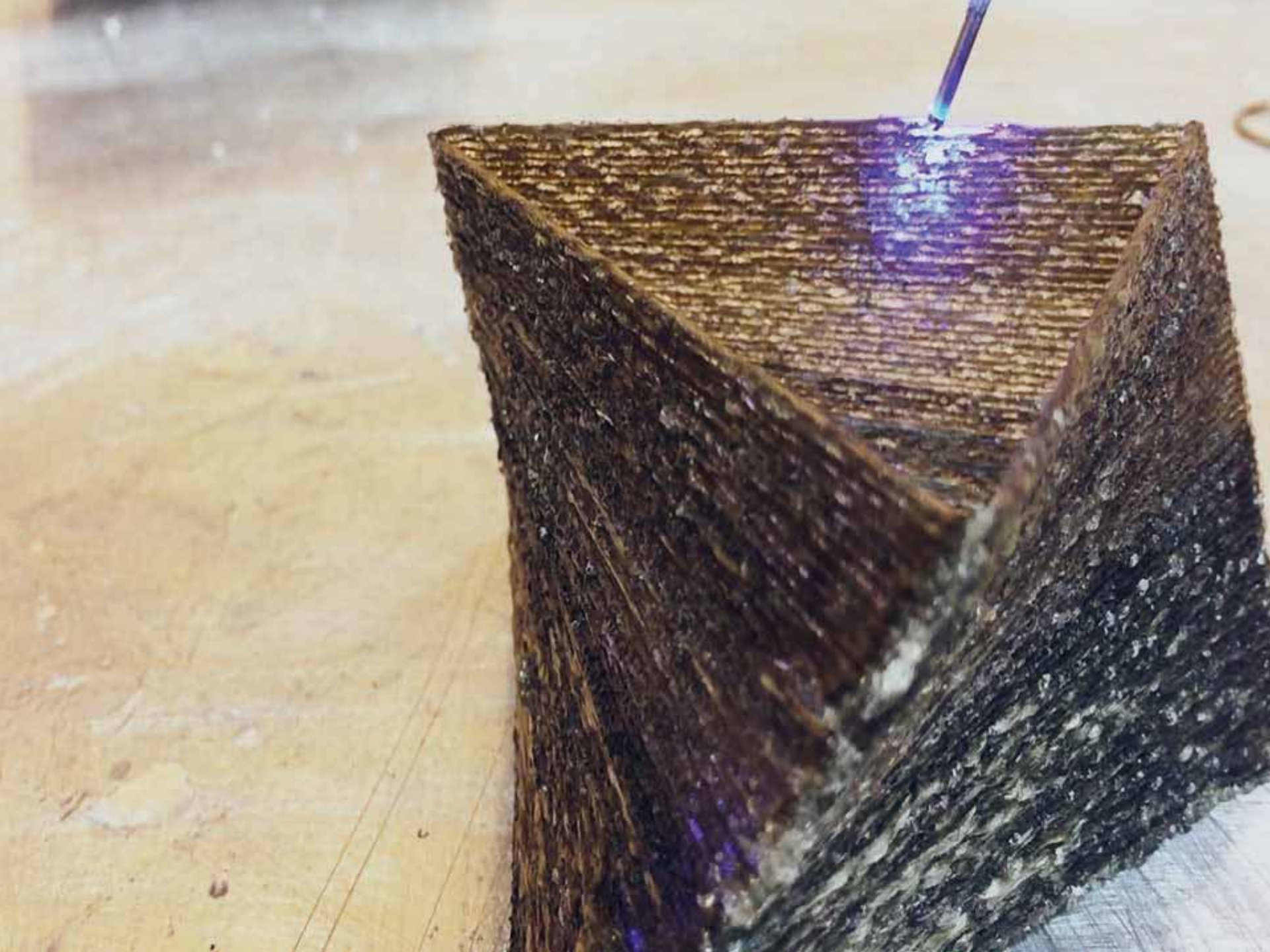


ATROPOS



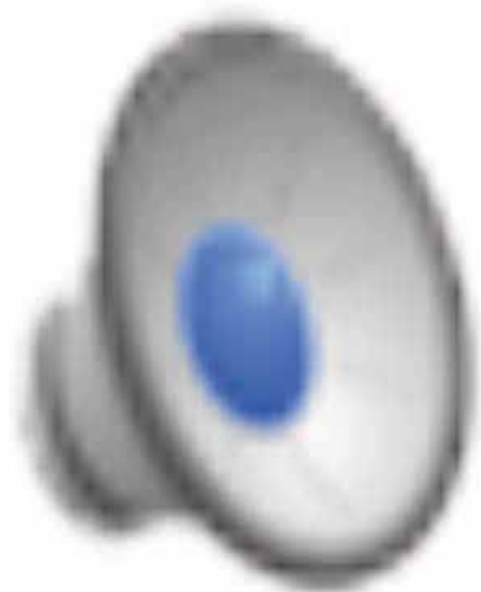






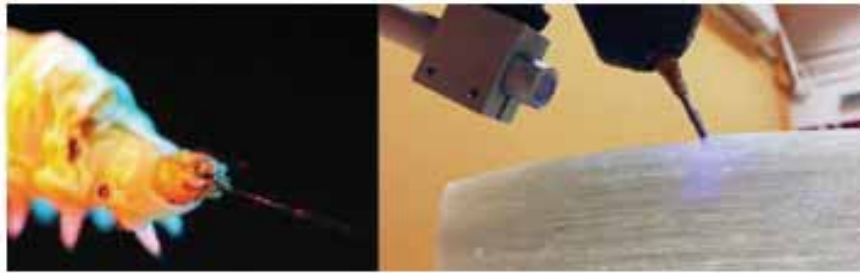






Thermosetting Composite Materials: Atropos Creates New Relationship Between 3D Printing & Robotics

by Bridget Butler-Millbapt | 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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+LAB REDEFINES THE COMPOSITE MANUFACTURING INDUSTRY WITH THE ATROPOS KUKA ROBOTIC ARM

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THE COMPOSITES AND ADVANCED MATERIALS EXPO

Material and Process Innovation Award

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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

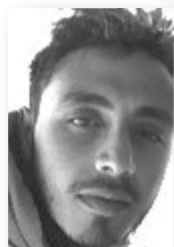
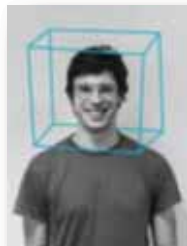
**Development of Cocured Integral Wing
Interspar Box using VERITY Process**
Advanced Composites Division, NAL

Thermoplastic Resistive Welding Fabric
T Plates Global, LLC.



GRAZIE.

Alla Z, e...



Fare o non fare. Non esiste provare.



**Grazie a voi tutti
per la cortese attenzione.**

marinella.levi@polimi.it

www.piulab.it

www.3dprintingcomposites.xyz

