

11 Dicembre 2025

GREEN THINKING

INNOVAZIONE E SOSTENIBILITÀ
PER VIVERE IL FUTURO



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LIFE COMPANY



Tecnologie Green:

Idee che cambiano il mondo

Valerio Galli

11 Dicembre 2025



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Elettronica Commestibile

Batterie, Transistor & Co.

Valerio Galli

11 Dicembre 2025



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Indice

- 01 Chi sono
- 02 Elettronica commestibile
- 03 Dispositivi elettronici commestibili
- 04 Batterie commestibili
- 05 Robot commestibili

Chi sono

Il mio percorso



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Il mio percorso



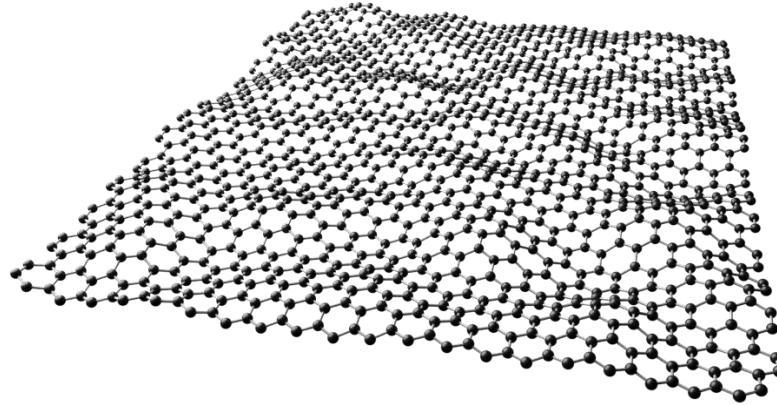
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Il mio percorso



Ingegneria dei Materiali e delle Nanotecnologie @PoliMi



Tesi magistrale @BeDimensional



Dottorato in Fisica @IIT



Istituto Italiano di Tecnologia

I Centri IIT



Sede Centrale, GENOVA
(CCT, CHT, CIIR, CRIS, NSYN)



Center for Advanced Biomaterials for Health
Care, Università Federico II di Napoli, NAPOLI



Center for Biomolecular Nanotechnologies,
Università del Salento, LECCE



Center for Clinical and Computational
Genomics, AOSTA



Center for Cultural Heritage Technology, R-
FARM, RONCADE



Center for Genomic Science,
Campus FOM-IEO, MILANO



Center for Life Nano & Neuroscience,
Sapienza Università di Roma, ROMA



Center for Material Interfaces,
Scuola Superiore Sant'Anna, PONTEDERA



Center for Nano Science and Technology,
Politecnico di Milano, MILANO



Center for Nanotechnology Innovation,
Scuola Normale Superiore, PISA



Center for Neuroscience and Cognitive
Science, Università di Trento, TRENTO



Center for Sustainable Future Technologies,
Politecnico di Torino, TORINO



Center for Translational Neurophysiology,
Università di Ferrara, FERRARA

U.S. OUTSTATION



IIT@Harvard
Harvard University, CAMBRIDGE, MA (USA)



IIT@MIT Massachusetts Institute of
Technology, CAMBRIDGE, MA (USA)



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Printed and Molecular Electronics @CNST, IIT



Mario Caironi, PI

- 1 Technologist
- 2 Researchers
- 7 Post-Docs
- 9 PhDs



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Elettronica Commestibile

INGOMBRO
WEBCAM RELATORE

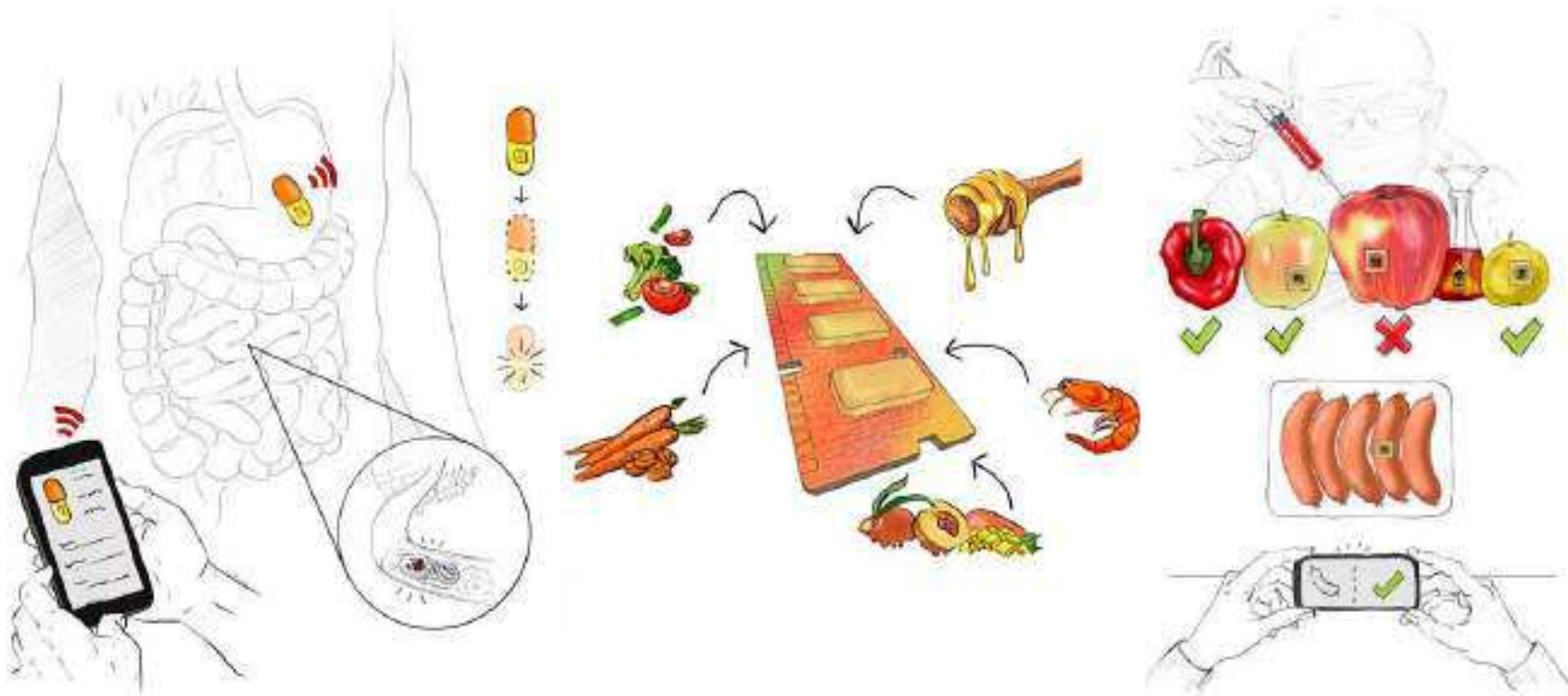
Perché? Cos'è? Come si fa?



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Perché elettronica commestibile?



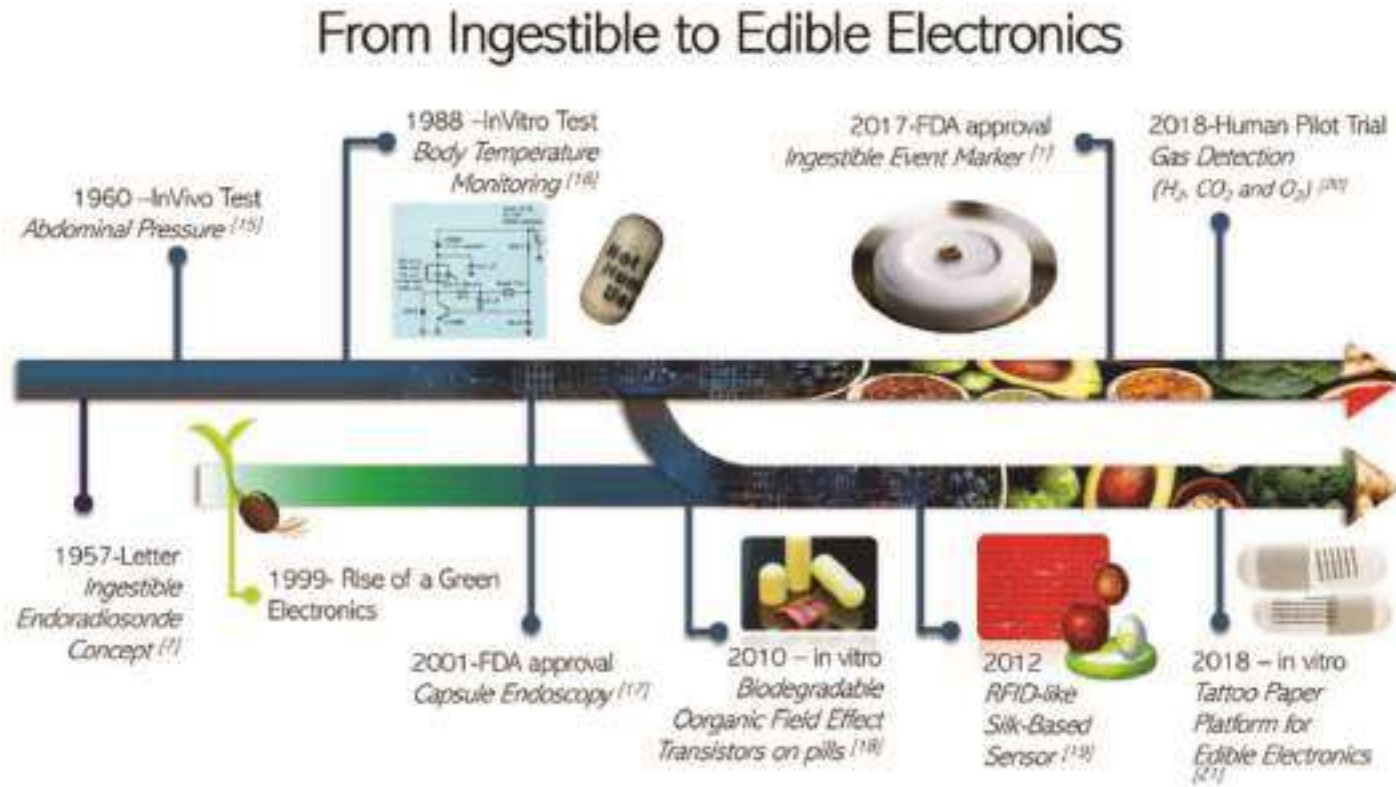
Sharova, Alina S., et al. "Edible electronics: The vision and the challenge." *Advanced Materials Technologies* 6.2 (2021): 2000757.



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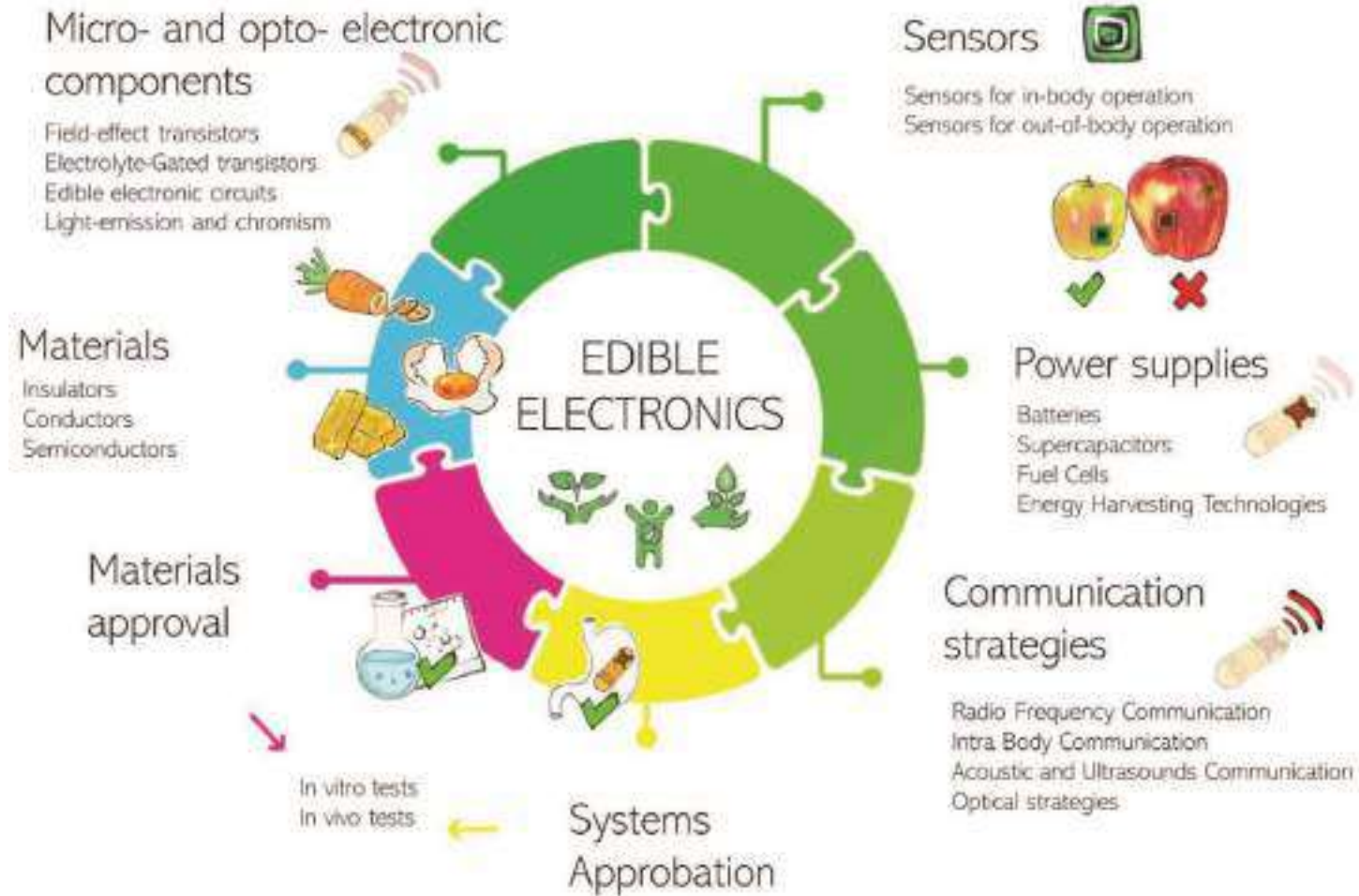
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Elettronica ingeribile



Sharova, Alina S., et al. "Edible electronics: The vision and the challenge." *Advanced Materials Technologies* 6.2 (2021): 2000757.

Cosa ci serve



Sharova, Alina S., et al. "Edible electronics: The vision and the challenge." *Advanced Materials Technologies* 6.2 (2021): 2000757.



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Cibo per l'elettronica



Sharova, Alina S., et al. "Edible electronics: The vision and the challenge." *Advanced Materials Technologies* 6.2 (2021): 2000757.

Isolanti



Conduttori



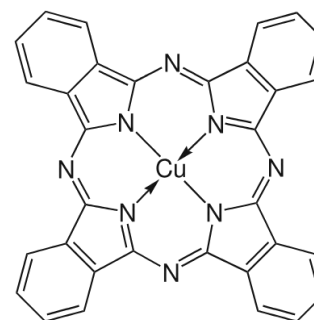
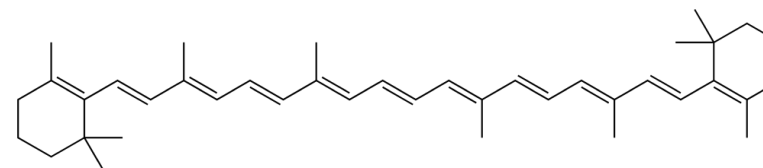
Sharova, Alina S., et al. "Edible electronics: The vision and the challenge." *Advanced Materials Technologies* 6.2 (2021): 2000757.



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Semiconduttori



Sharova, Alina S., et al. "Edible electronics: The vision and the challenge." *Advanced Materials Technologies* 6.2 (2021): 2000757.

Dispositivi elettronici commestibili

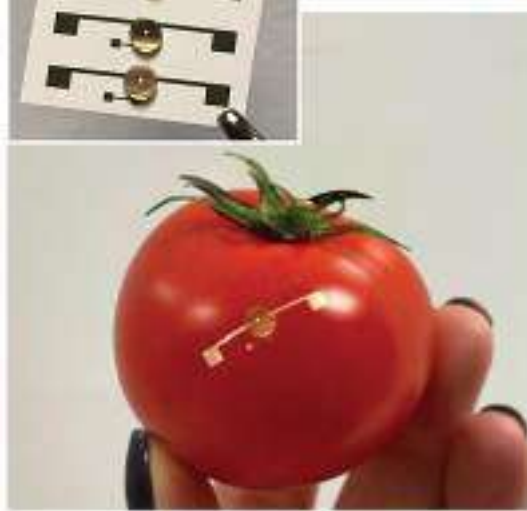
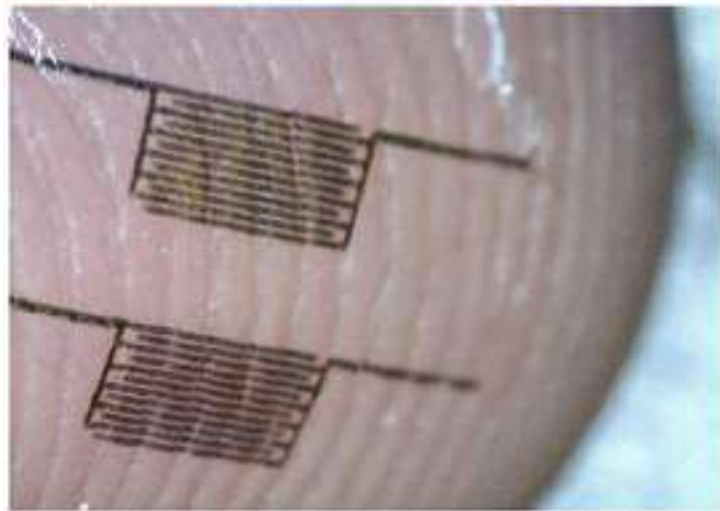
Cosa abbiamo realizzato finora



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Transistor



Sharova, Alina S., et al. "Chitosan-gated organic transistors printed on ethyl cellulose as a versatile platform for edible electronics and bioelectronics." *Nanoscale* (2023).
Sharova, Alina S., and Mario Caironi. "Sweet Electronics: Honey-Gated Complementary Organic Transistors and Circuits Operating in Air." *Advanced Materials* 33.40 (2021): 2103183.
Feltri, Elena, et al. "A fully edible transistor based on a toothpaste pigment." *Advanced Science* 11.41 (2024): 2404658.



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Sensori



Ilic, Ivan K., et al. "Self-powered edible defrosting sensor." *ACS sensors* 7.10 (2022): 2995-3005.

Annese, Valerio F., et al. "An Edible Bistable Tilt Sensor Enabling Autonomous Operation of a Partially Eatable Rolling Robot." *Advanced Sensor Research* 2.12 (2023): 2300092.



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Batterie



TIME
BEST
INVENTIONS
2023



Ilic, Ivan K., et al. "An edible rechargeable battery." *Advanced Materials* 35.20 (2023): 2211400.
Galli, Valerio, et al. "A Coplanar Edible Rechargeable Battery with Enhanced Capacity." *Advanced Materials Technologies* (2024): 2400715.



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Batterie commestibili

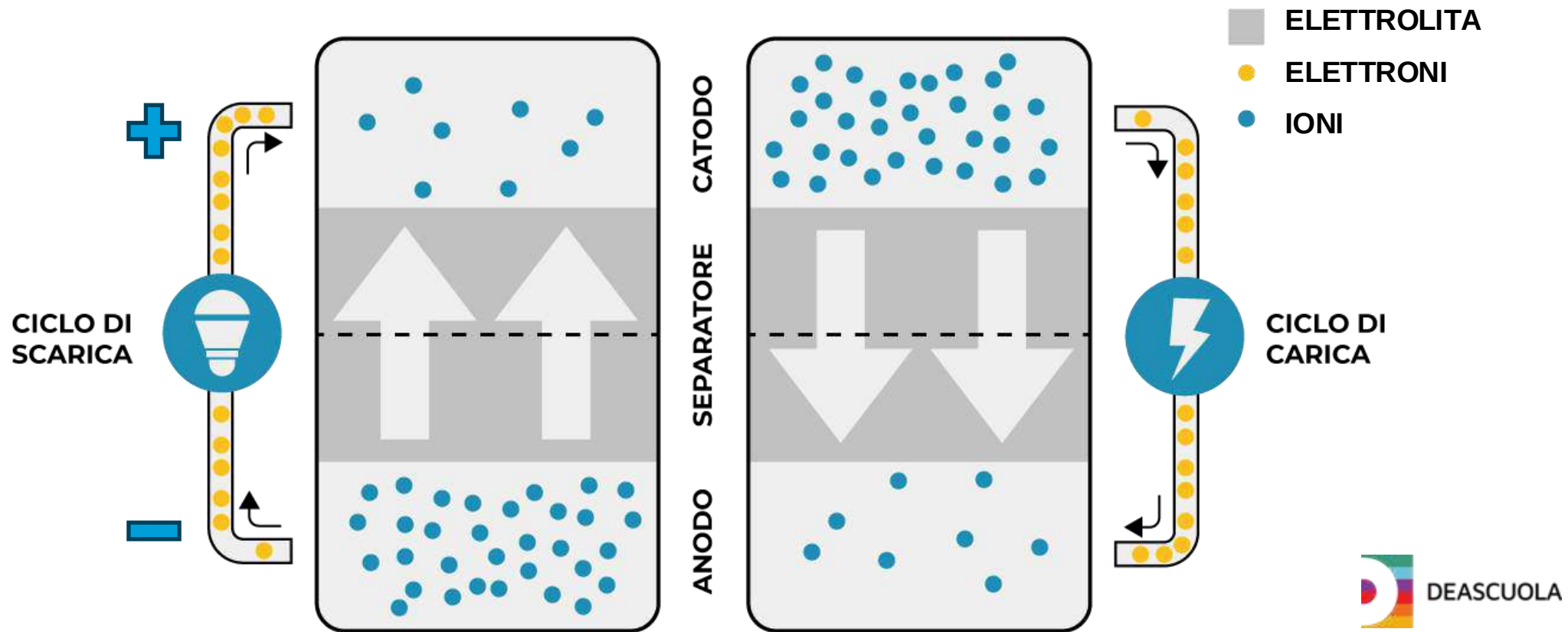
Come sono fatte e come funzionano

Cos'è una batteria

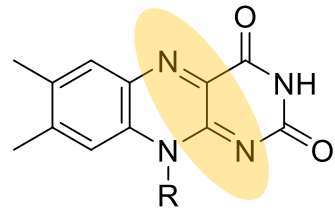
È un dispositivo che converte l'energia chimica in energia elettrica mediante una reazione di ossidoriduzione.

Batterie non ricaricabile (es. alcaline 1.5 V)

Batterie ricaricabili (es. litio 3.7 V)



Materiali commestibili per batterie



RIBOFLAVINA

Anodo

NaHSO_4

Elettrolita

CERA D'API

Packaging



Catodo



Filler conduttivo
+ Binder

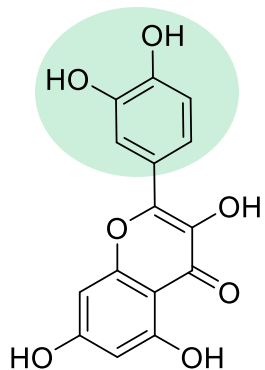


Separatore



Collettore di
corrente
ORO

QUERCETINA



CARBONE ATTIVO
+
ETILCELLULOSA

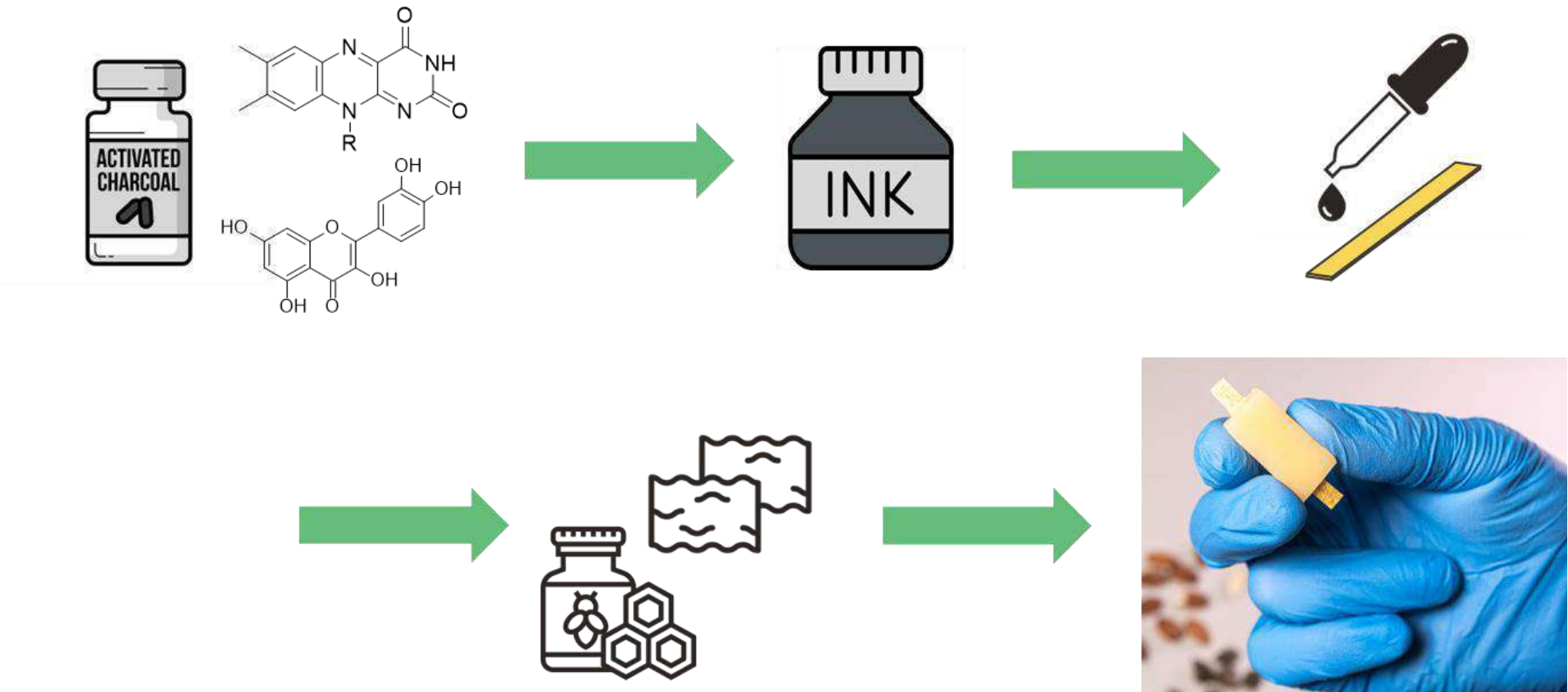
NORI



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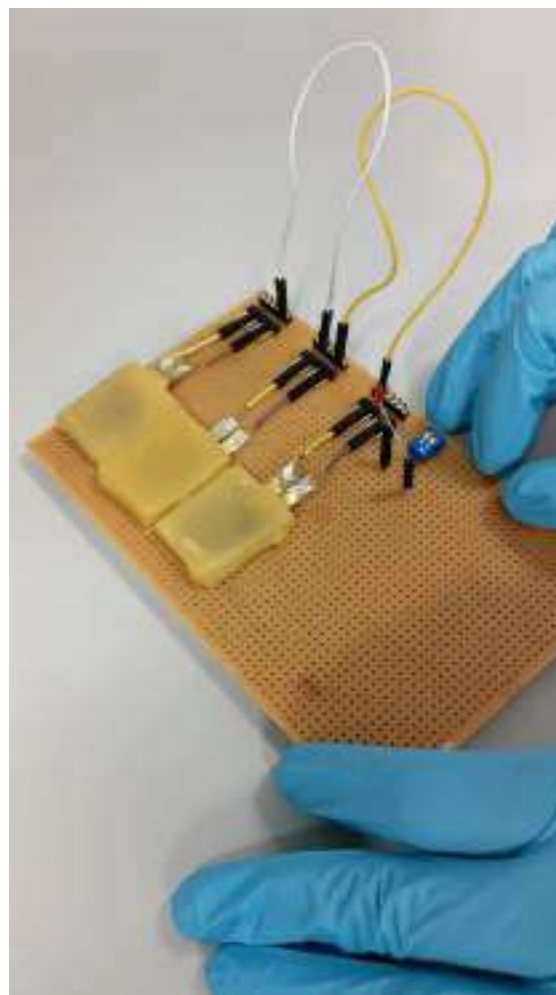
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Come si fa



Caratteristiche e funzionamento

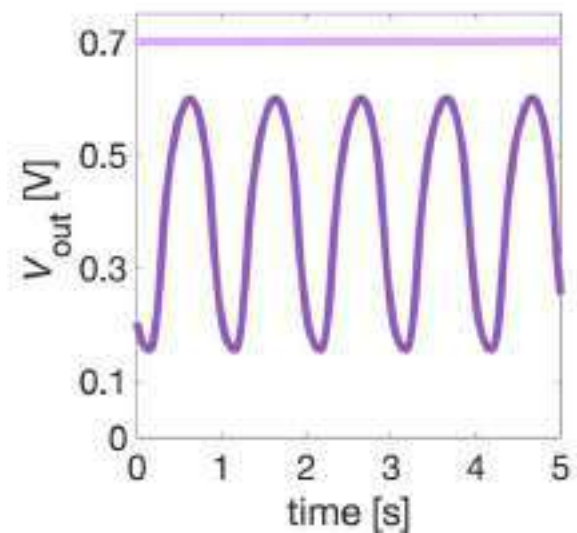
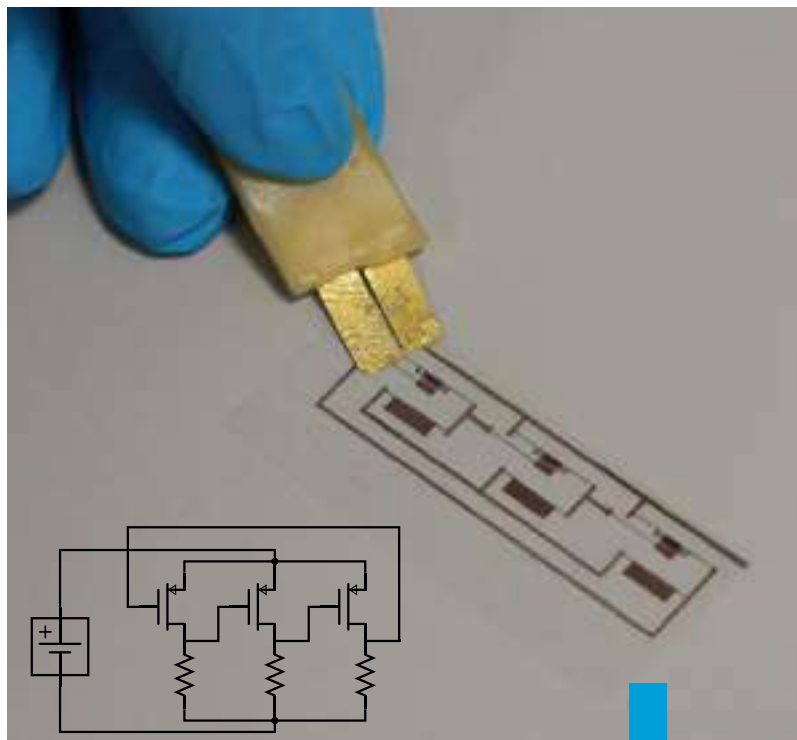
- Tensione ~ 0.65 V
- Capacità 20 μ Ah
- Ricaricabile
- Completamente commestibile



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Verso pillole intelligenti commestibili



Coco, Giulia, et al. "Printed Integrated Logic Circuits Based on Chitosan-Gated Organic Transistors for Future Edible Systems." *Advanced Functional Materials* (2025): e06452.
Lamanna, L., et al. "Monitoring of Drug Release via Intra Body Communication with an Edible Pill." *Advanced Materials Technologies* 8.1 (2023): 2200731



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Robot Commestibili

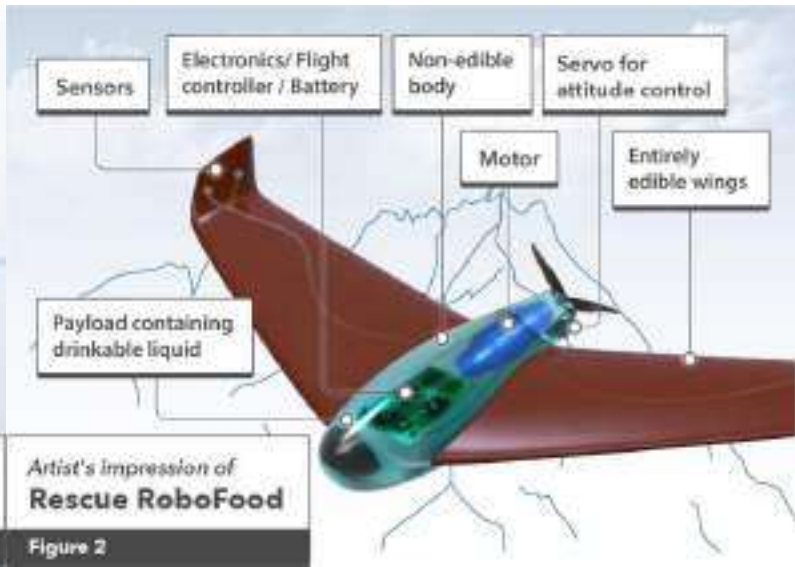
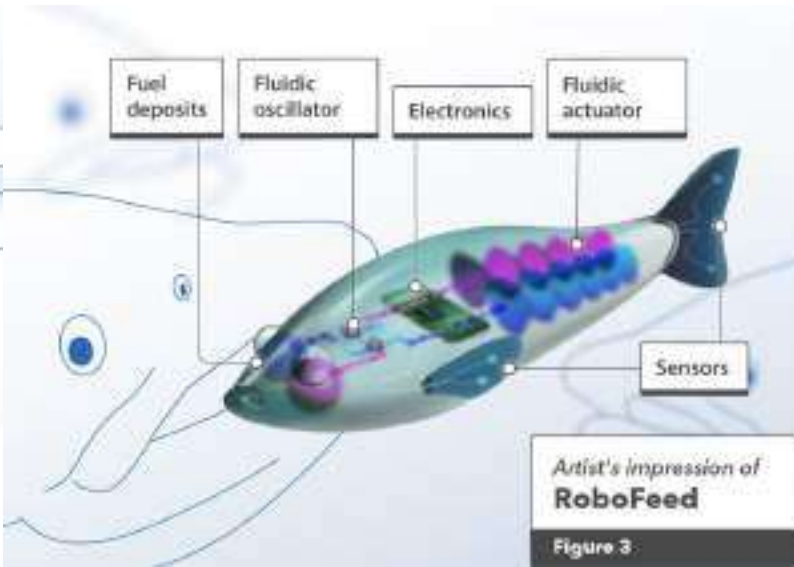
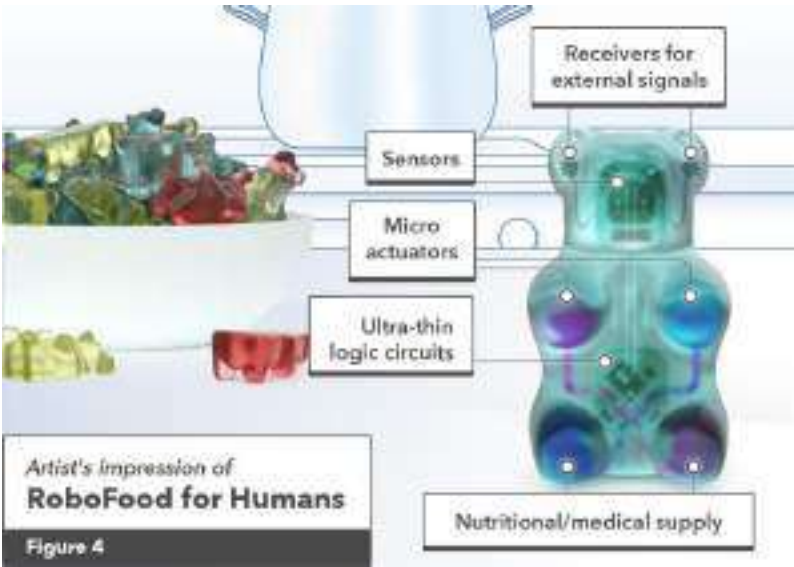
Perché? Cosa sono?



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Robot commestibili



ROBOFOOD



Robot commestibili



Annese, Valerio F., et al. "An Edible Bistable Tilt Sensor Enabling Autonomous Operation of a Partially Eatable Rolling Robot." *Advanced Sensor Research* 2.12 (2023): 2300092.

Zhang, Shuhang, et al. "Edible aquatic robots with Marangoni propulsion." *Nature Communications* 16.1 (2025): 4238.

Un nuovo approccio alla gastronomia



ALCHEMIST



The Fat Duck
heston blumenthal



mugaritz



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Batterie al cioccolato e orsetti gommosi a EXPO 2025 Osaka



Batterie al cioccolato e orsetti gommosi a EXPO 2025 Osaka



Wired Podcast



<https://www.wired.it/article/wired-iit-raccontano-futuro-podcast-mangeremo-robot/>



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POLITECNICO
MILANO 1863



ISTITUTO ITALIANO
DI TECNOLOGIA

ROBOFOOD



Horizon 2020
Programme



www.robofood.org
www.elfoproject.eu
www.pme.iit.it

Grazie!



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SCOPRI E ISCRIVITI AI PROSSIMI APPUNTAMENTI

per i docenti

nl.deascuola.it/greenthinking

13.01.2026 / 17:00-18:30

Innovazione green
Esempi virtuosi a
confronto, quali
competenze allenare a
scuola

Ilaria Zanardi
Rappresentante A2A

05.02.2026 / 17:00-18:30

**AI, innovazione e
sostenibilità: equilibri e
opportunità**

Luigi Borgogno
Rappresentante A2A

25.02.2026 / 17:00-18:30

**AI può cambiare il
modo di fare scuola**

Adriano Mancini



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SCOPRI E ISCRIVITI AI PROSSIMI APPUNTAMENTI

per gli studenti

nl.deascuola.it/greenthinking

20.01.2026 / 11:00-12:00

Green Jobs

**Le professioni del futuro
sono già qui**

Rappresentante A2A

12.02.2026 / 11:00-12:00

Ecoansia e comunicazione

**Come affrontare le paure
e trasformarle in azione**

Serena Giacomini
Giulia Gialdi

14.04.2026 / 11:00-12:00

Giustizia Climatica e salute globale

**il futuro è anche una
questione di equità**

Serena Giacomini
Elisa Pisu



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