

Etat de l'art

Robots mous

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EnsadLab

MATÉRIAUX RESPONSIFS

- pour la robotique
- pour l'art
- pour la robotique avec applications en art

Joan de Deuze, 2012
at Boolegilde





[Vidéo en ligne](#)

30% RH



36% RH



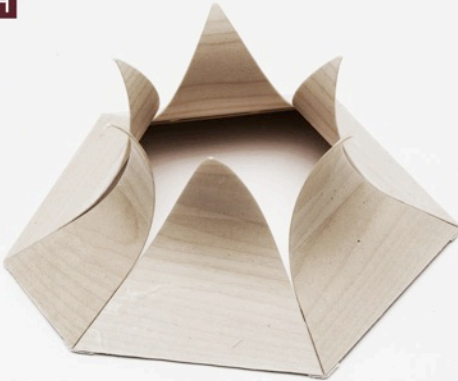
49% RH



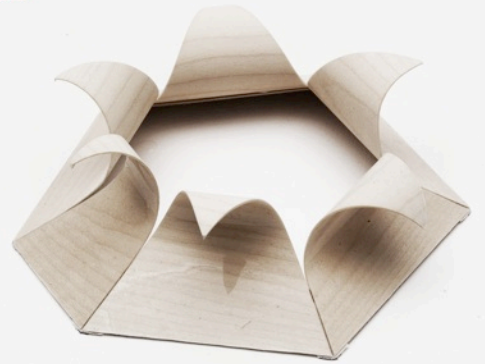
55% RH



62%RH

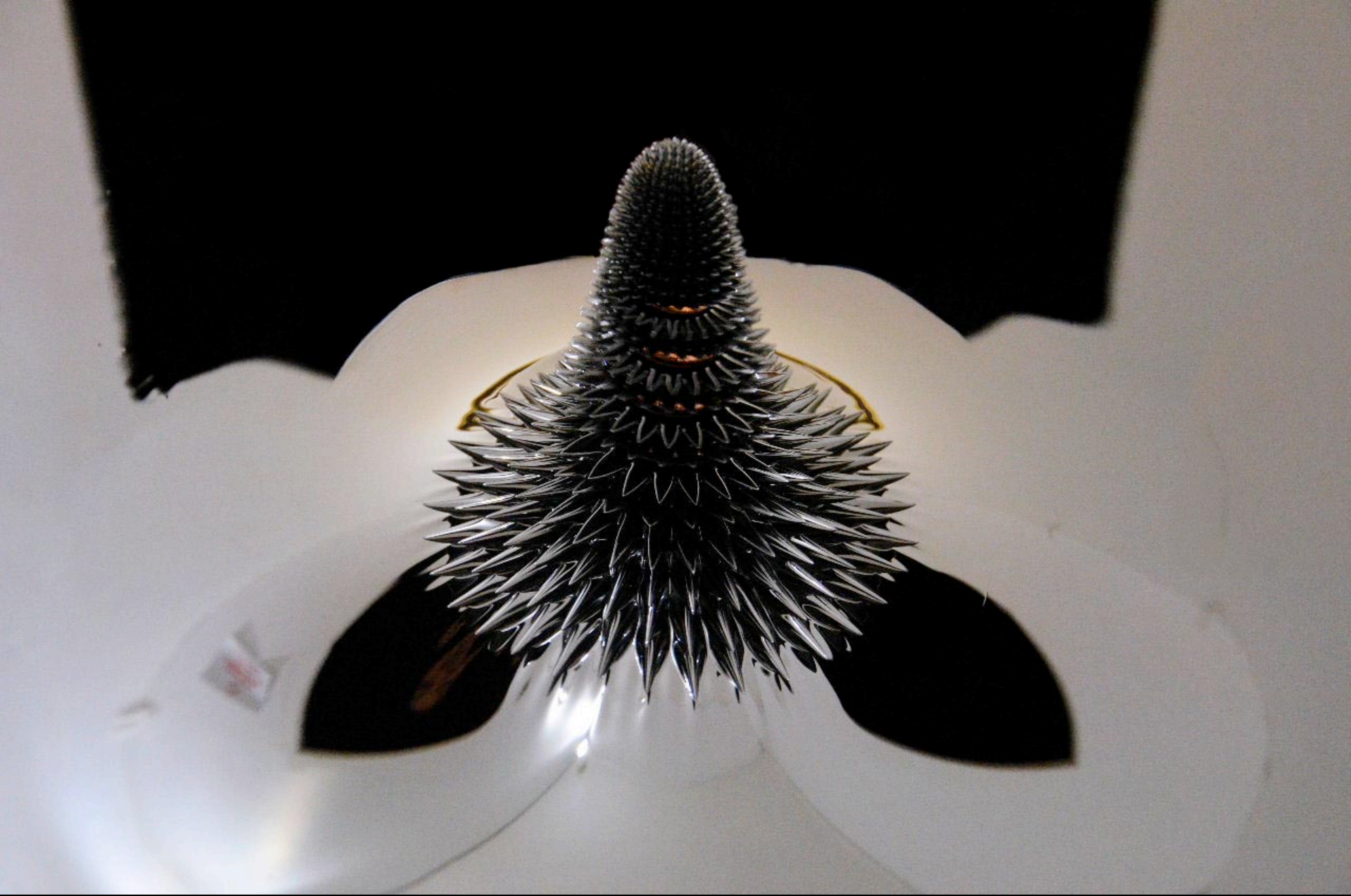


75% RH



Hylozoic Soil. 2007. Philip Beesley

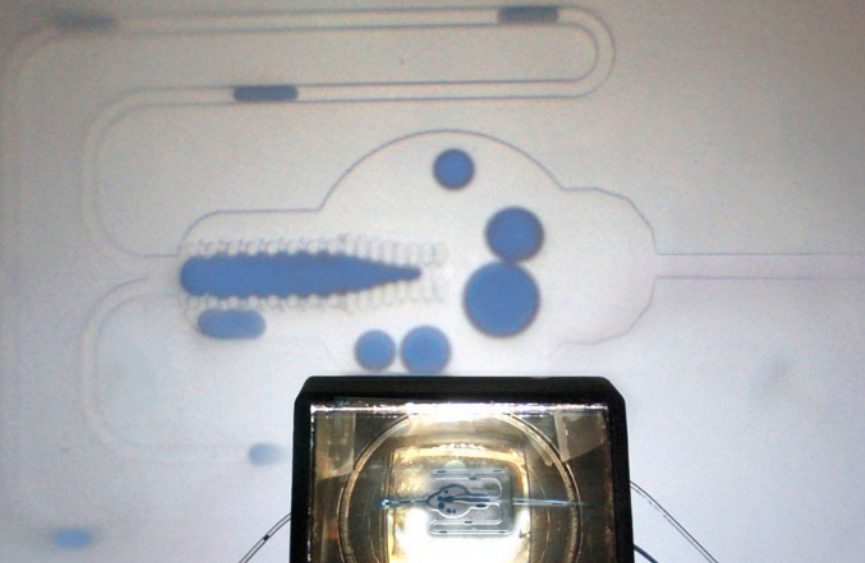




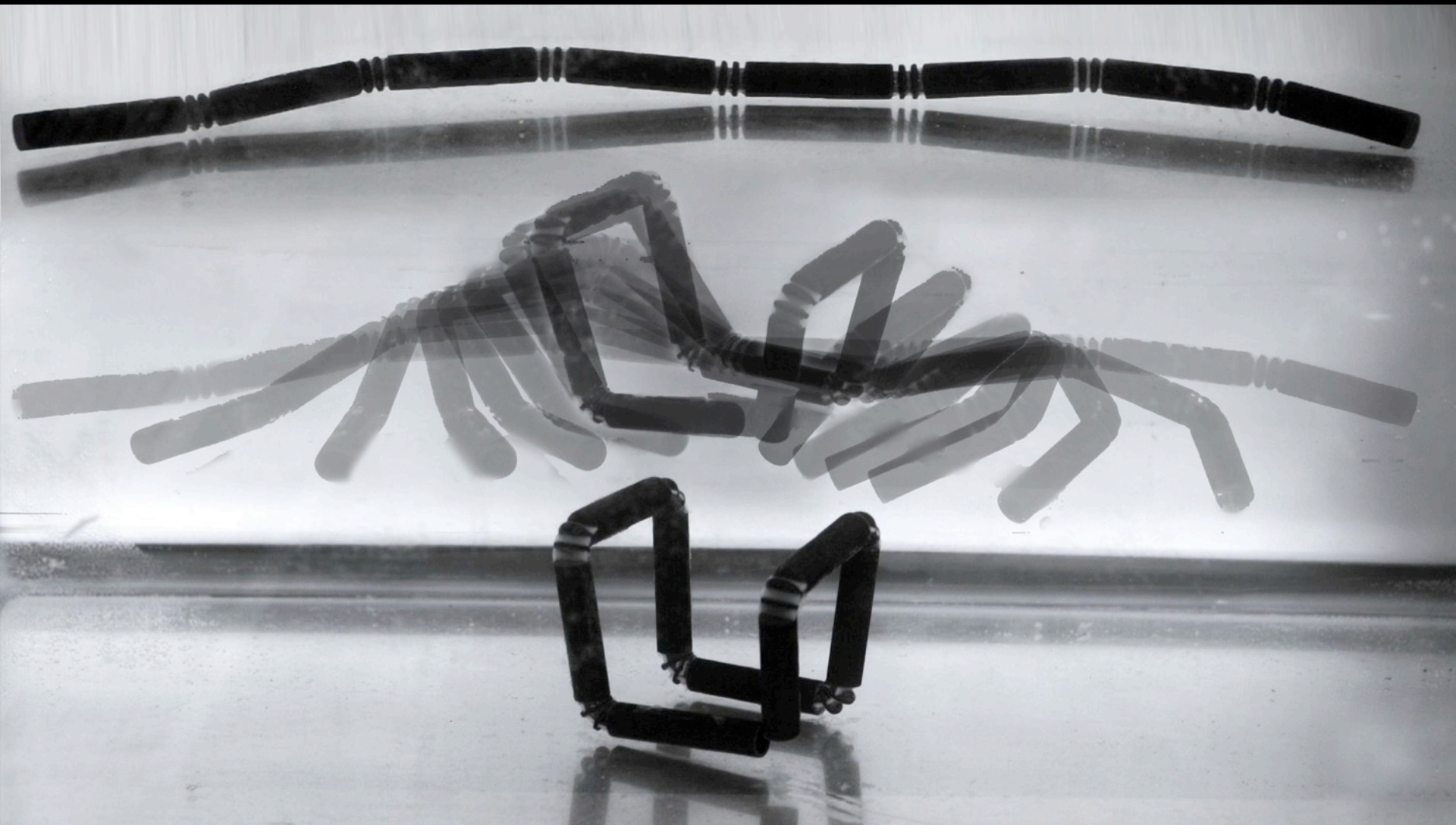
Sachiko Kodama, *Morpho Towers*



Marie-Julie Bourgeois, *Ou*



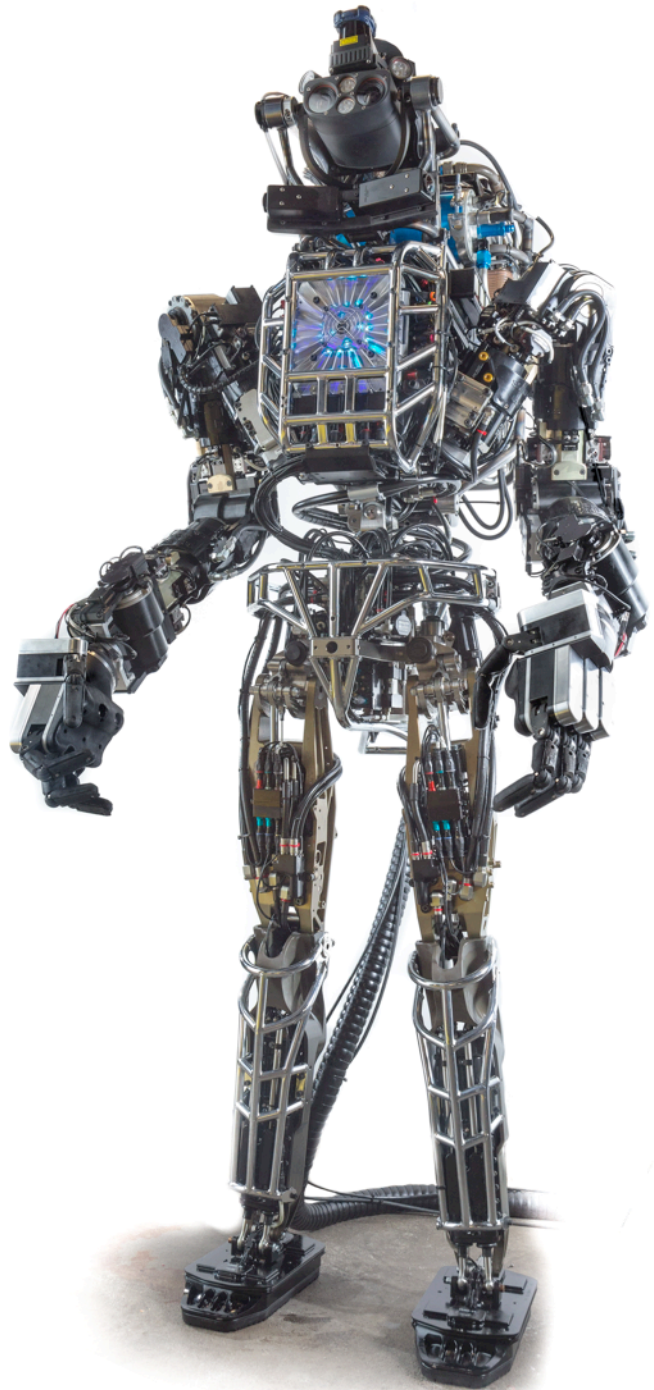
Trafic
Dominique Peysson
2014

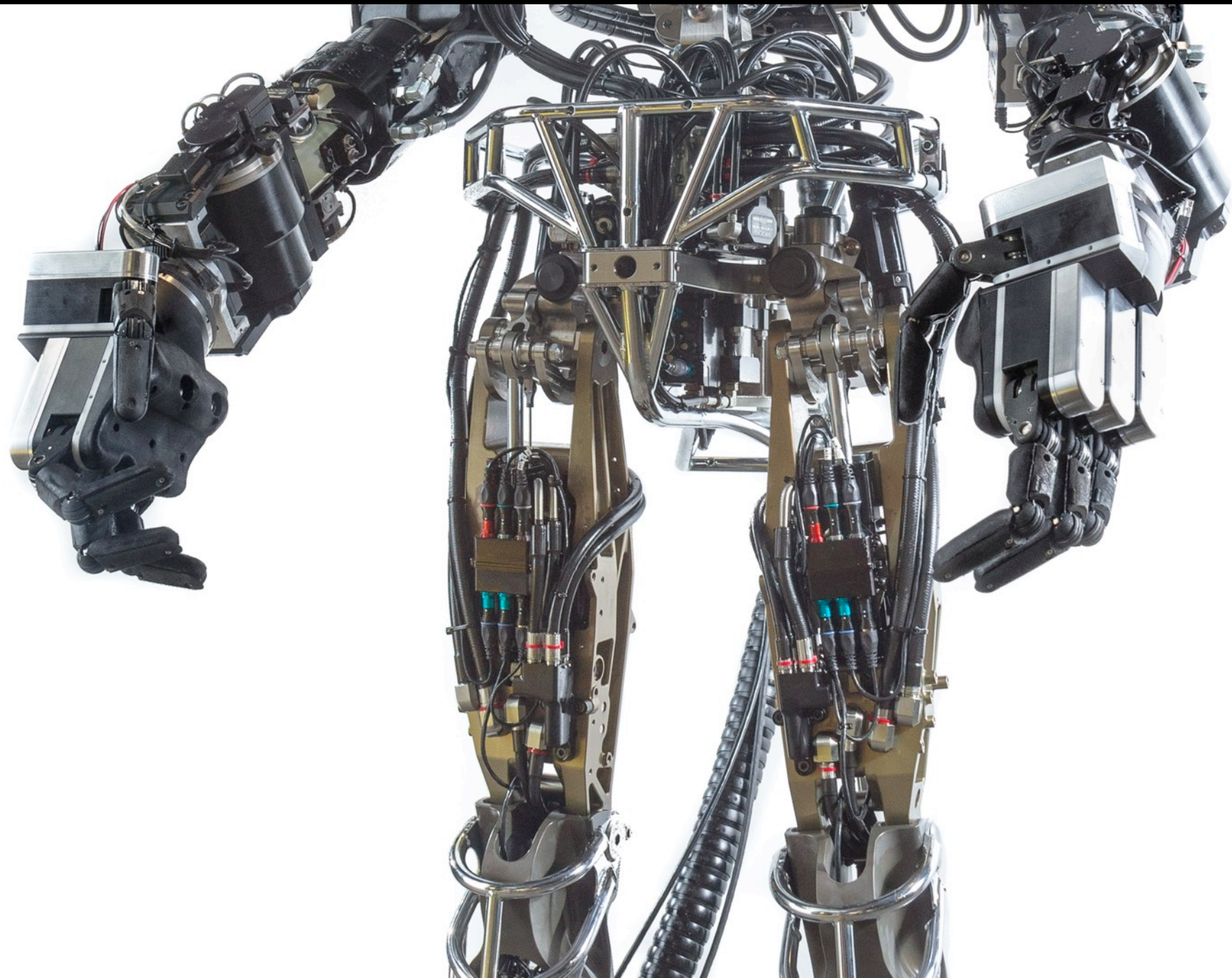


4D print, Skylar Tibbits

Robotique molle

Soft robotic





EAMEX





Hanson robotics.
super-humanlike robots

Quelle mécanique?

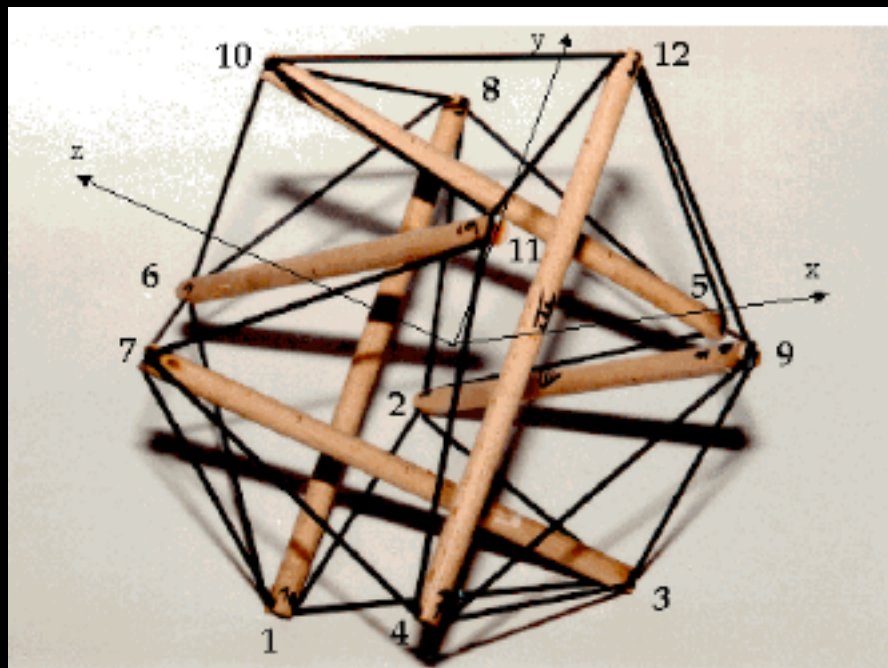
Mécanique : mécanique du point
mécanique du solide
Engrenages, moteurs

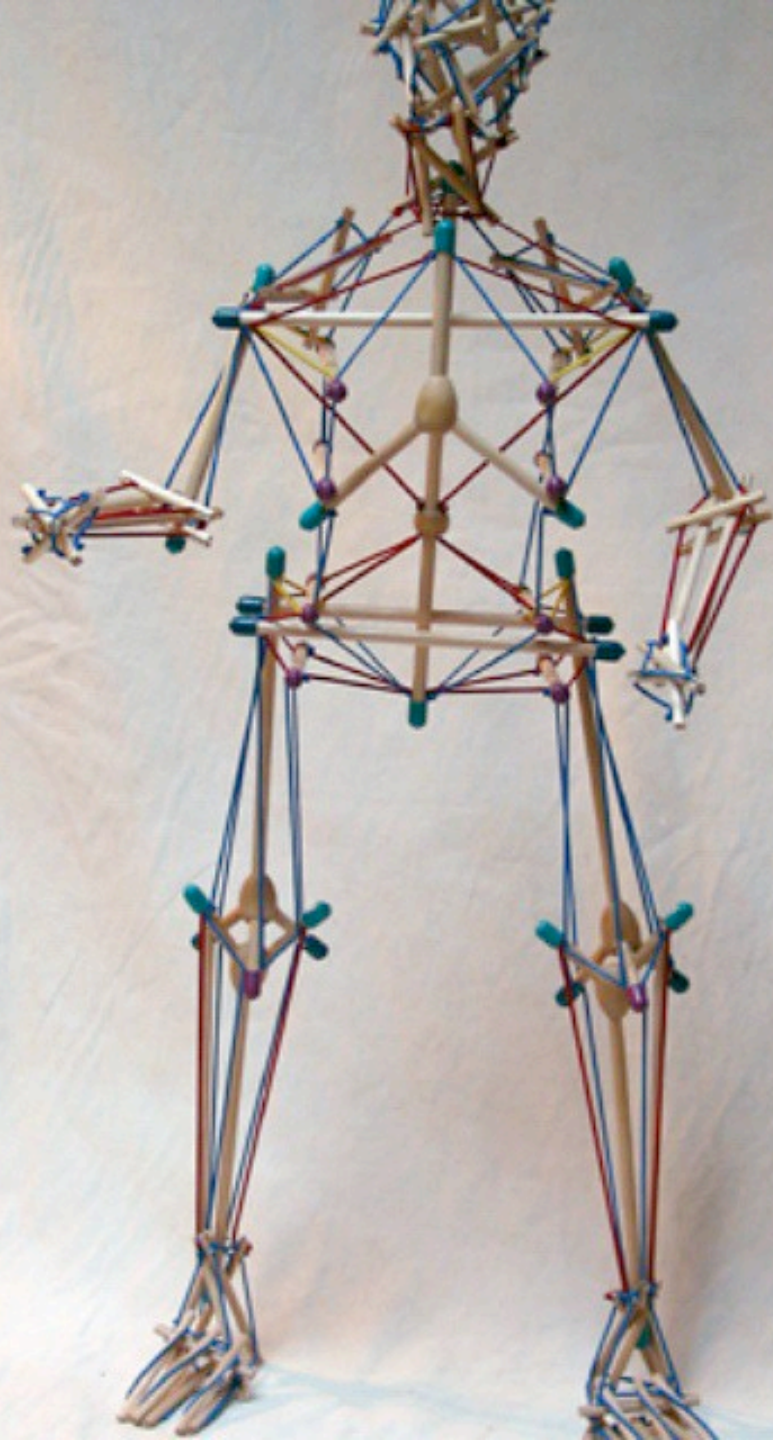


Boston Dynamics, avril 2010

Mécanique : mécanique du point
mécanique du solide
Engrenages, moteurs

Mécanique des milieux continus
fluides
matière molle
Polymères (plastiques)
Gels
Cristaux liquides





Quels matériaux?

Capables de combiner
des propriétés mécaniques différentes

ex: rigide/mou

Capables de combiner
des propriétés mécaniques différentes

rigide/mou

COMPOSITES

Capables de se transformer

Propriétés mécaniques modifiées

Rigide ↔ mou

Capables de se transformer
Passer de propriétés mécaniques à
d'autres propriétés.

Rigide \Leftrightarrow mou

Rigidité progressive

Réparation

Rhéofluidifiant, rhéodurcissant

Présentent d'autres fonctionnalités

Mouvement

Forme, transformation (gonflement, ...)

viscoélasticité

Transparence/opacité

Couleur

Détournement de la lumière

Résilience

Moins dangereux pour l'homme

Matériaux intelligents/composites

Sensibles + capable de se transformer et évoluer

Forme, viscoélasticité, couleur

Excitations : mécanique, température, électrique, magnétique, lumineuse, gaz (odeurs)

Combinaison

nature de la matière

+

Structure interne

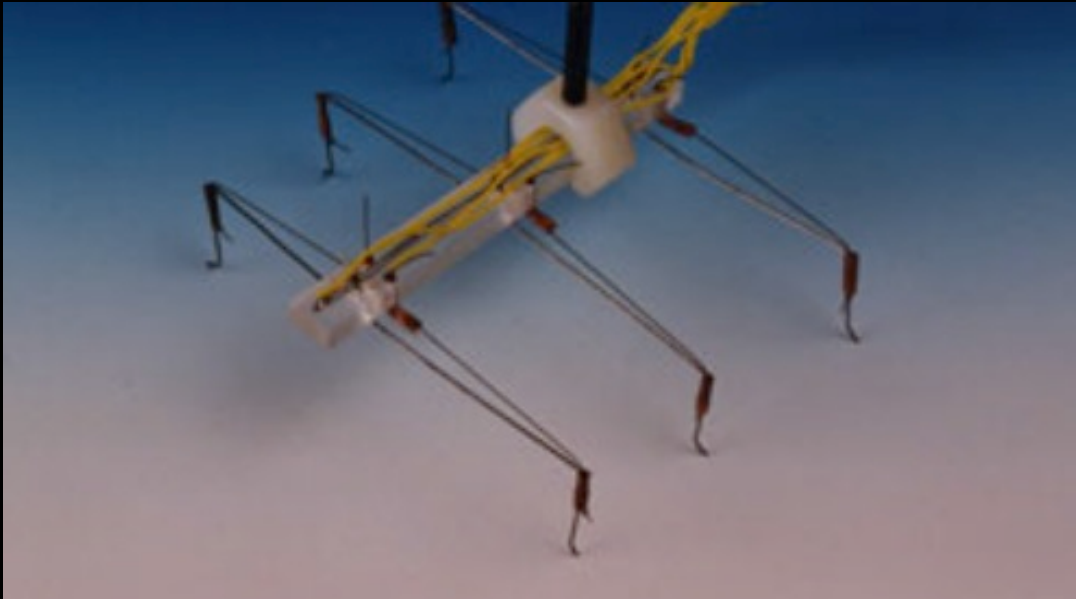
(alliage à mémoire de forme)

+

Structure de l'ensemble

(composite, tenségrité)

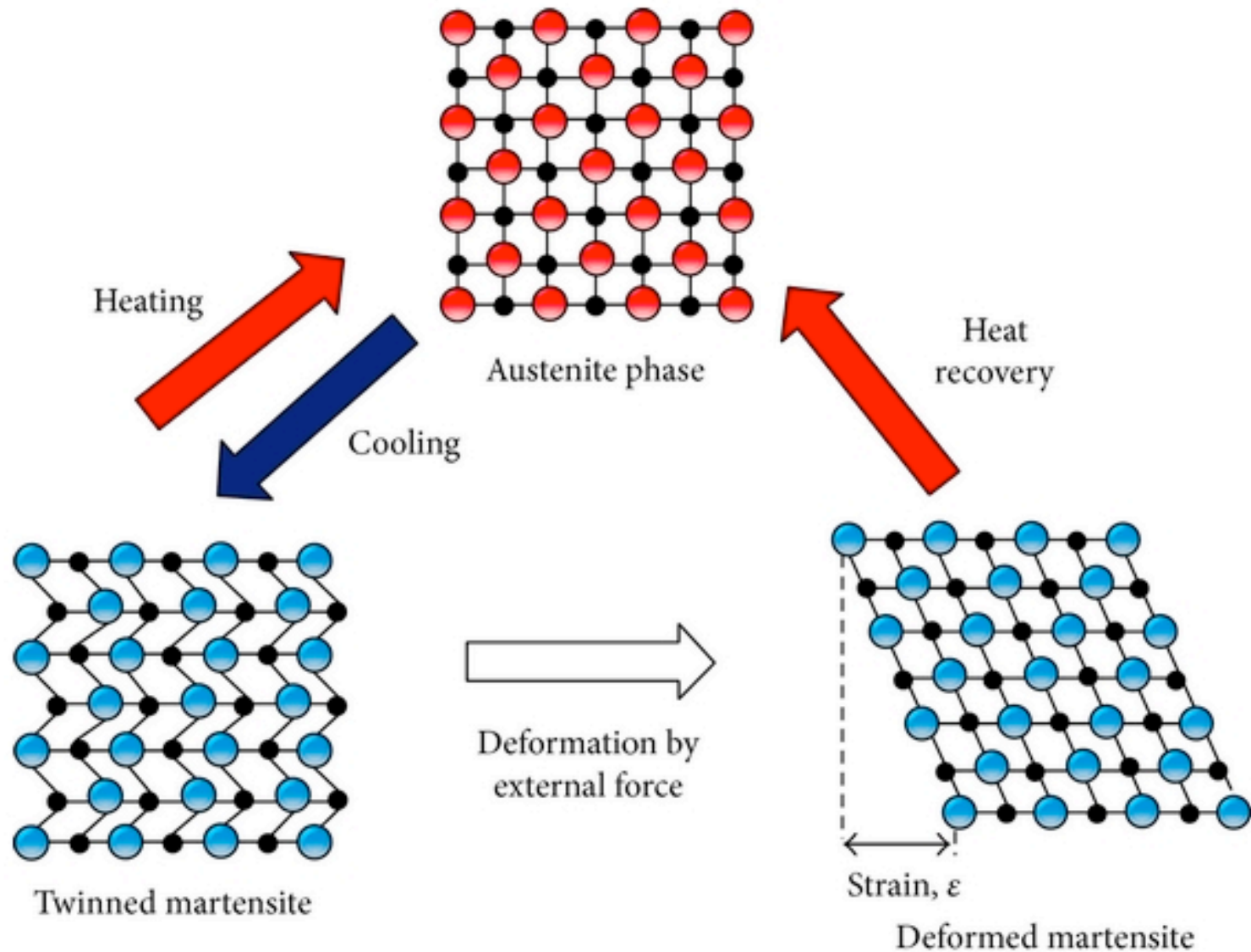
Micro-robot actionné avec un alliage à mémoire de forme



Le mode d'actionnement peut être

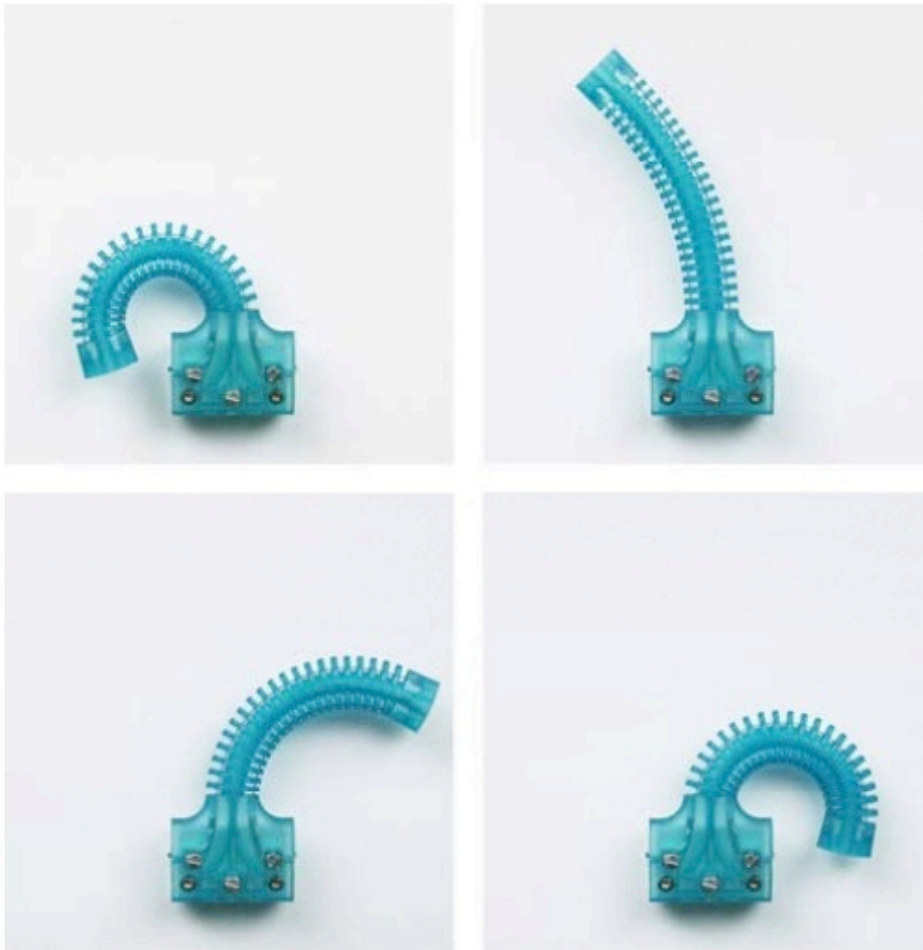
électrostatique,
électromagnétique,
magnétostrictif,
piézo-électrique,
fluidique,
expansion thermique,
matériaux à mémoire de forme (alliages,
polymères),
chimique.

Alliage à mémoire de forme



Robots mous

Muscle artificiel à mémoire de forme

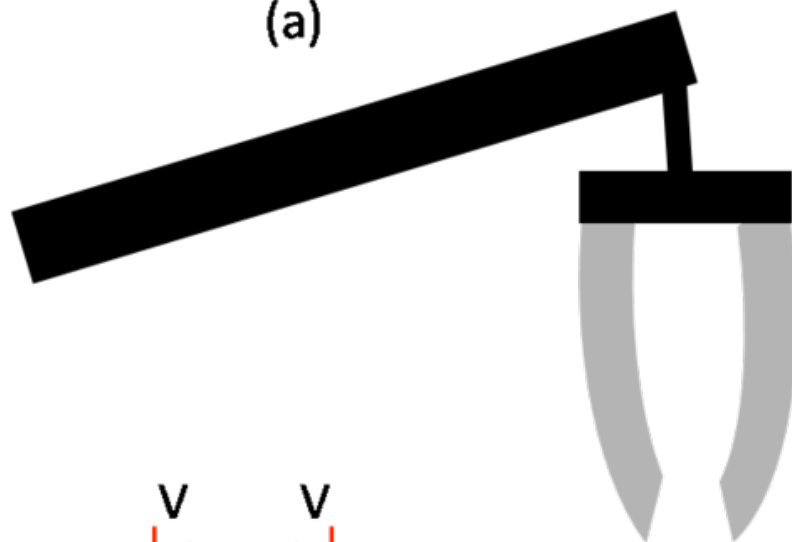


SRI

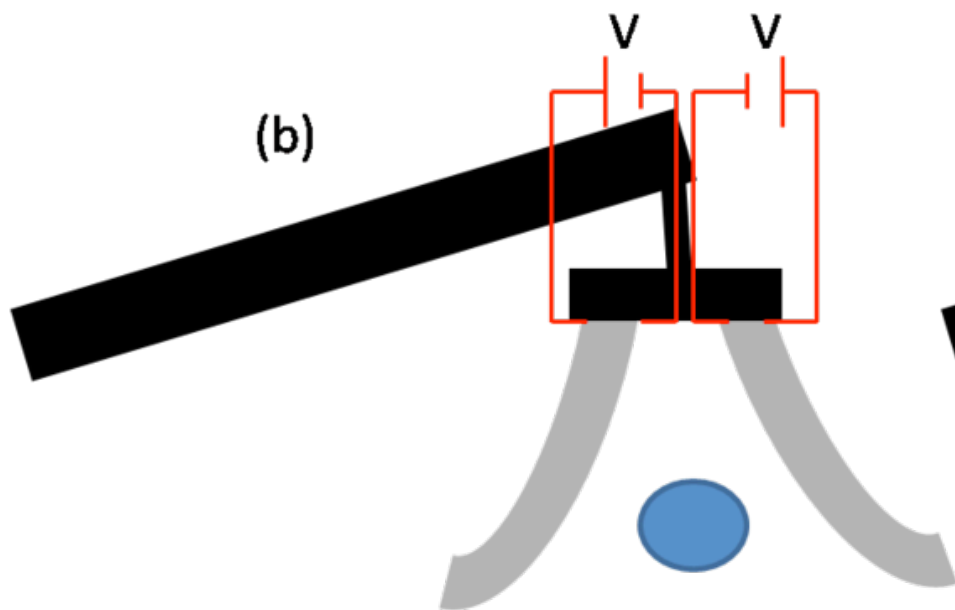
Electroactive Polymer Artificial Muscle



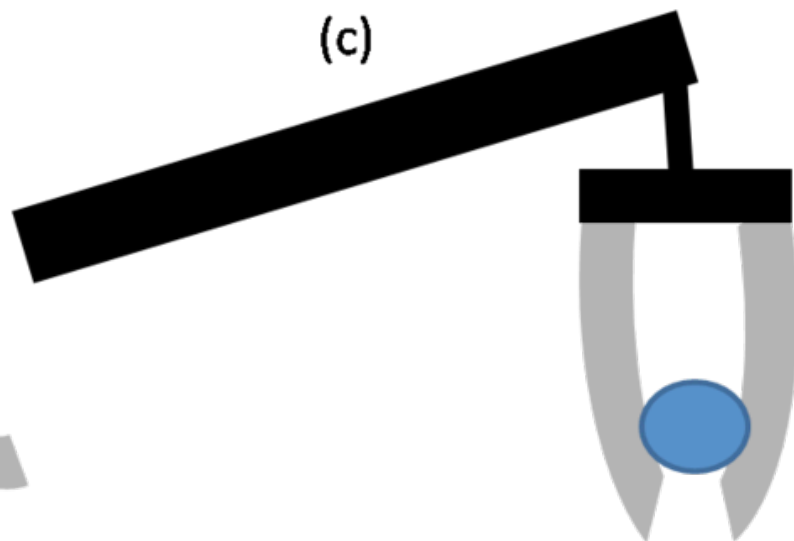
(a)



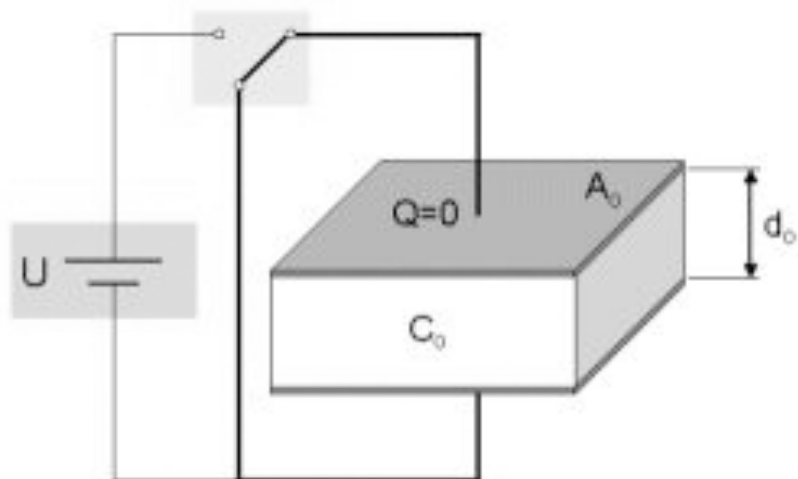
(b)



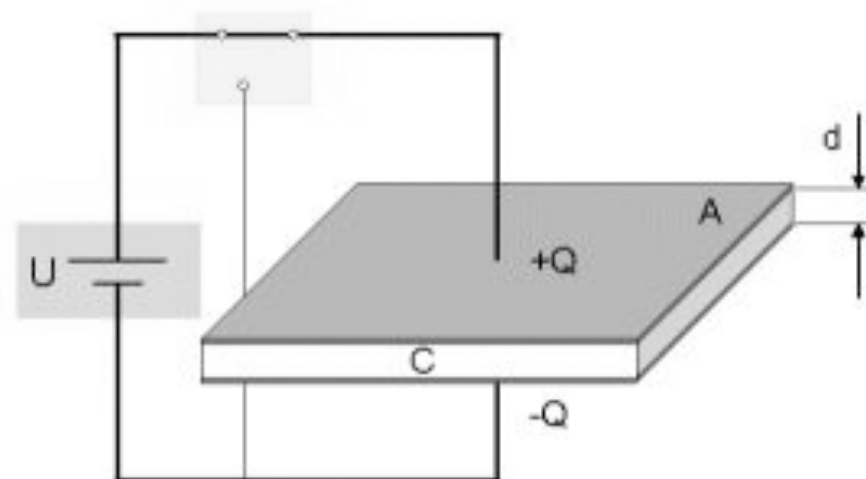
(c)



Short-Circuited



Actuated



$$C_0 = \epsilon_0 \epsilon_r \frac{A_0}{d_0} < C = \epsilon_0 \epsilon_r \frac{A}{d}$$

EPAM

Electroactive Polymer Artificial Muscle

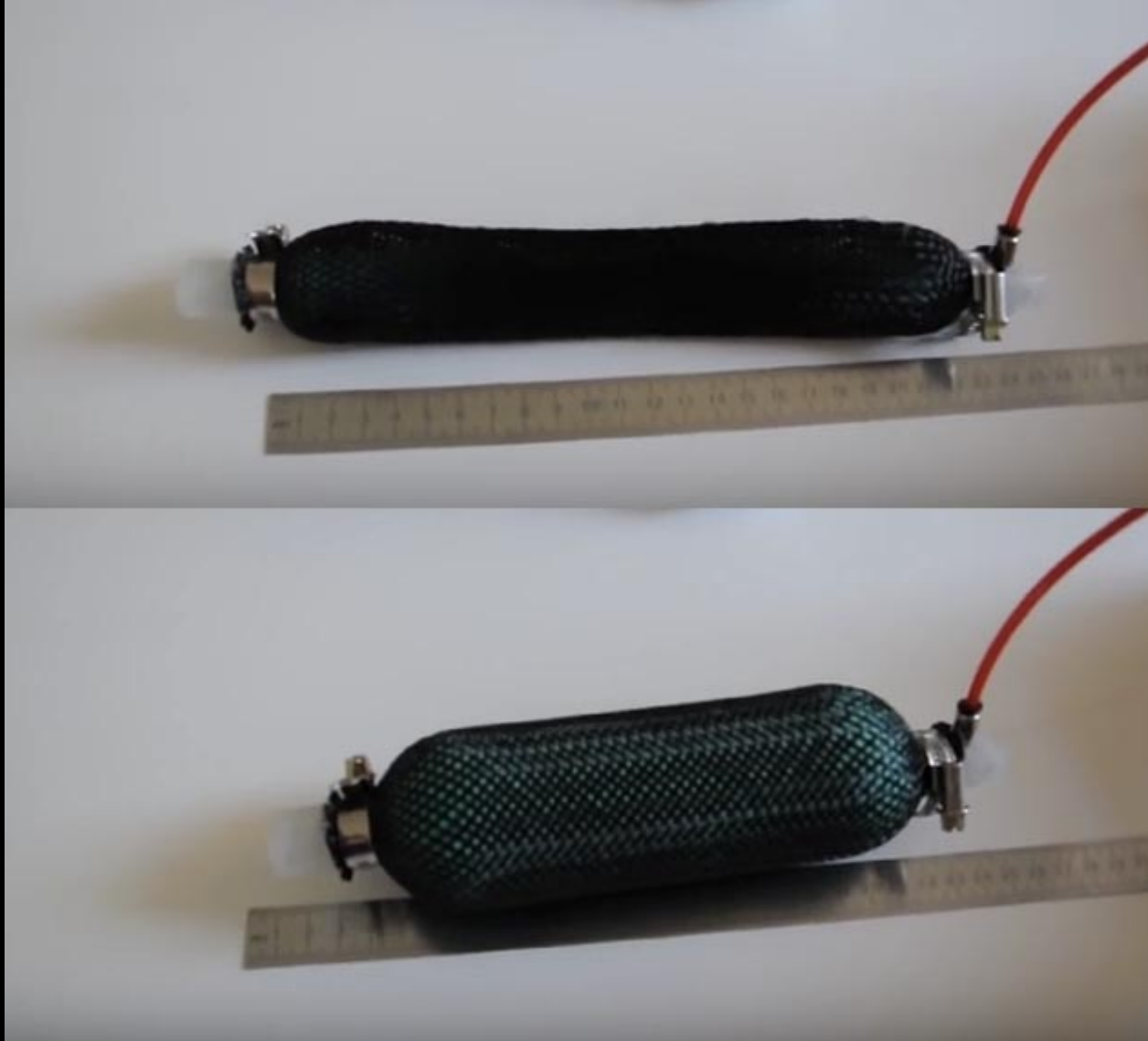


EAP
National
Universitu
of
Singapore

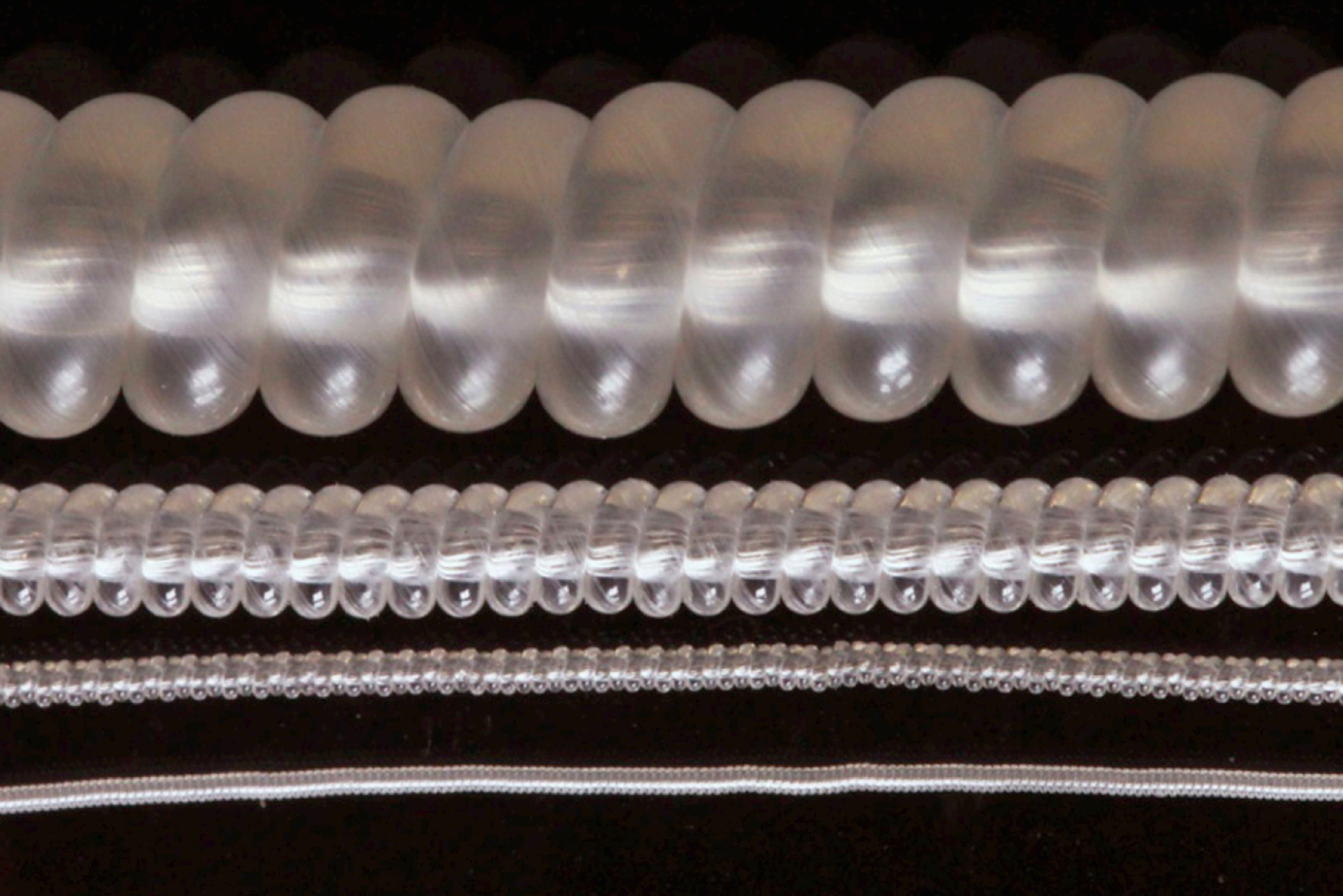


Dérivés

DIY : comment faire son muscle artificiel?



Des nanotubes de carbones dans lesquels ont infusé de la paraffine, qui augmente de volume en chauffant. Grande puissance, fort étirement.



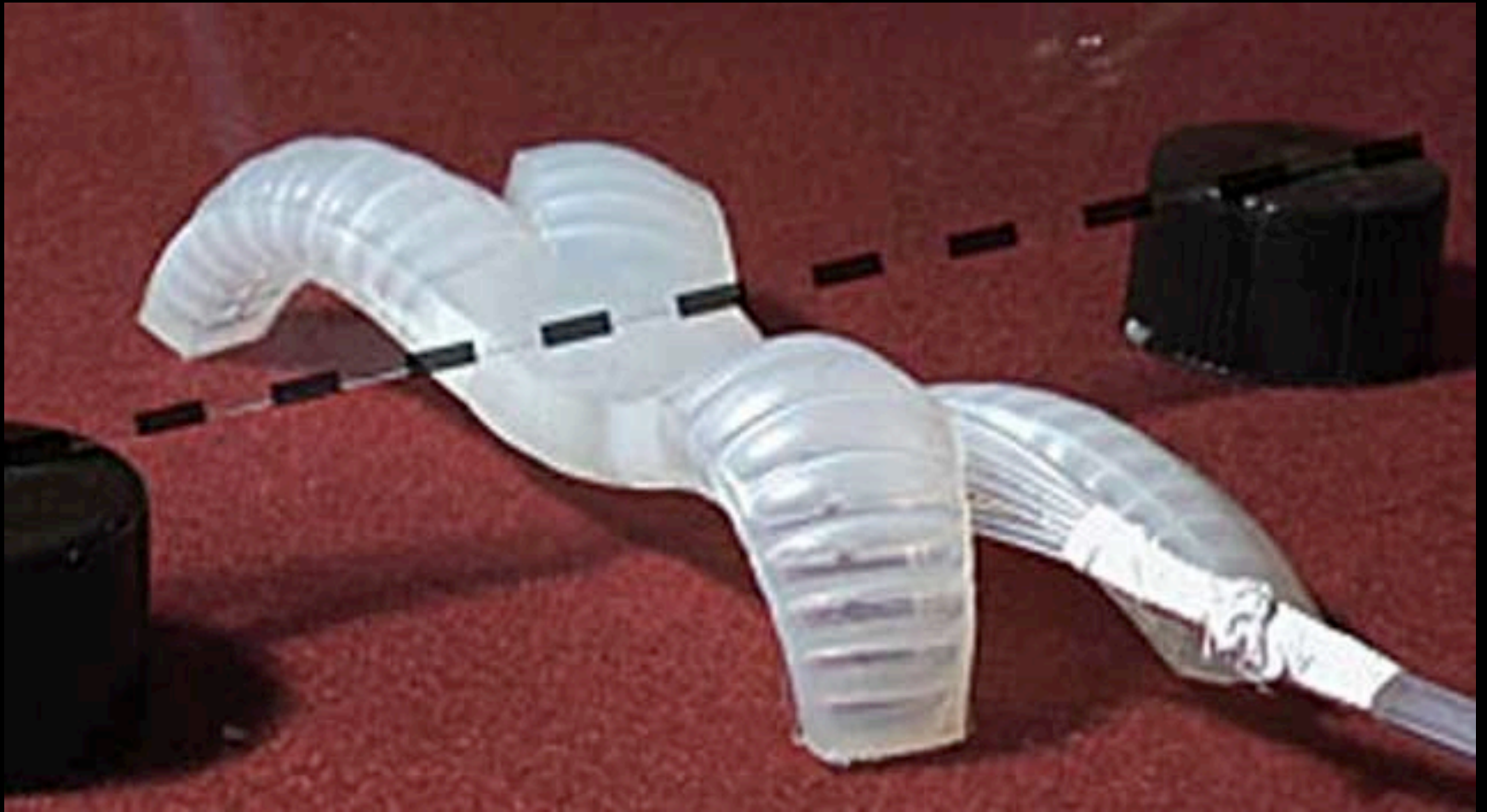
Fils de nylon (fils de pêche) torsadés, dilatation lorsqu'on les chauffe

Professor Geoff Spinks

Intelligent Polymer Research Institute, ARC Centre of Excellence for Electromaterials Science



EPN embeded pneumatic networks Harvard

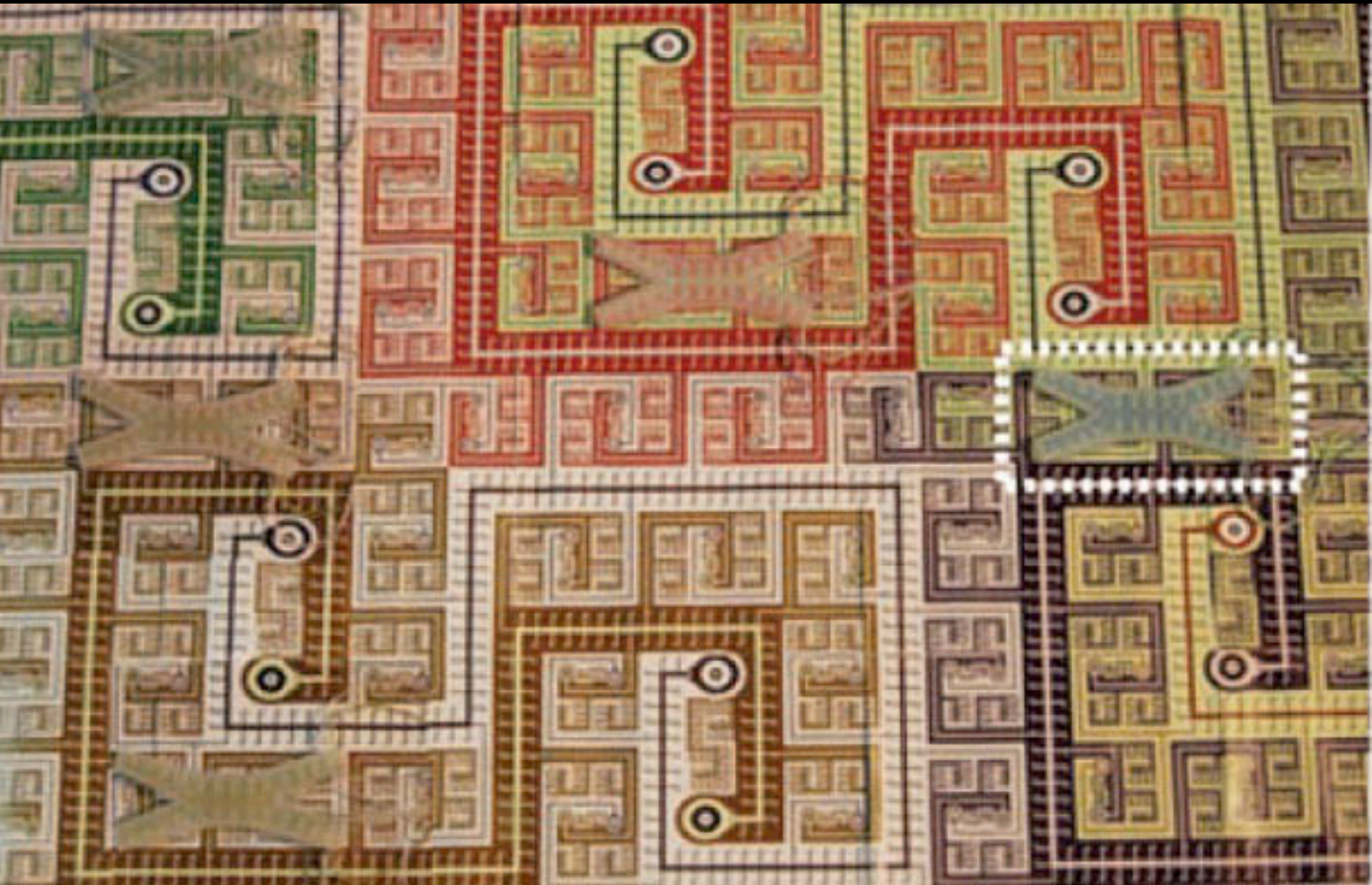


Turgescence

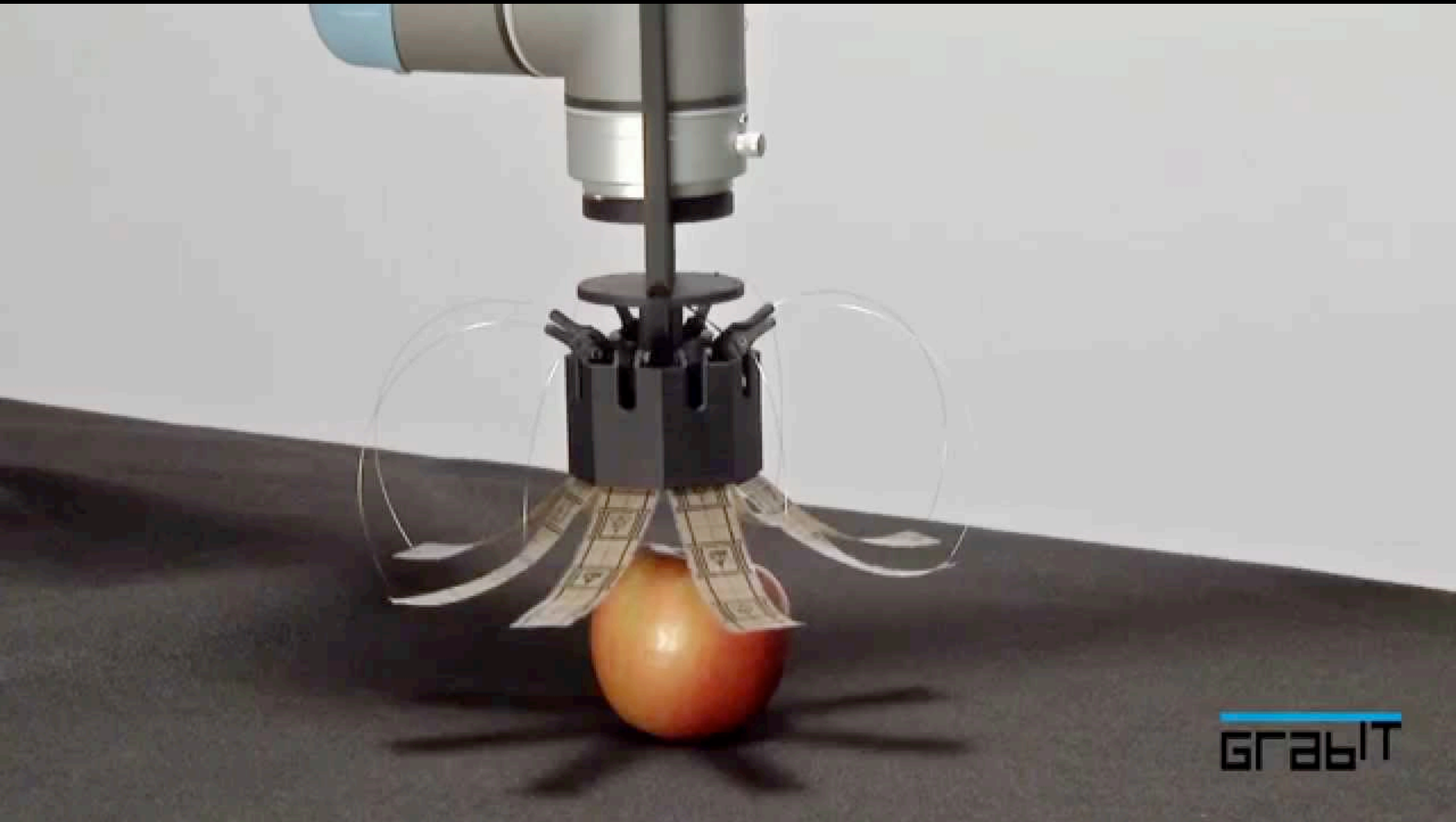
DIY

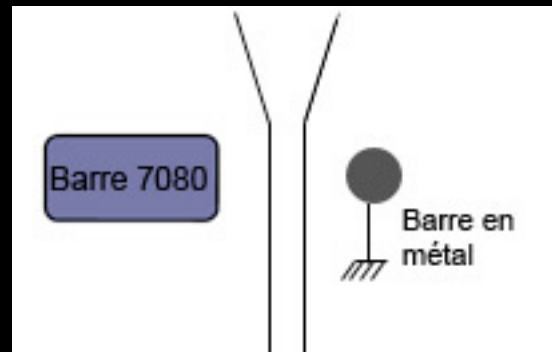
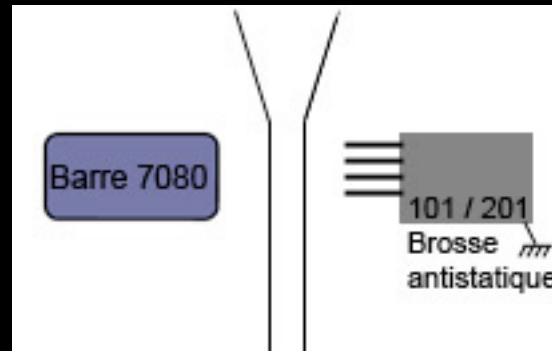


Camouflage



Grabit. Électrostatique





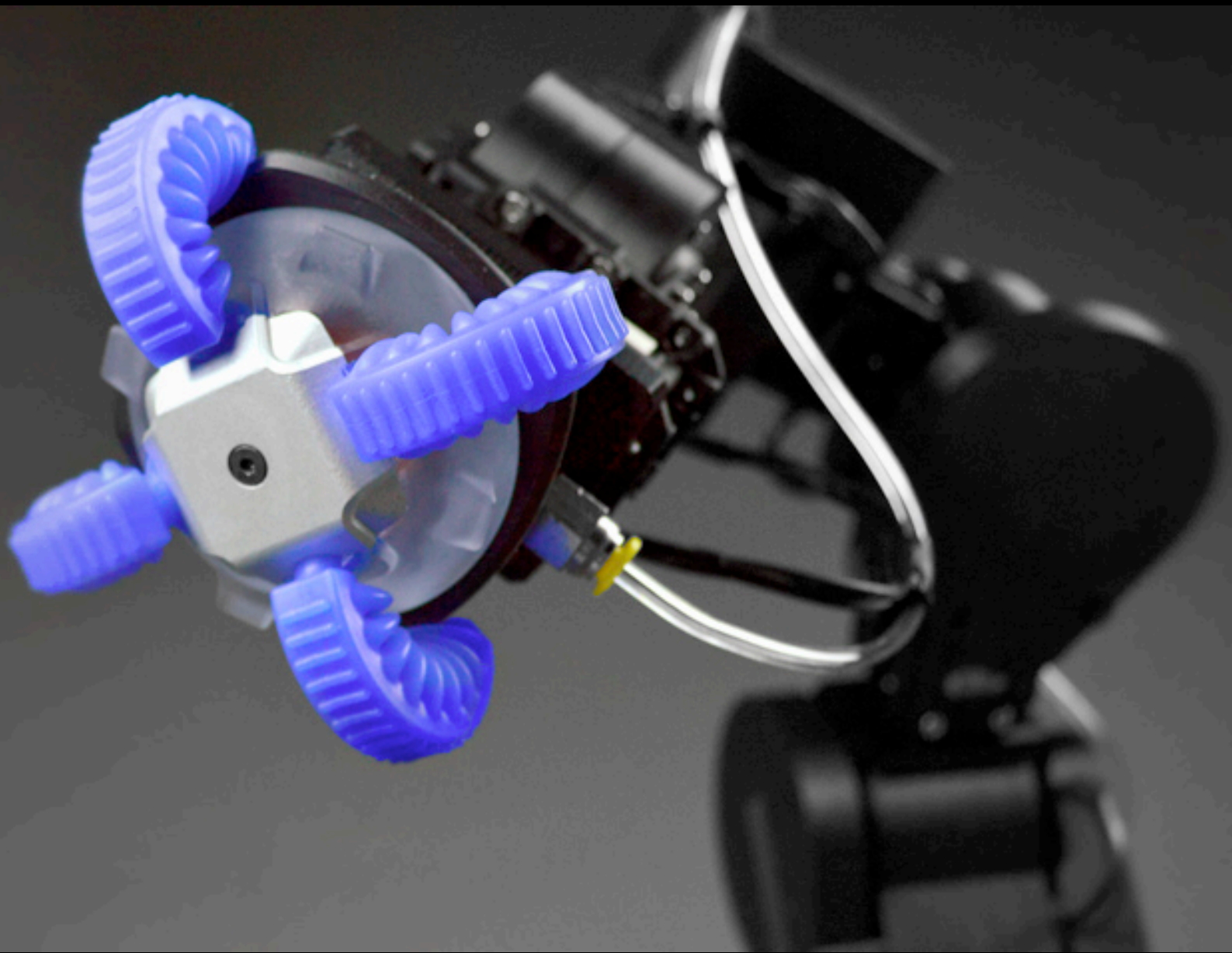
Octopus

Robot mou qui sait se camoufler

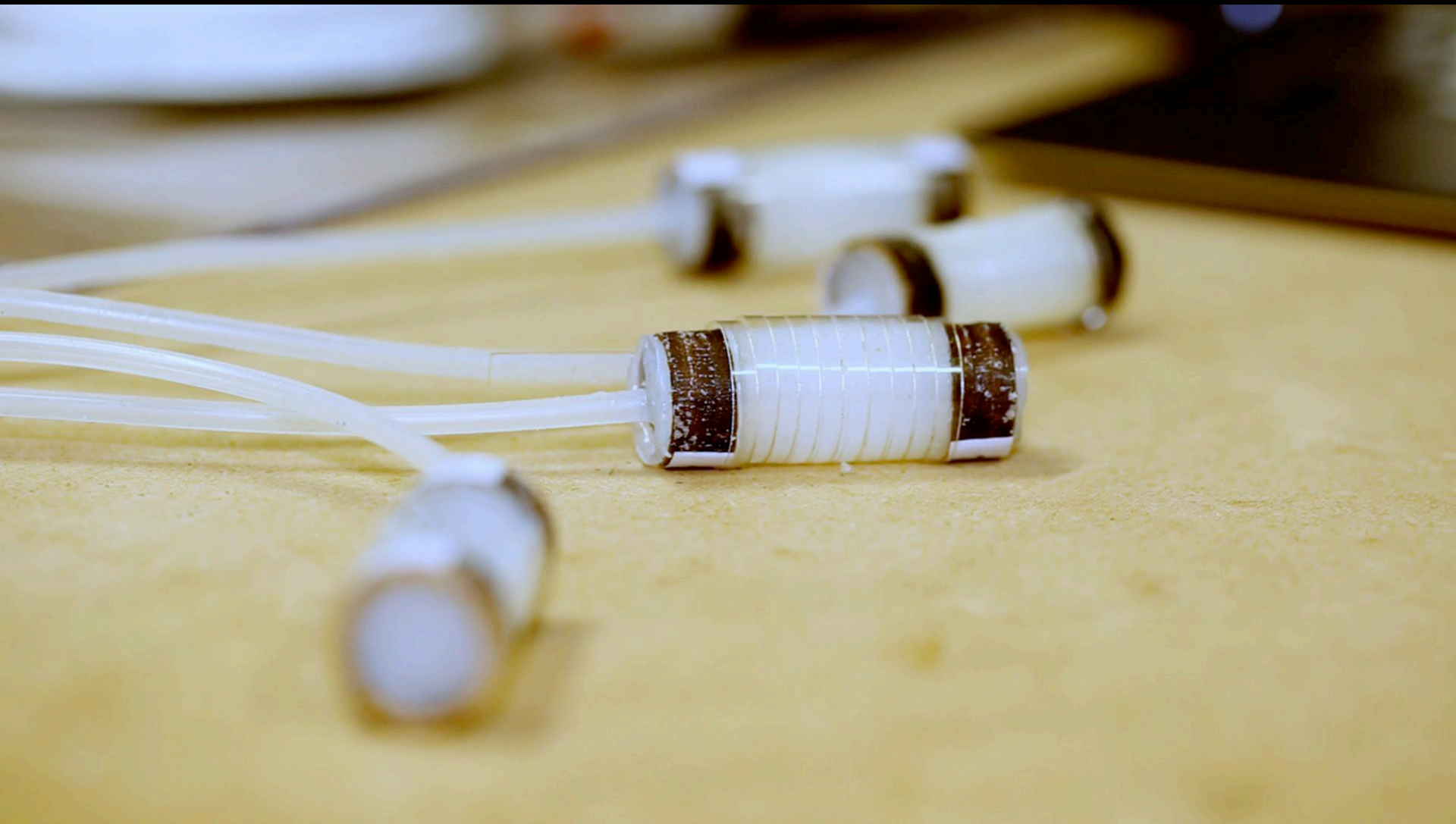




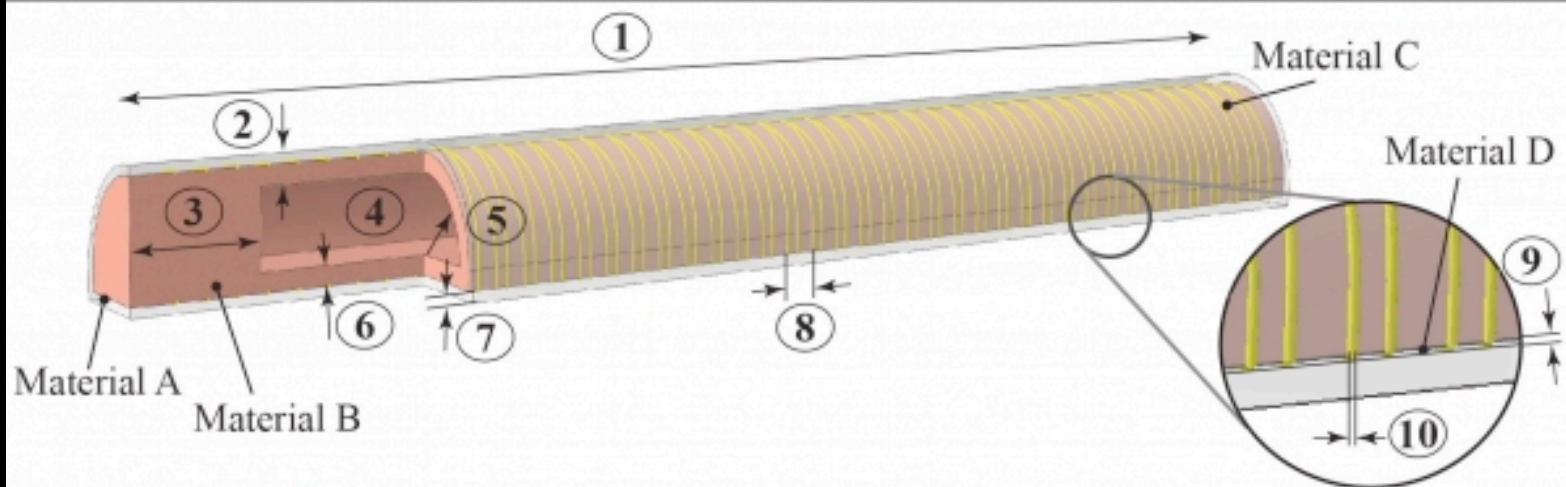
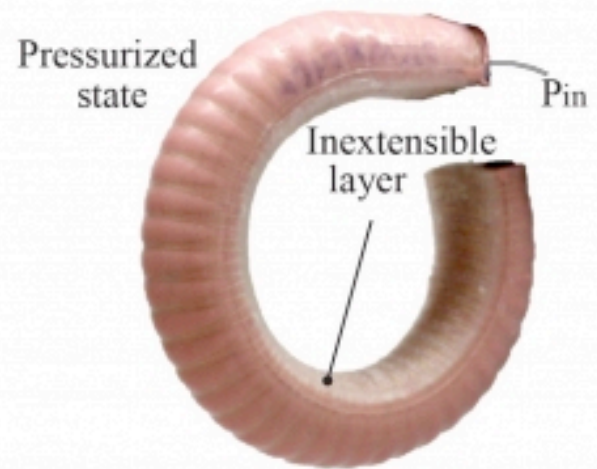
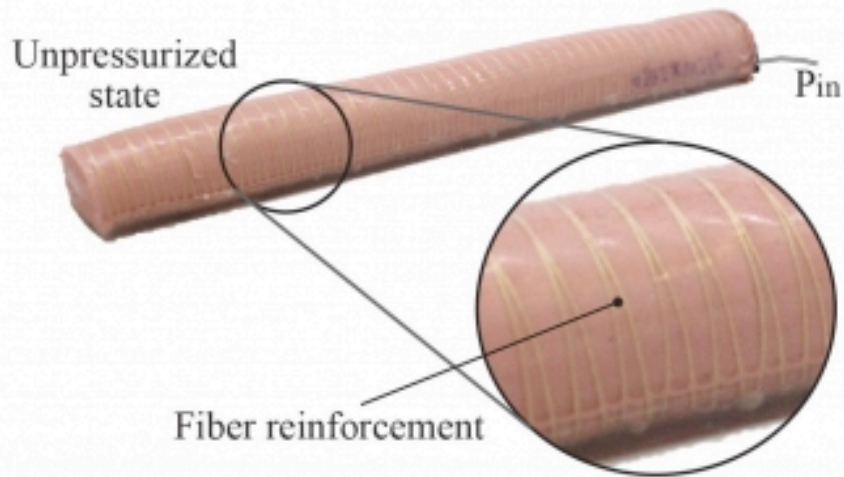








<https://actu.epfl.ch/news/soft-robots-that-mimic-human-muscles/>



- ① Actuator length ② Wall thickness ③ Cap thickness ④ Air chamber ⑤ Radius
 ⑥ Base layer ⑦ Sheath thickness ⑧ Thread pitch ⑨ Inextensible layer ⑩ Thread diameter

Jambot

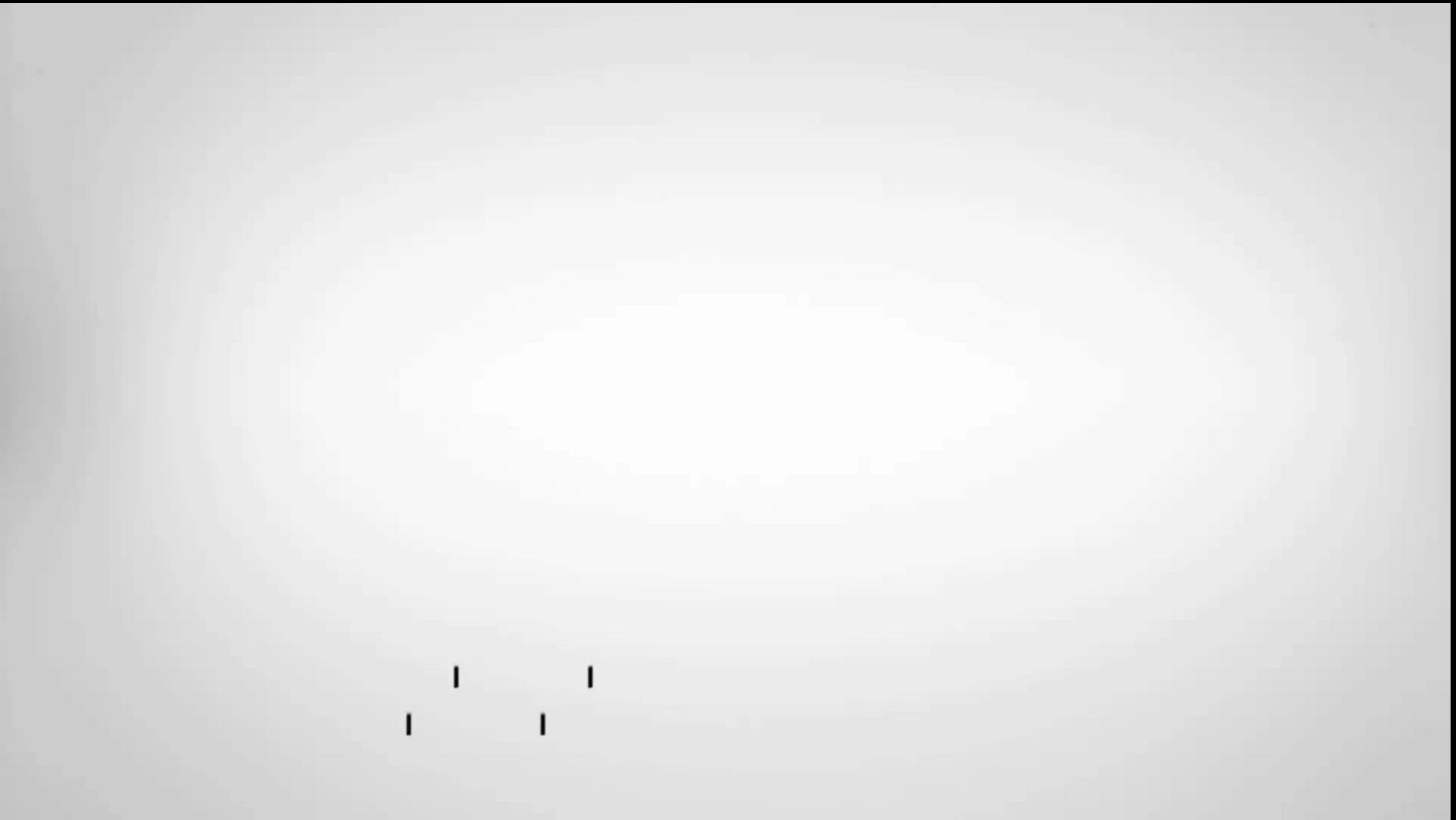


MIT jammable robot manipulator

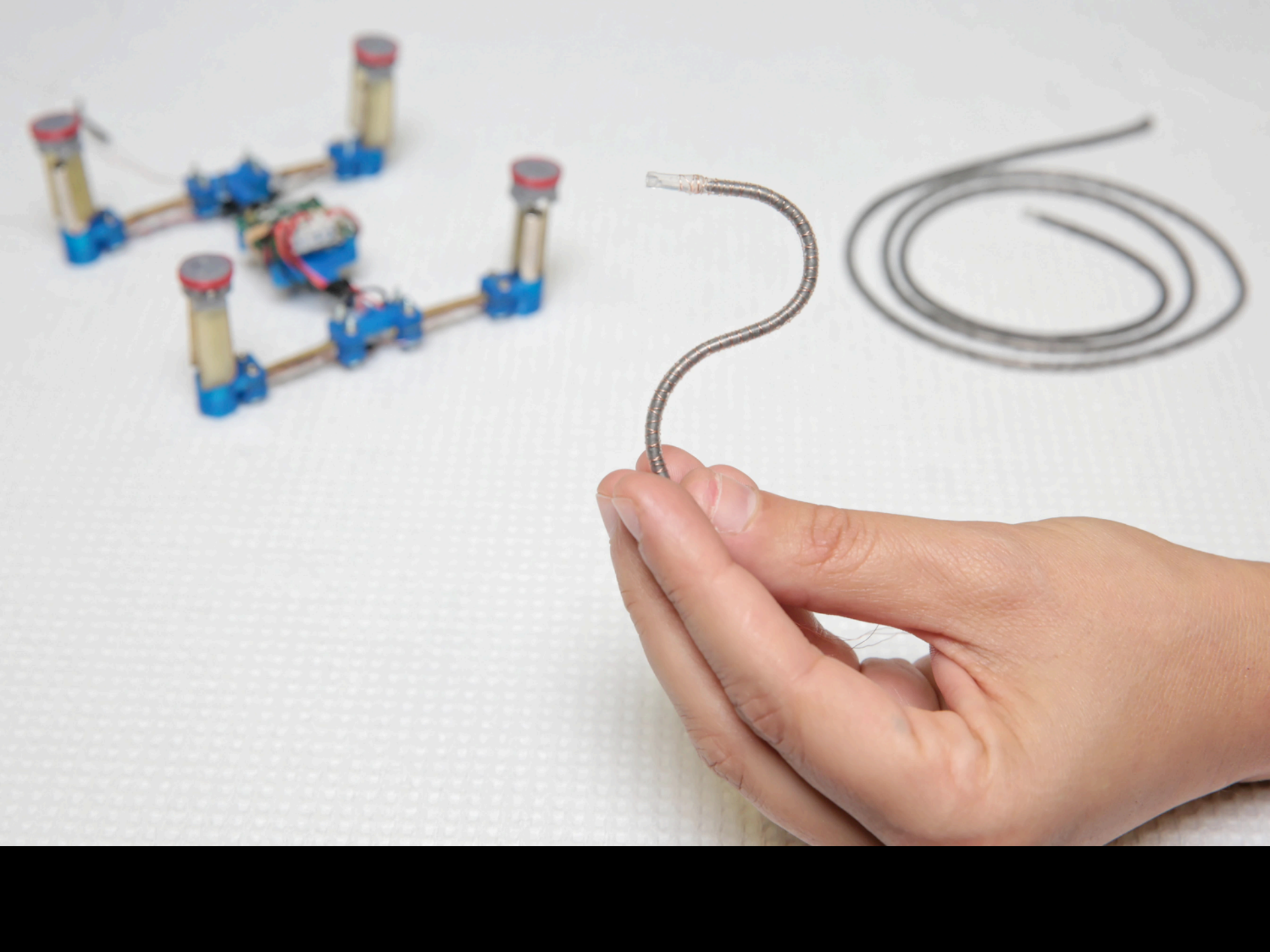
Hydrogen Fuelled Robot JellyFish 'RoboJelly'



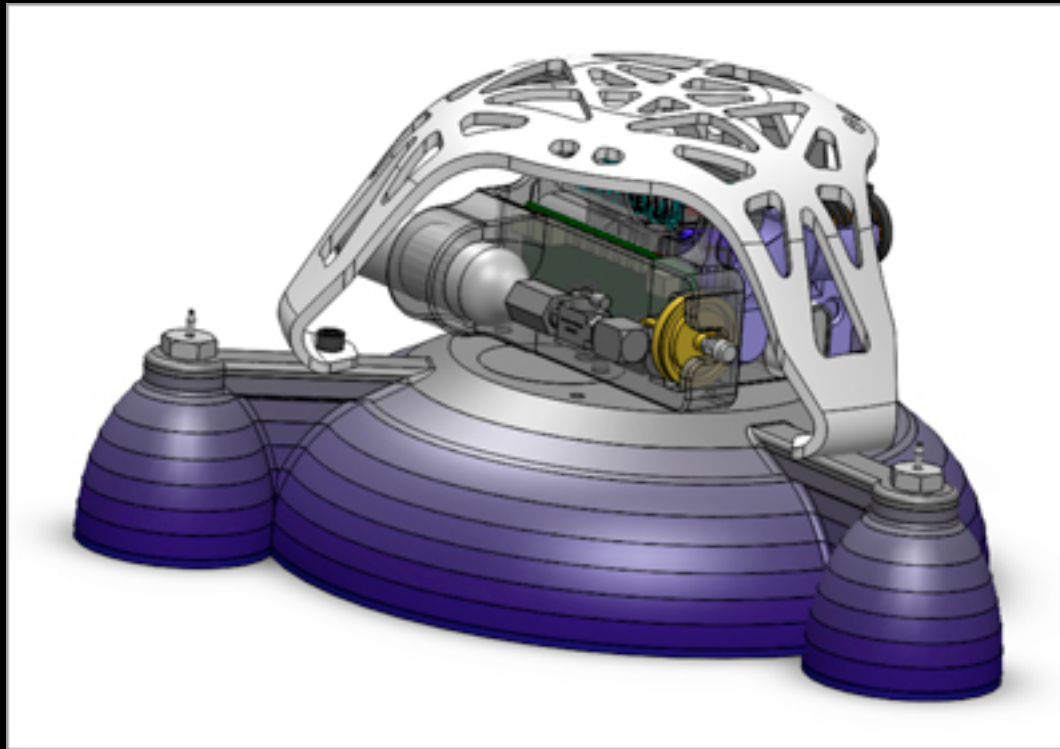
Meshworm







functionally-graded soft robots

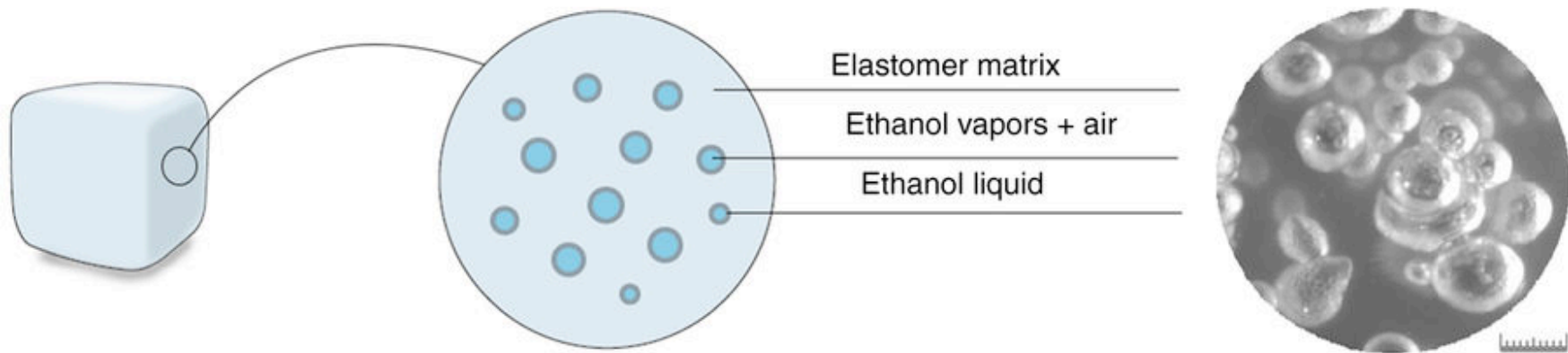
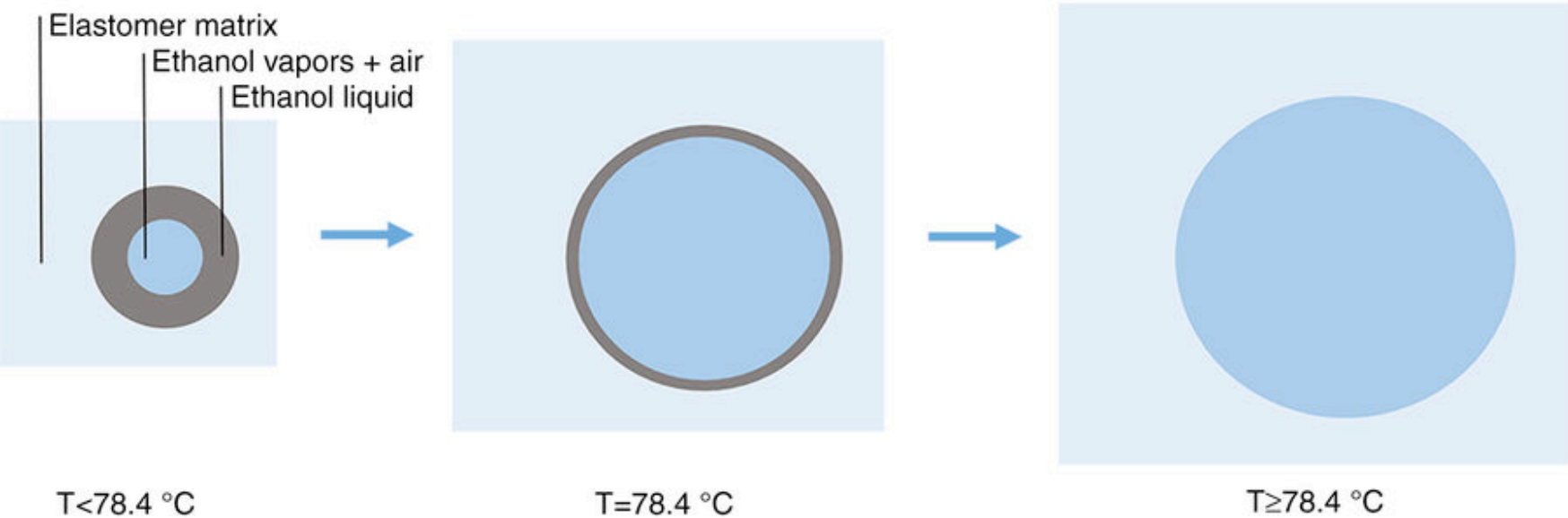


a



b



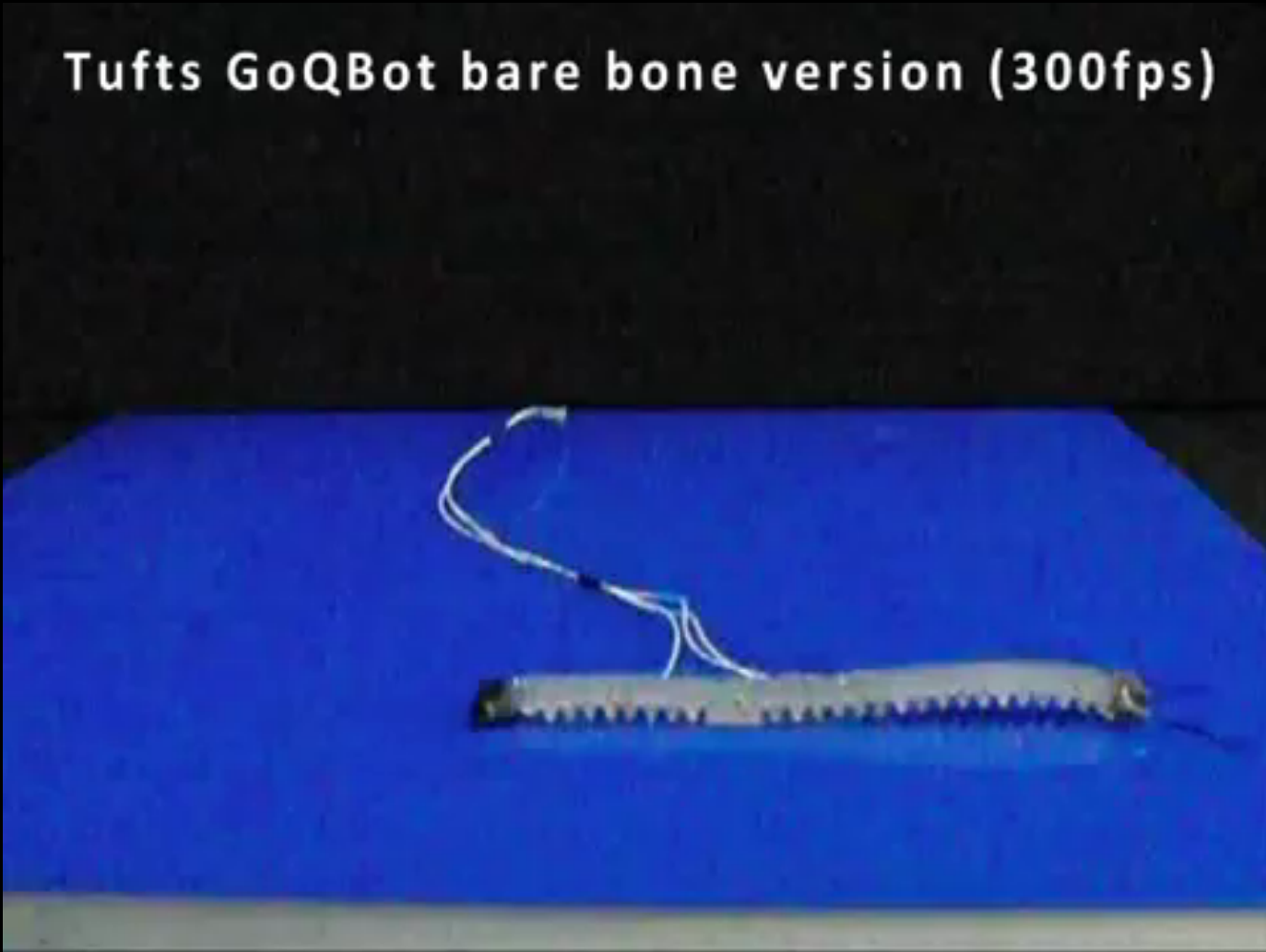
a**b**

[Article en ligne sur le site du cours](#)

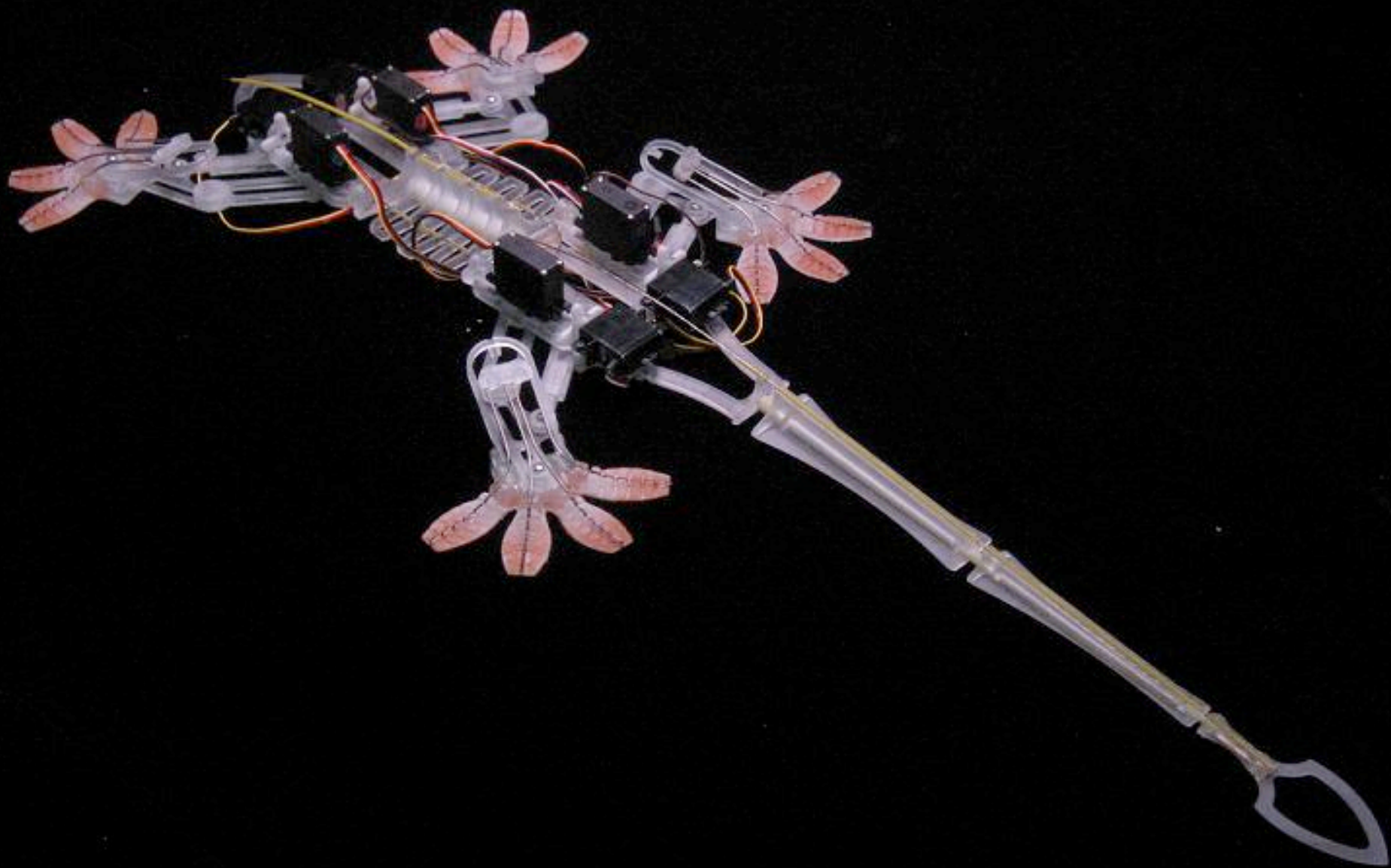
[Procédure](#)

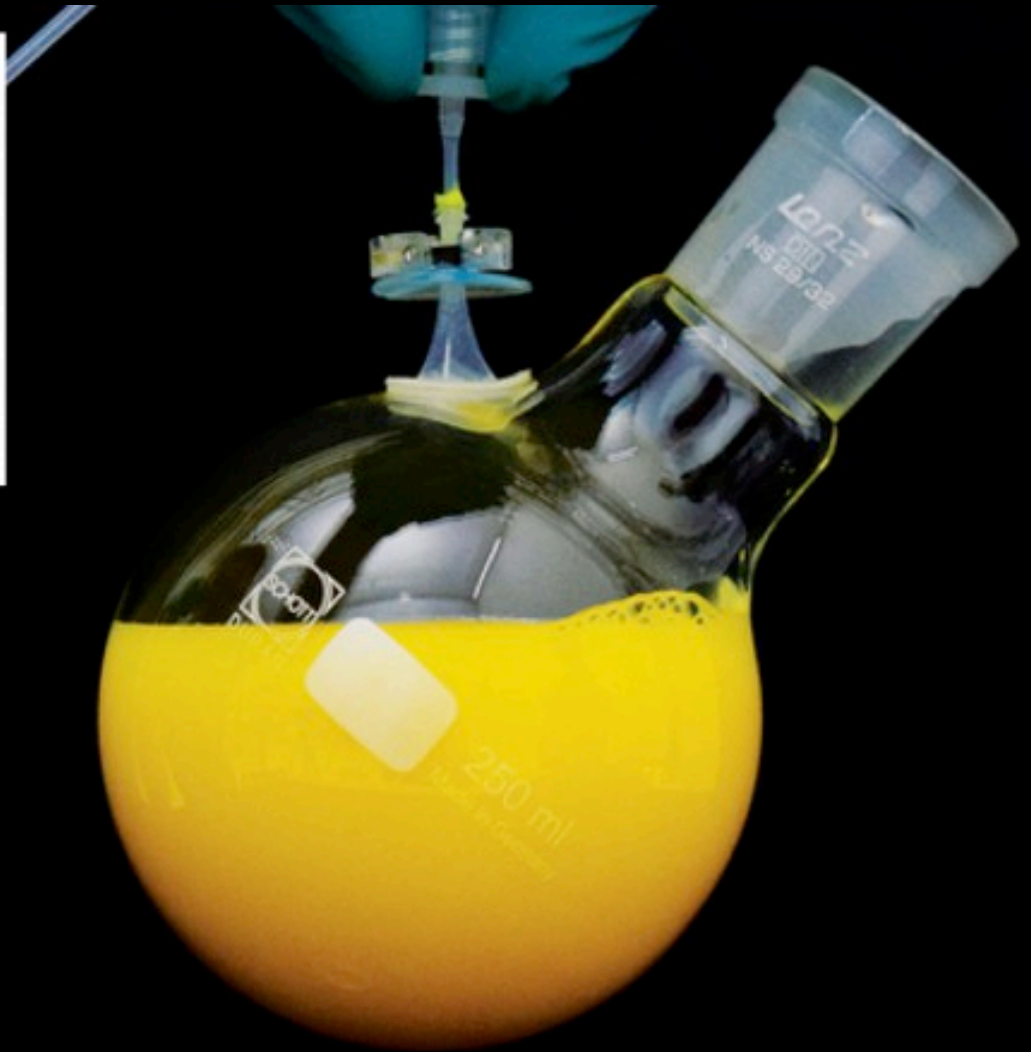
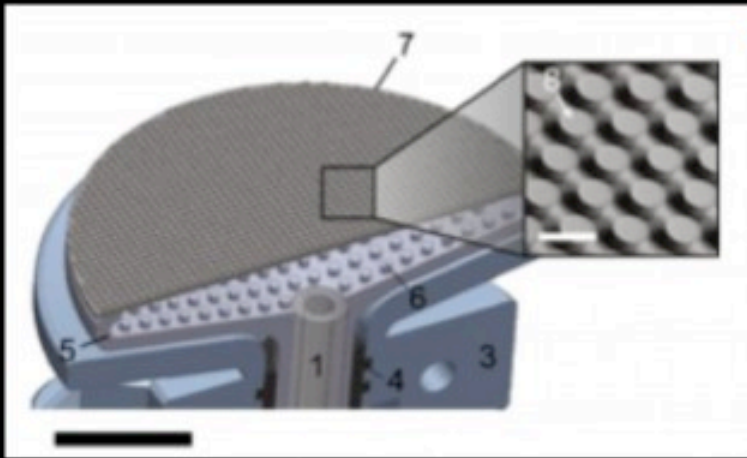
Déplacement plus rapide

Tufts GoQBot bare bone version (300fps)

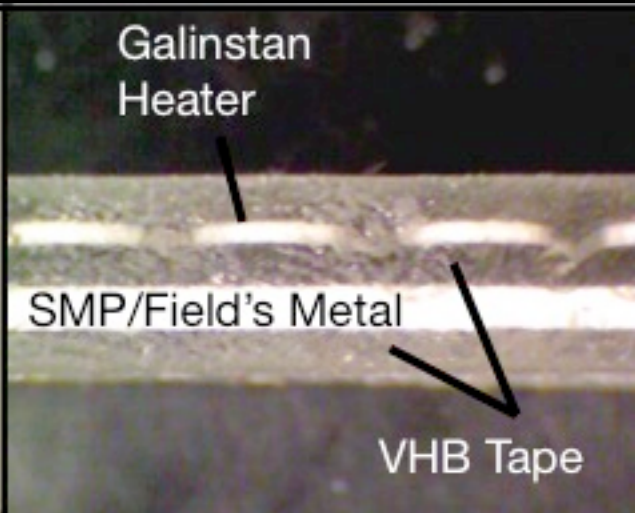
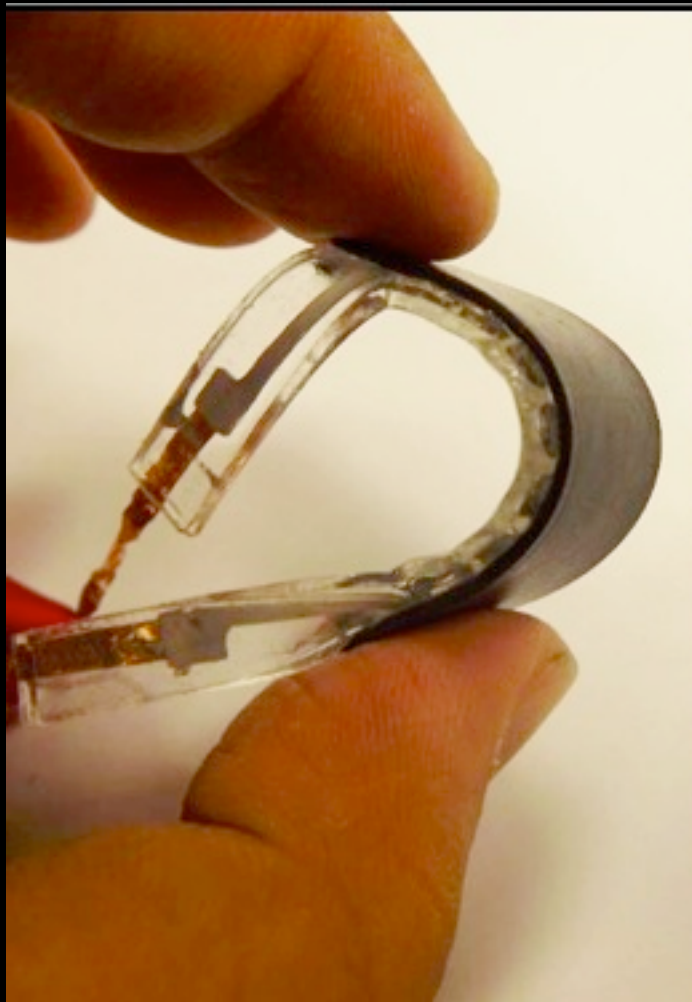








SML : Soft Machine Lab
Carnegie Mellon University, Pittsburgh



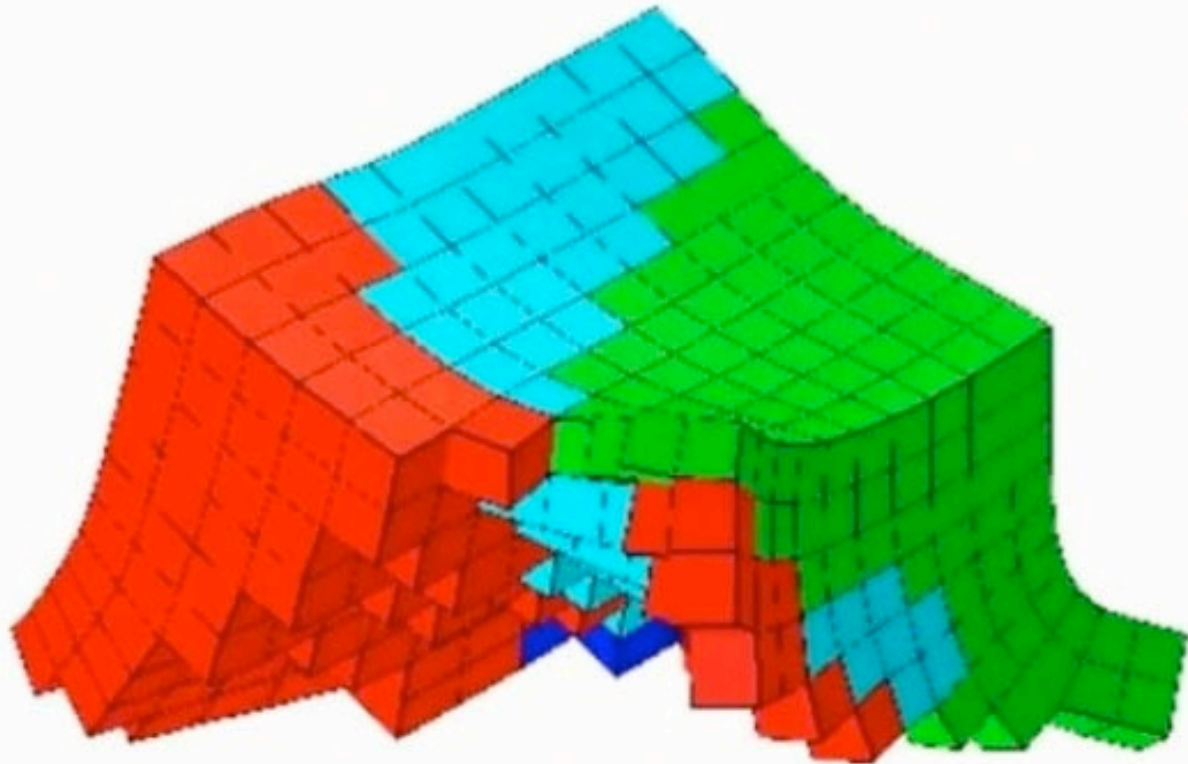
Intelligence adaptative

Dans le software + le hardware

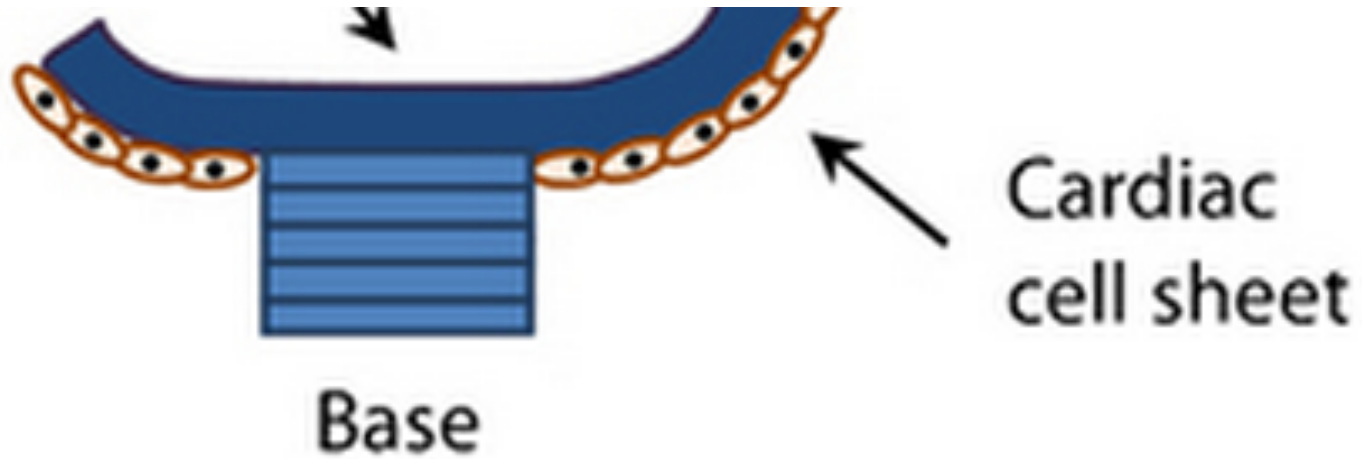


Rétroaction


Evolution in action



Un bio-bot qui marche



 Cardiac cells

 Cantilever hydrogel material

Bio-Bot:

A soft, biological robot
less than a centimeter long

Article de revue

[http://3heads4nosels.hybridprocess.org/
publications_articles/](http://3heads4nosels.hybridprocess.org/publications_articles/)

Untethered soft robotics

Steven I. Rich, Robert J. Wood and Carmel Majidi