

Università degli studi di Padova

DEPARTMENT OF
INFORMATION
ENGINEERING

UNIVERSITY OF PADOVA



Chimica per l'elettronica

Fuel Cell

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CORSO DI LAUREA MAGISTRALE IN INGEGNERIA ELETTRONICA

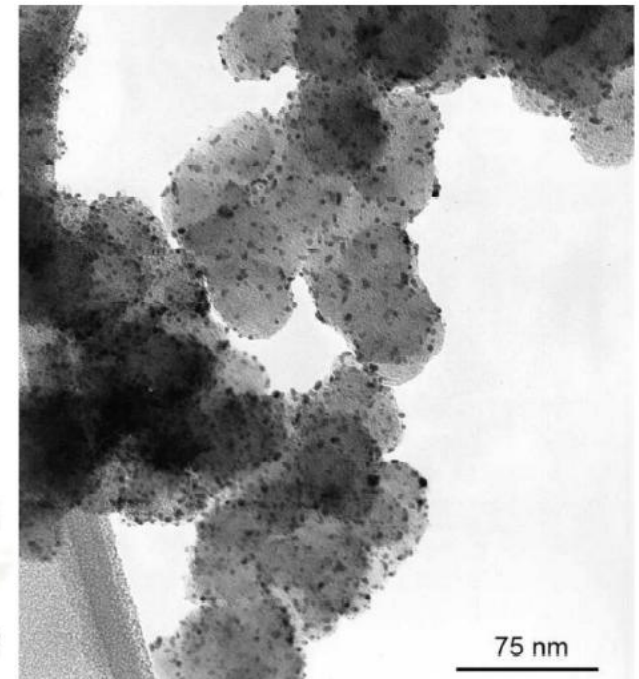
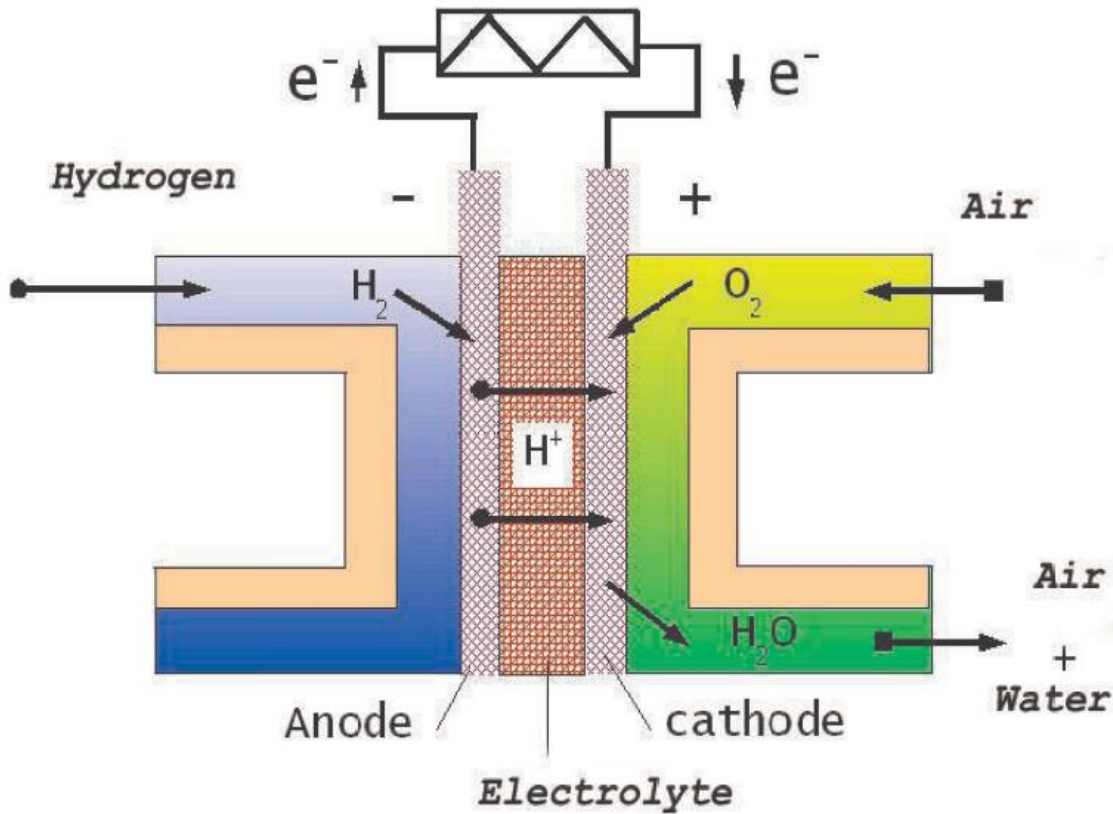


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1. Principio di funzionamento





2. Aspetti elettro-chimici

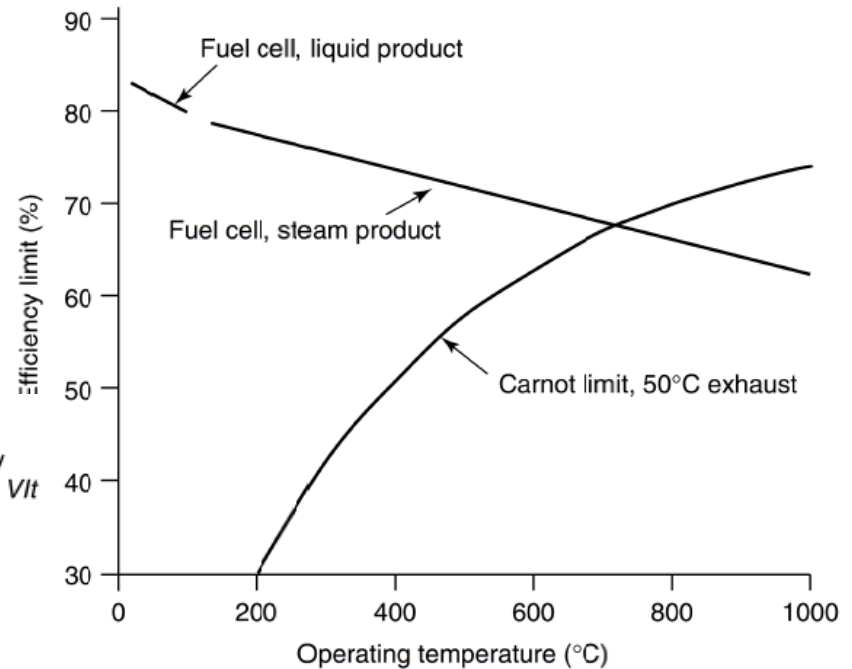
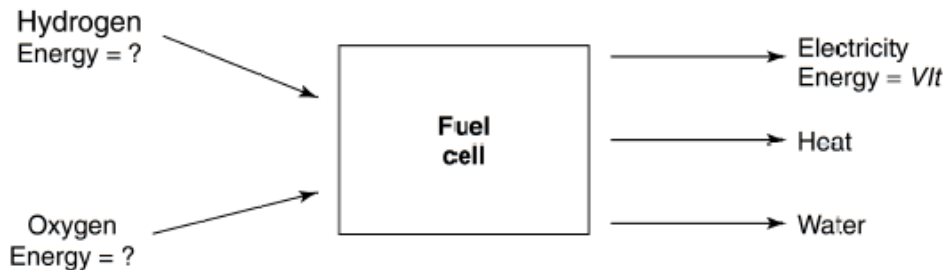
- L'energia libera di Gibbs
- Open Circuit Voltage (OCV)
- Limiti di efficienza

$$E = \frac{-\Delta \bar{h}_f}{2F} = \begin{cases} 1.48 \text{ V} & \text{HHV} \\ 1.25 \text{ V} & \text{LHV} \end{cases}$$

$$\eta = \mu_f \cdot \frac{V}{1.48} \cdot 100\%$$

Equazione di Nerst

$$E = E^0 + \frac{RT}{2F} \ln\left(\frac{P_{H_2} \cdot P_{O_2}^{\frac{1}{2}}}{P_{H_2O}}\right)$$



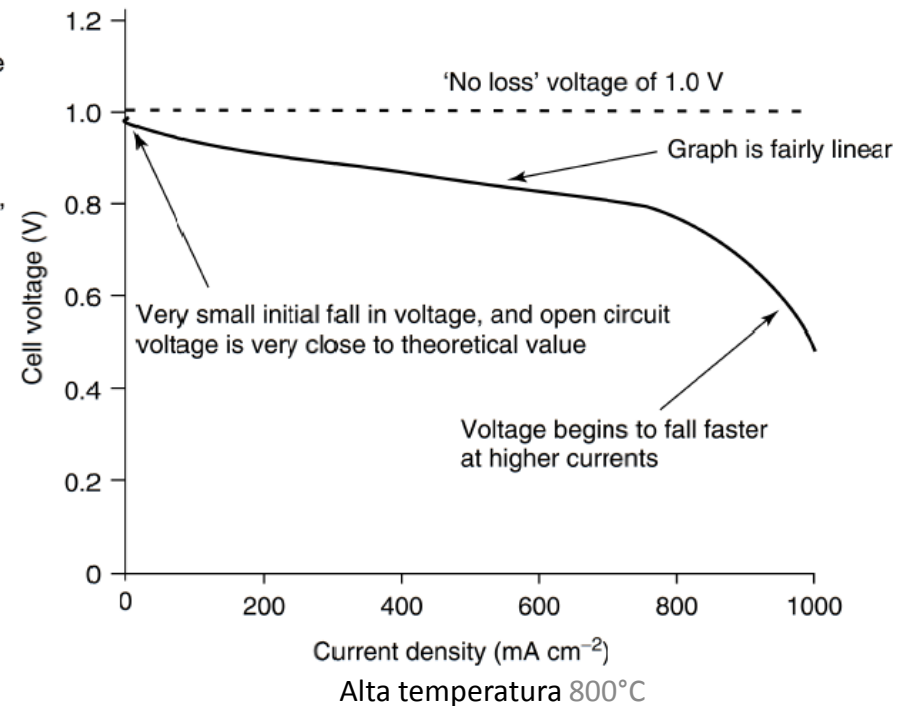
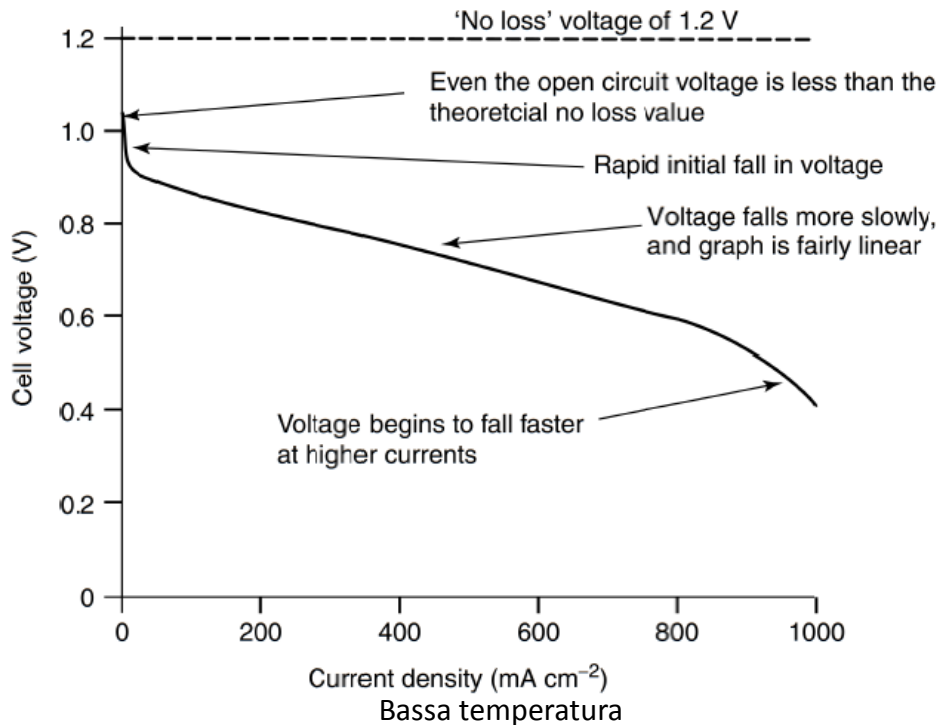


2. Aspetti elettro-chimici

- Caratteristiche I-V

$$V = E - \Delta V_{Ohm} - \Delta V_{act} - \Delta V_{trans}$$

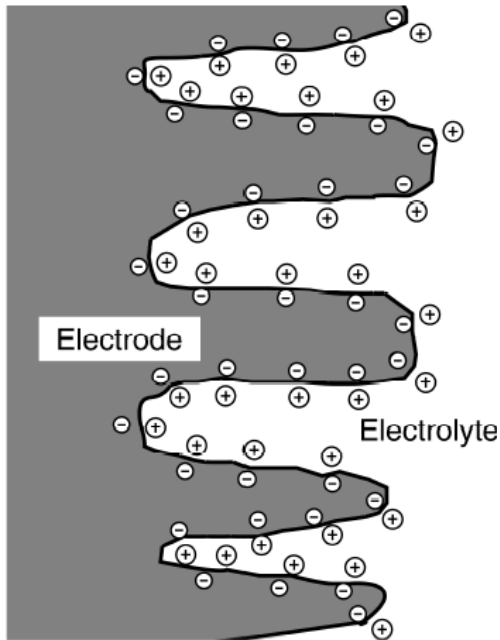
- Perdite di attivazione
- Fuel crossover
- Perdite resistive
- Perdite di concentrazione



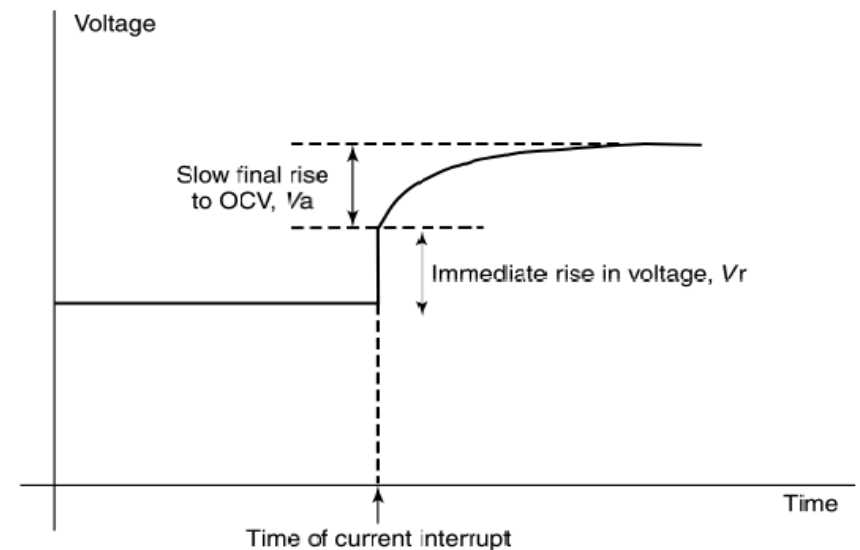
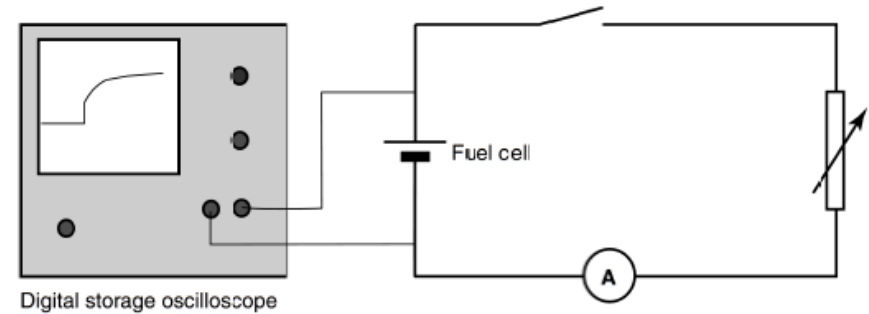
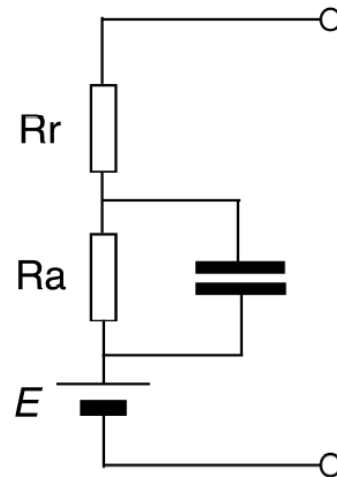


2. Aspetti elettro-chimici

- Charge double layer



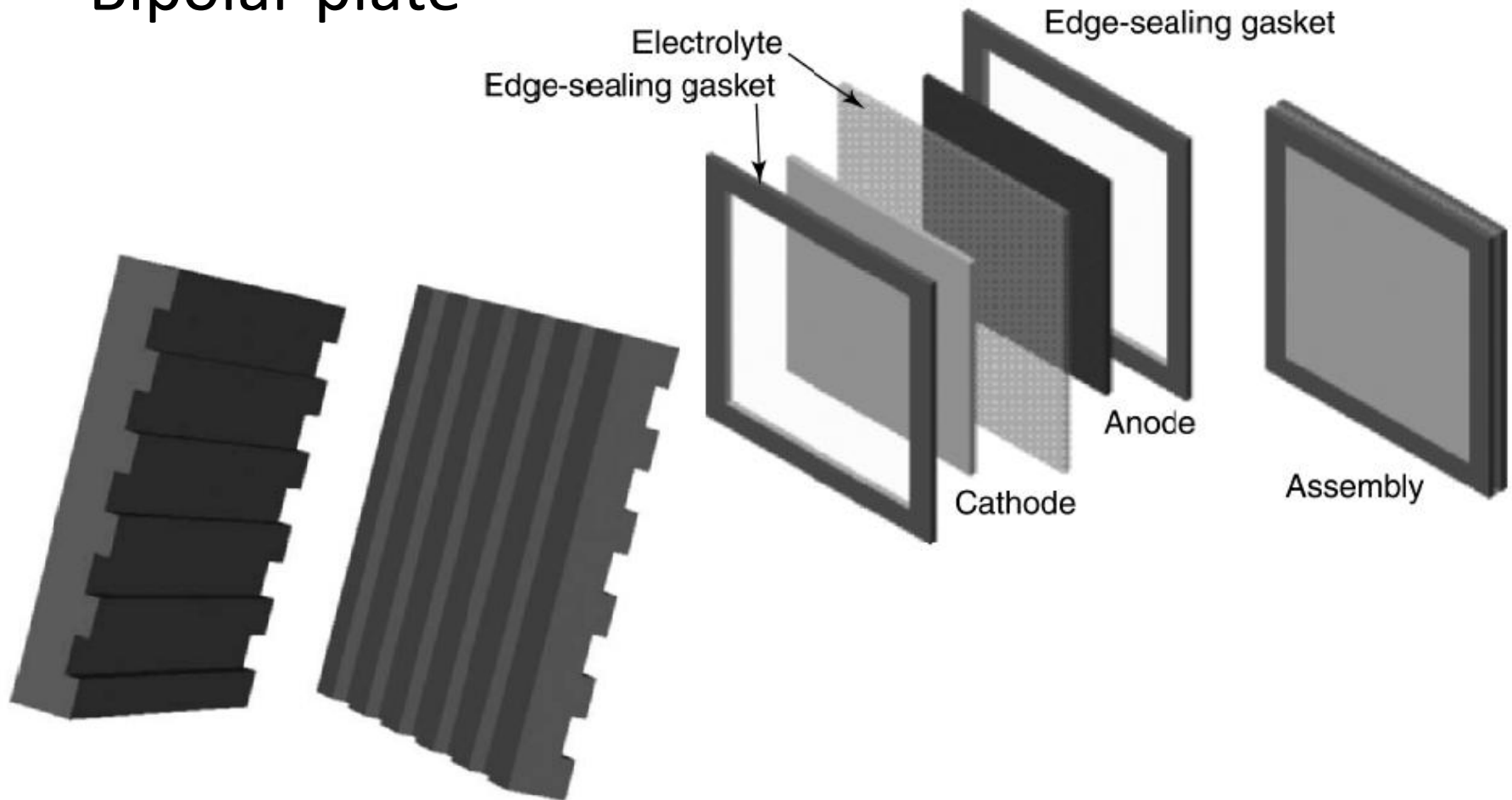
$$C = \epsilon \frac{A}{d}$$





3. Realizzazione

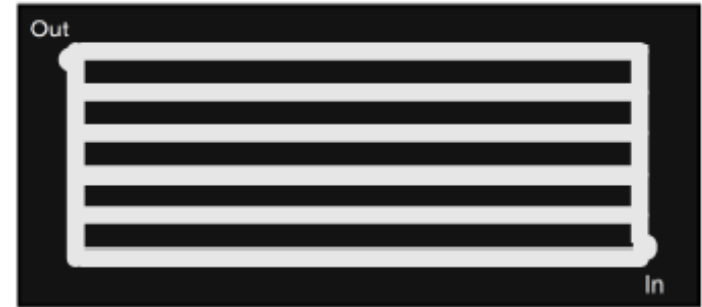
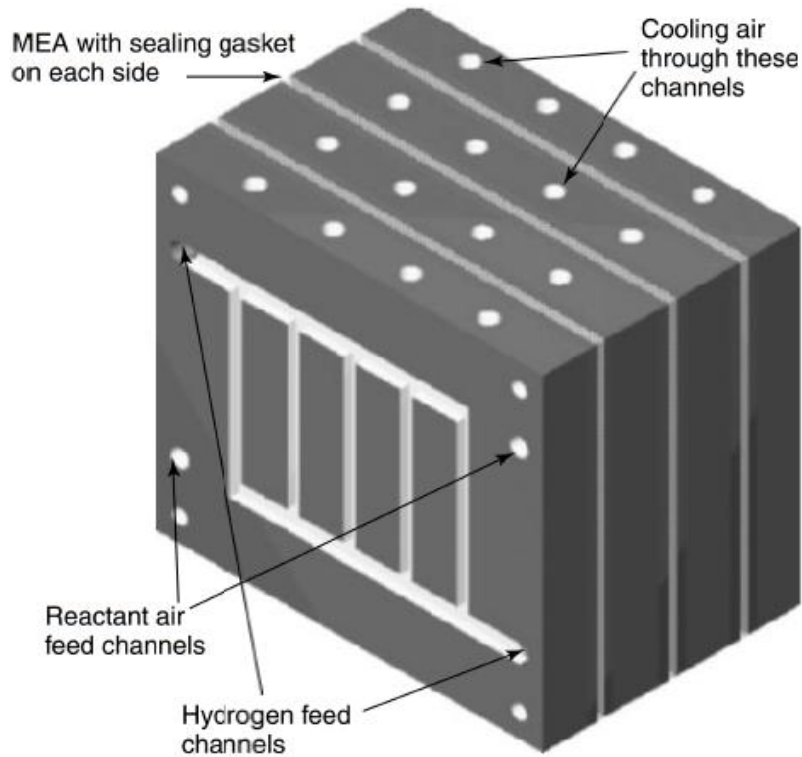
- Bipolar plate





3. Realizzazione

- Bipolar plate - pattern



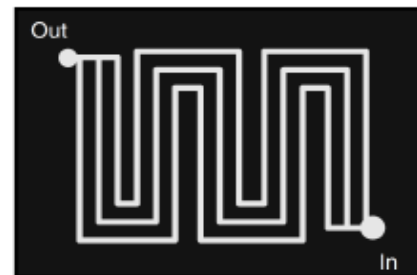
(e) Long parallel



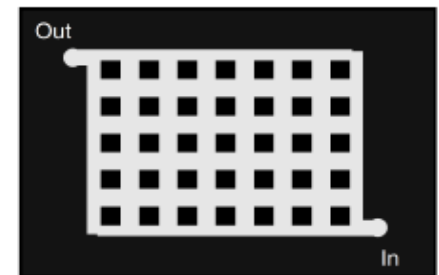
(a) Parallel



(b) Serpentine



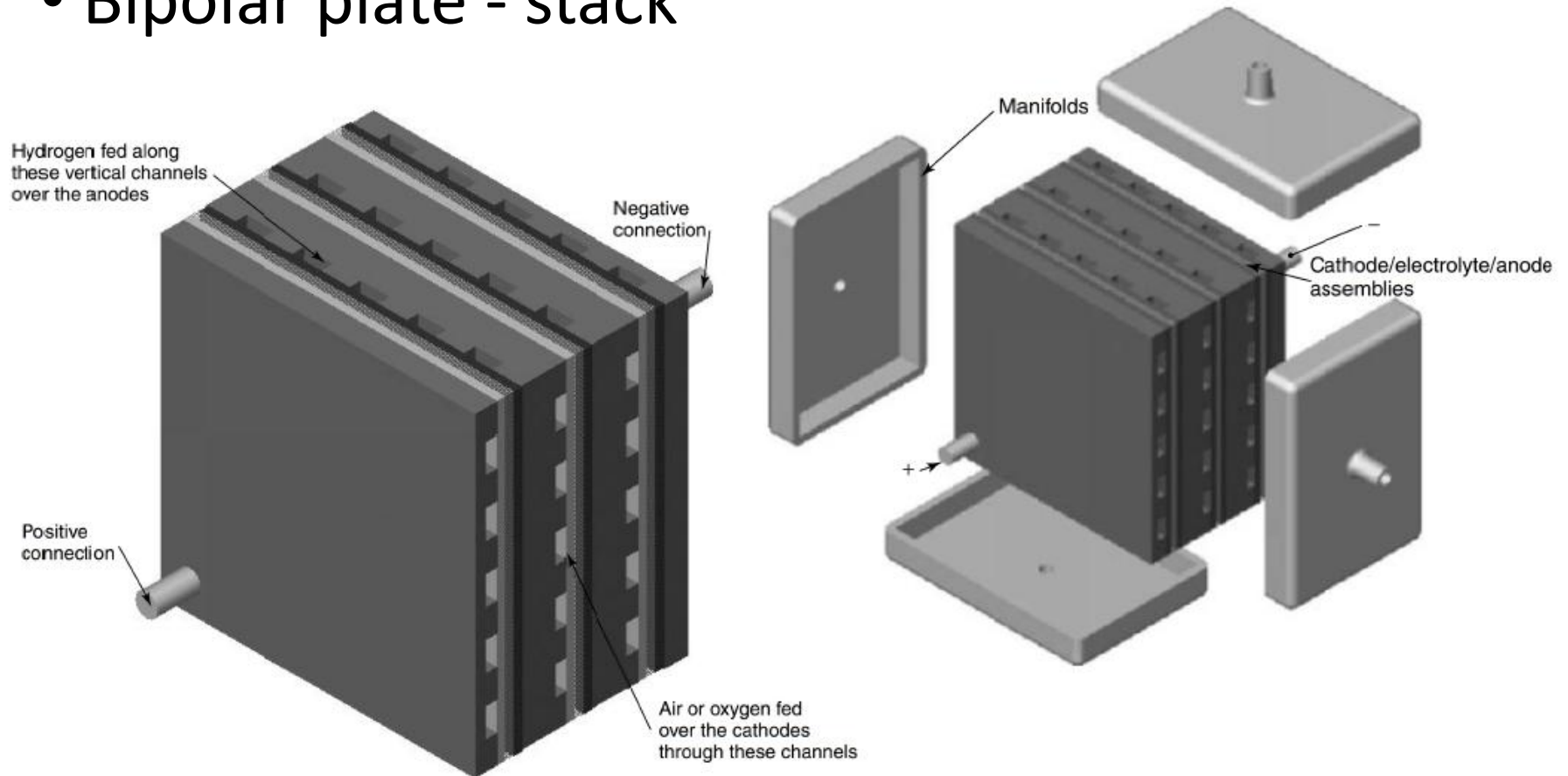
(c) Parallel serpentine



(d) Grid

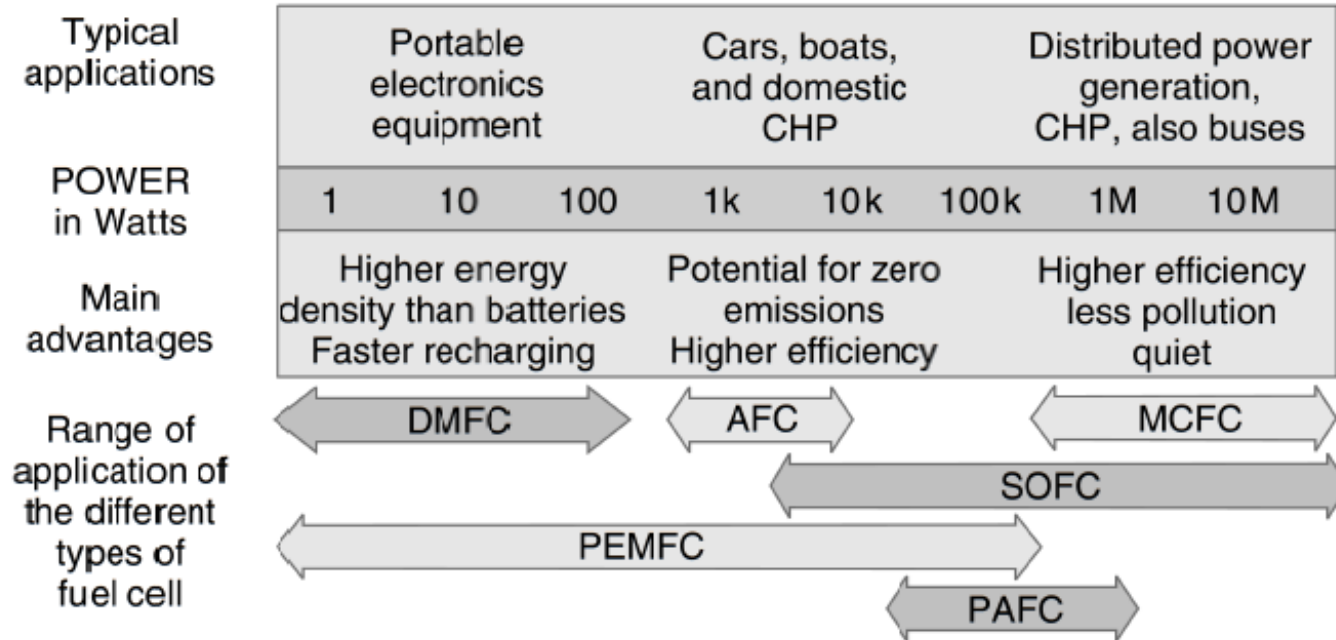
3. Realizzazione

- Bipolar plate - stack





4. Tipi di fuel cell



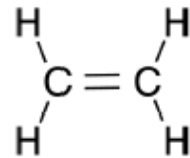
Sigla	Tipo	Ioni mobili	Temperature d'esercizio
AFC	Alkaline	OH^-	50 – 200°C
PEMFC	Proton exchange membrane	H^+	30 – 100°C
DMFC	Direct Methanol	H^+	20 – 90°C

PAFC	Phosphoric acid	H^+	~ 220°C
MCFC	Molten Carbonate	CO_3^{2-}	~ 650°C
SOFC	Solid Oxide	O^{2-}	500 – 1000°C

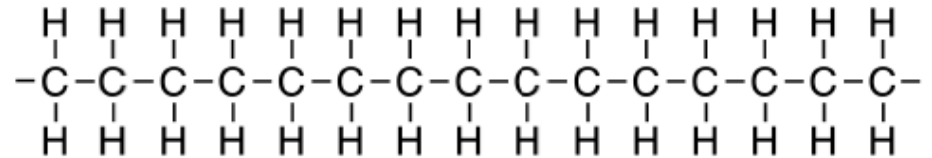
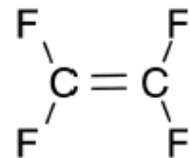


4. Tipi di fuel cell

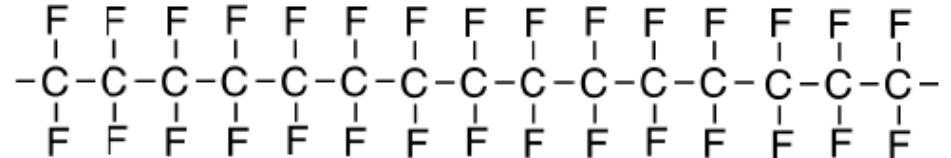
- 1. PEM



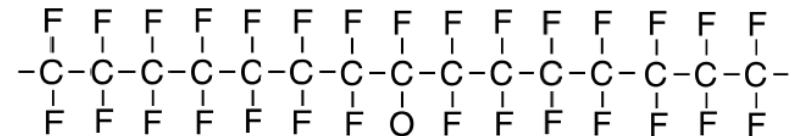
Ethylene



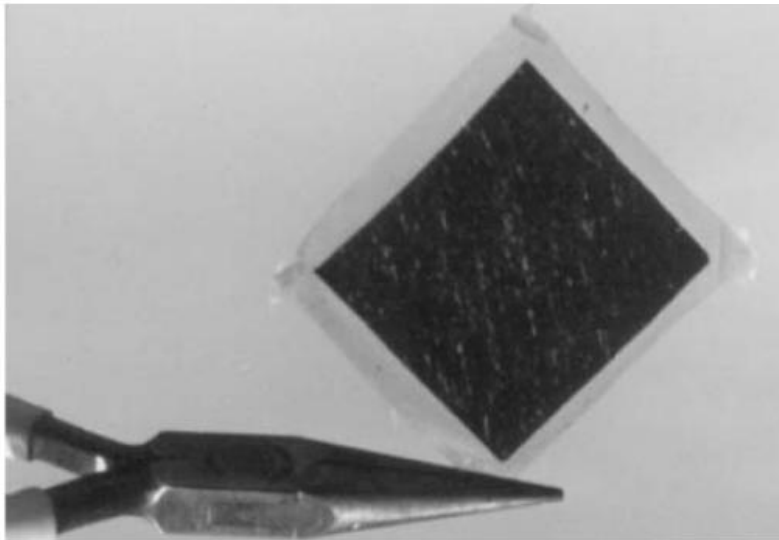
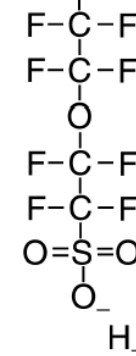
Polyethylene (or polythene)



Politetrafluoroetilene PTFE



fluoroetilene
sulfonato





4. Tipi di fuel cell

- AFC
- DMCF

Fuel cell ad alta temperatura

- PAFC
- MCFC
- SOFC

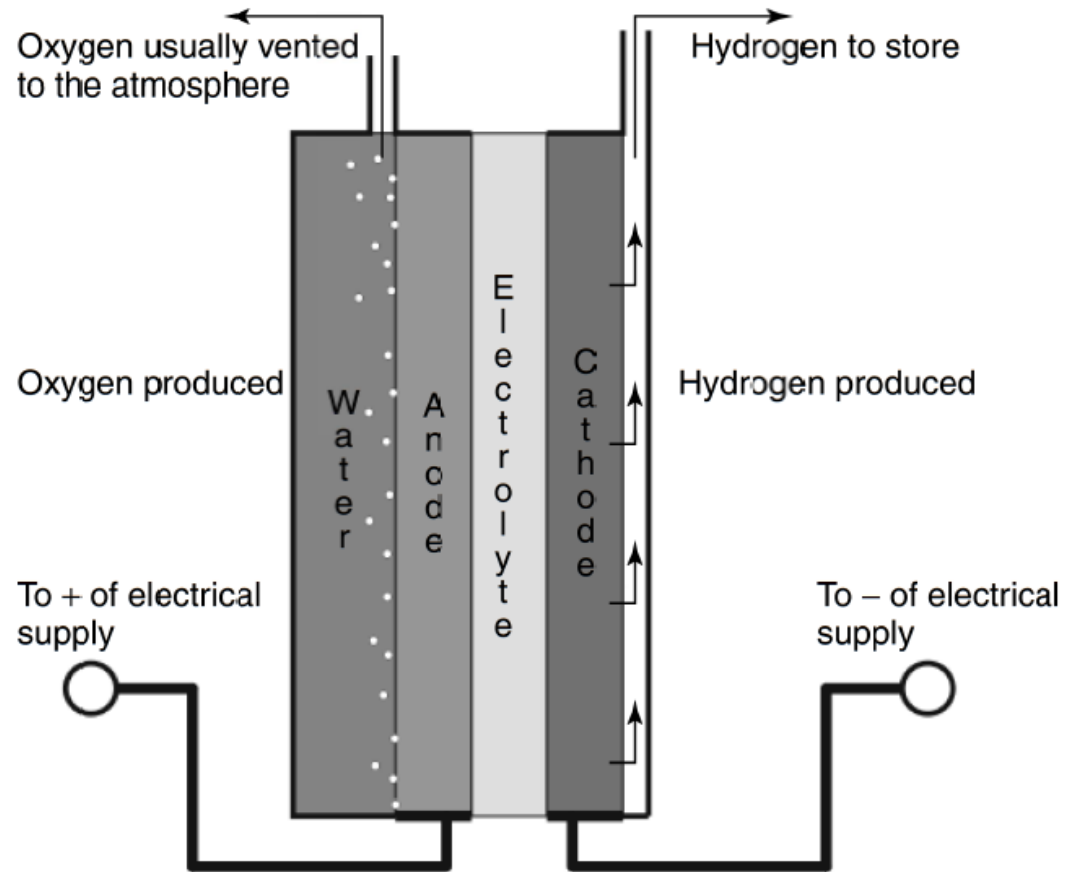




5. Alimentare le fuel cell

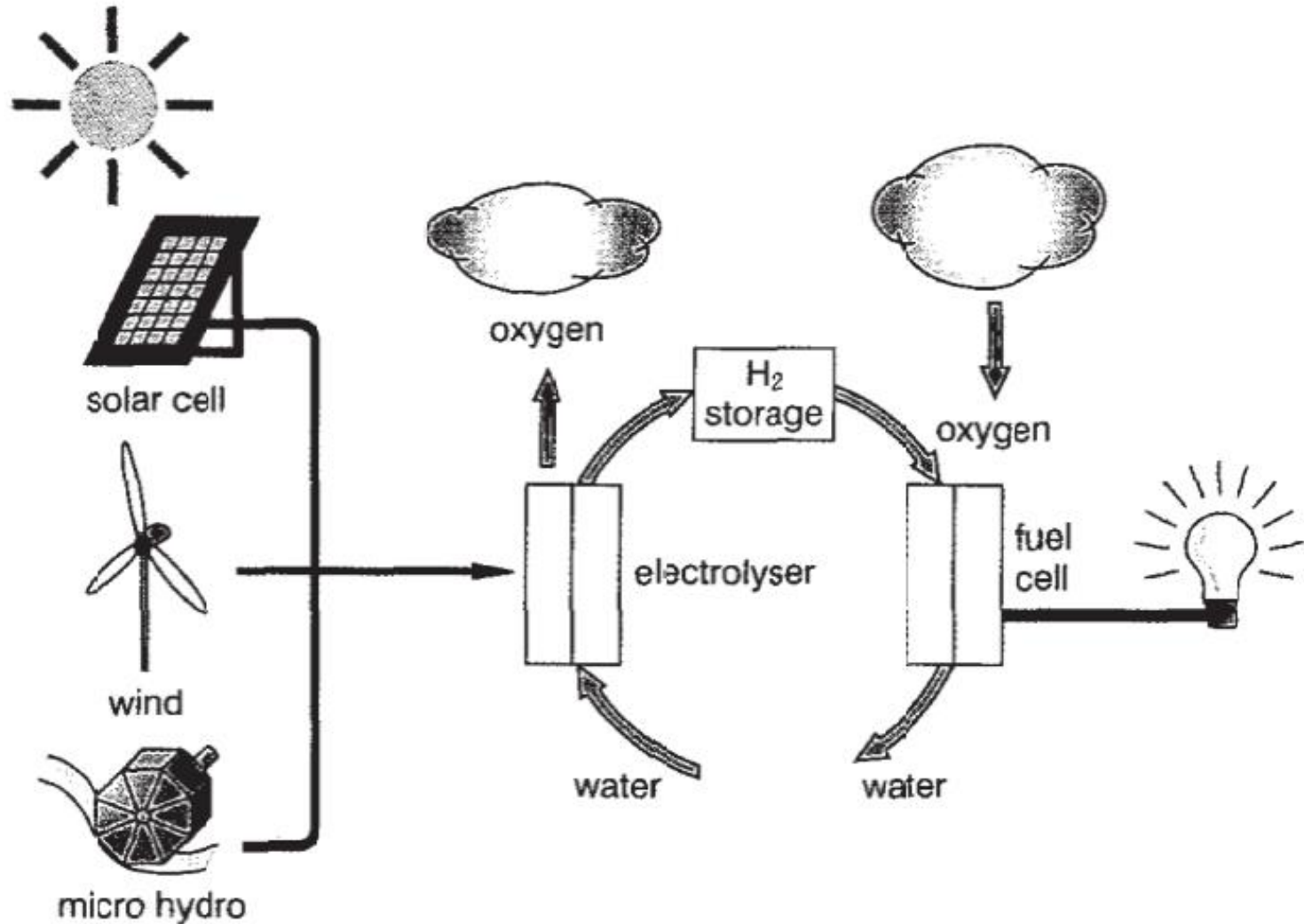
- Produzione dell'idrogeno
- Stoccaggio dell'idrogeno
- Sicurezza

• Elettrolizzatori



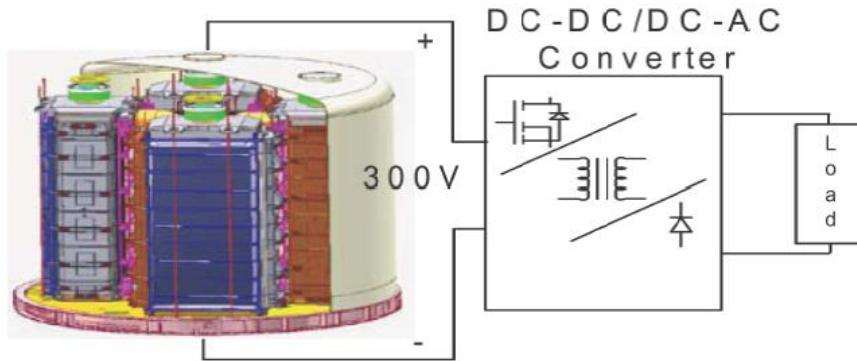


6. Applicazioni





6. Applicazioni



- Convertitori DC/DC e inverter
- Impiego in applicazioni mobili
- Alcool test
- Combined heat and power systems (CHP)