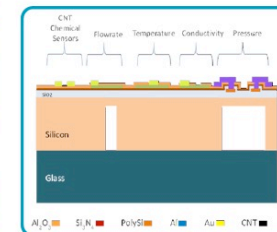
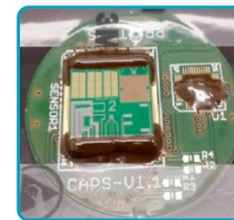
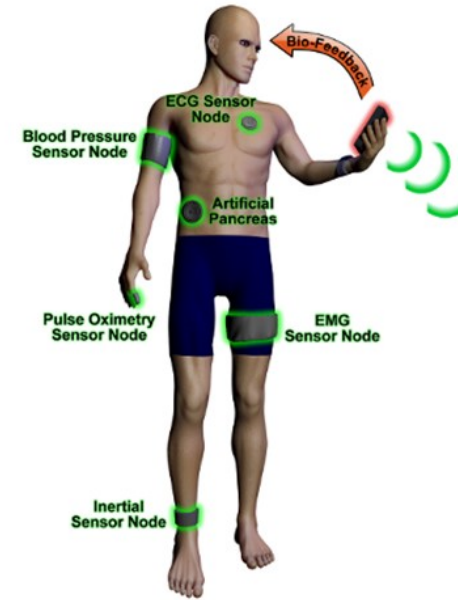
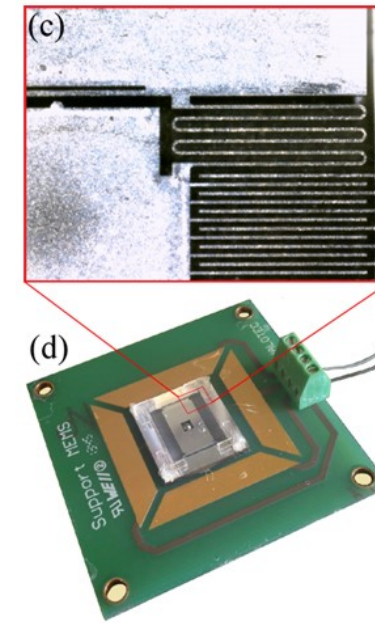
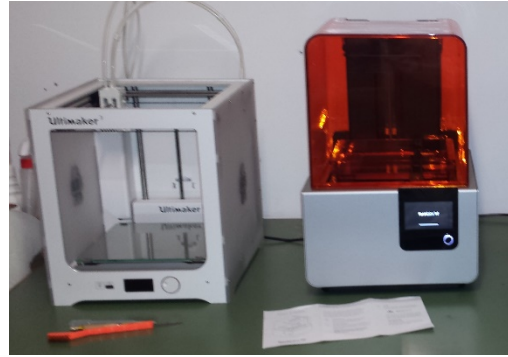
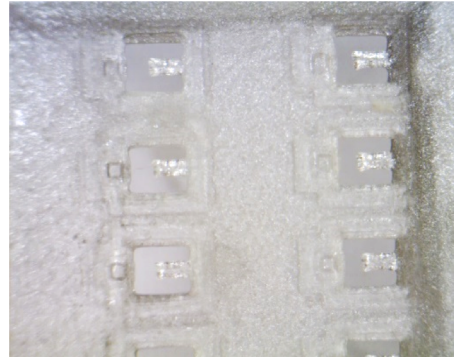
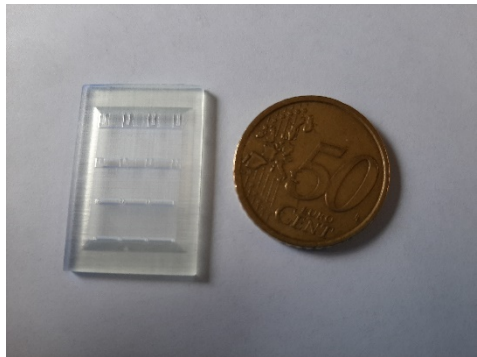


Sistemi di Energy Harvesting

- Sistemi **micro- e nano-elettromeccanici** (MEMS/NEMS) per il **recupero di energia vibrazionale** per sensori auto-alimentanti
- **Sensori autoalimentati** per il controllo dei parametri chimico-fisici dell'acqua (progetto ex-EU PROTEUS)
- Sistemi di **energy harvesting stampati in 3D** con materiali funzionalizzati (conduttivi)

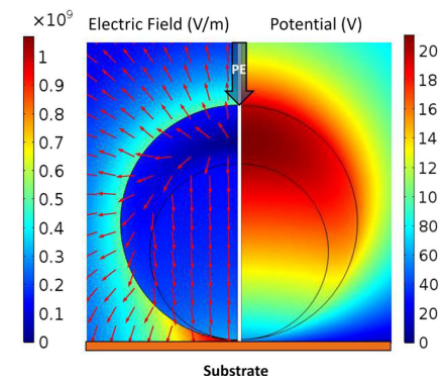
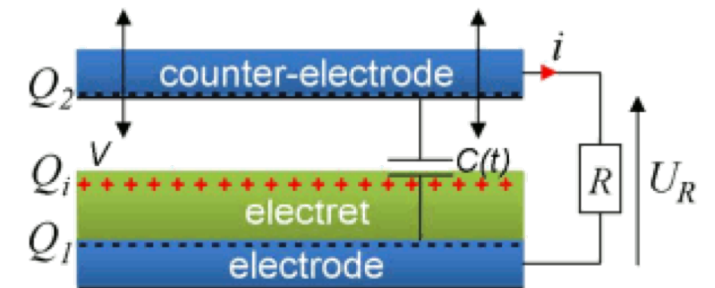
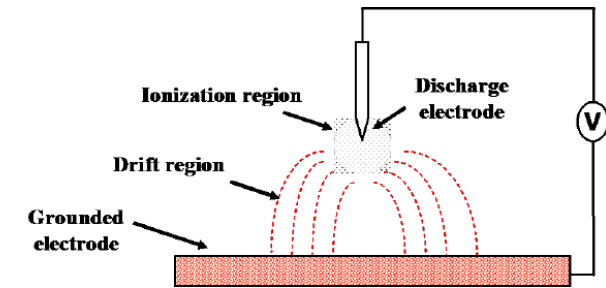
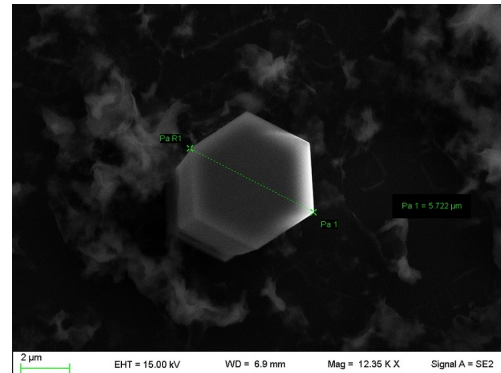
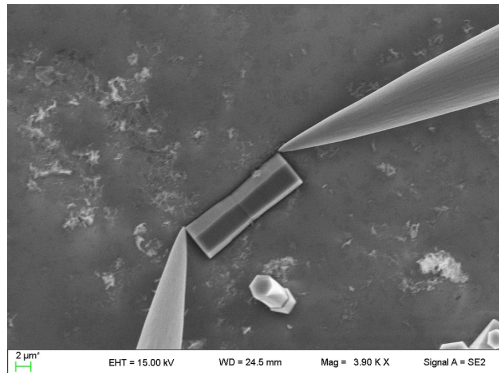


PROTEUS

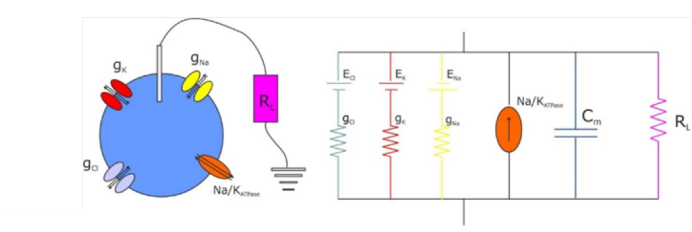
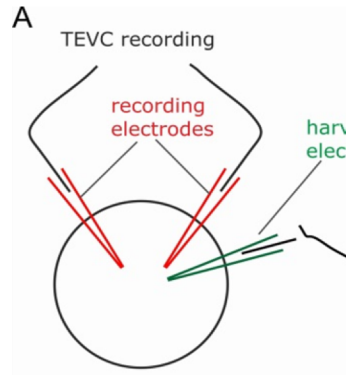
EnABLES

Materiali per Energy Harvesting

- Fabbricazione di **elettreti** per EH tramite scarica a corona (triennale)
- Fabbricazione di **piezoelettrici micro e nano strutturati** per energy harvesting



Energy Harvesting da cellule biologiche



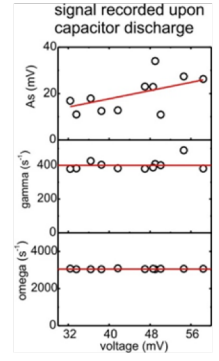
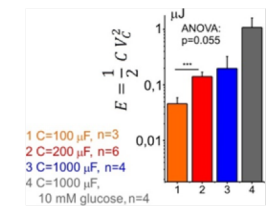
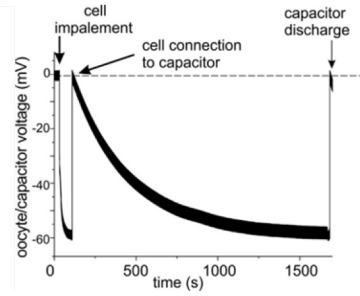
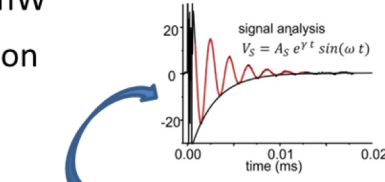
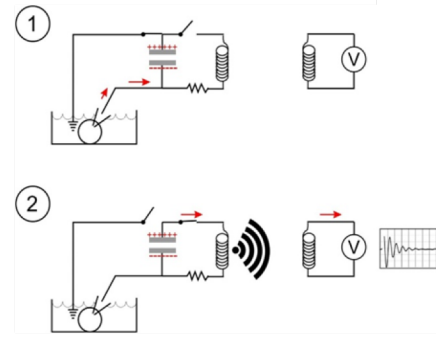
$$\frac{dV_m}{dt} = -\frac{I_m}{C_m}$$

$$\frac{d[ion]_i}{dt} = -\frac{I_{ion}}{z F V_{ol}}$$

$$P = I_L V_m$$

Parameter	Description	Value
r	Cell radius	7 μm
C_m	Specific membrane capacitance	0.01 $\text{pF}/\mu\text{m}^2$
g_{Ks}	Specific K channel conductance	$5 \cdot 10^{-4} \text{ nS}/\mu\text{m}^2$
g_{Na}	Specific Na channel conductance	$1 \cdot 10^{-4} \text{ nS}/\mu\text{m}^2$
g_{Cl}	Cl channel conductance	$1 \cdot 10^{-3} \text{ nS}/\mu\text{m}^2$
R_L	Load resistance	variable
p	Maximal turnover of the Na/K ATPase	133 ATP/s
D_{ATPase}	Density of Na/K ATPase	$3350/\mu\text{m}^2$
K_o	Extracellular K concentration	3 mM
Na_o	Extracellular Na concentration	142 mM
Cl_o	Extracellular Cl concentration	145 mM
nAA	Intracellular impermeable anions	0.198 pmol

Power harvested from a cell $\approx 1 \text{ nW}$
 Power required by next-generation biosensors $\approx 1 \mu\text{W}$



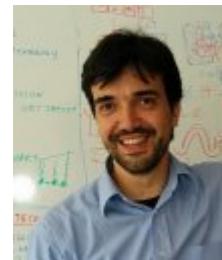
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