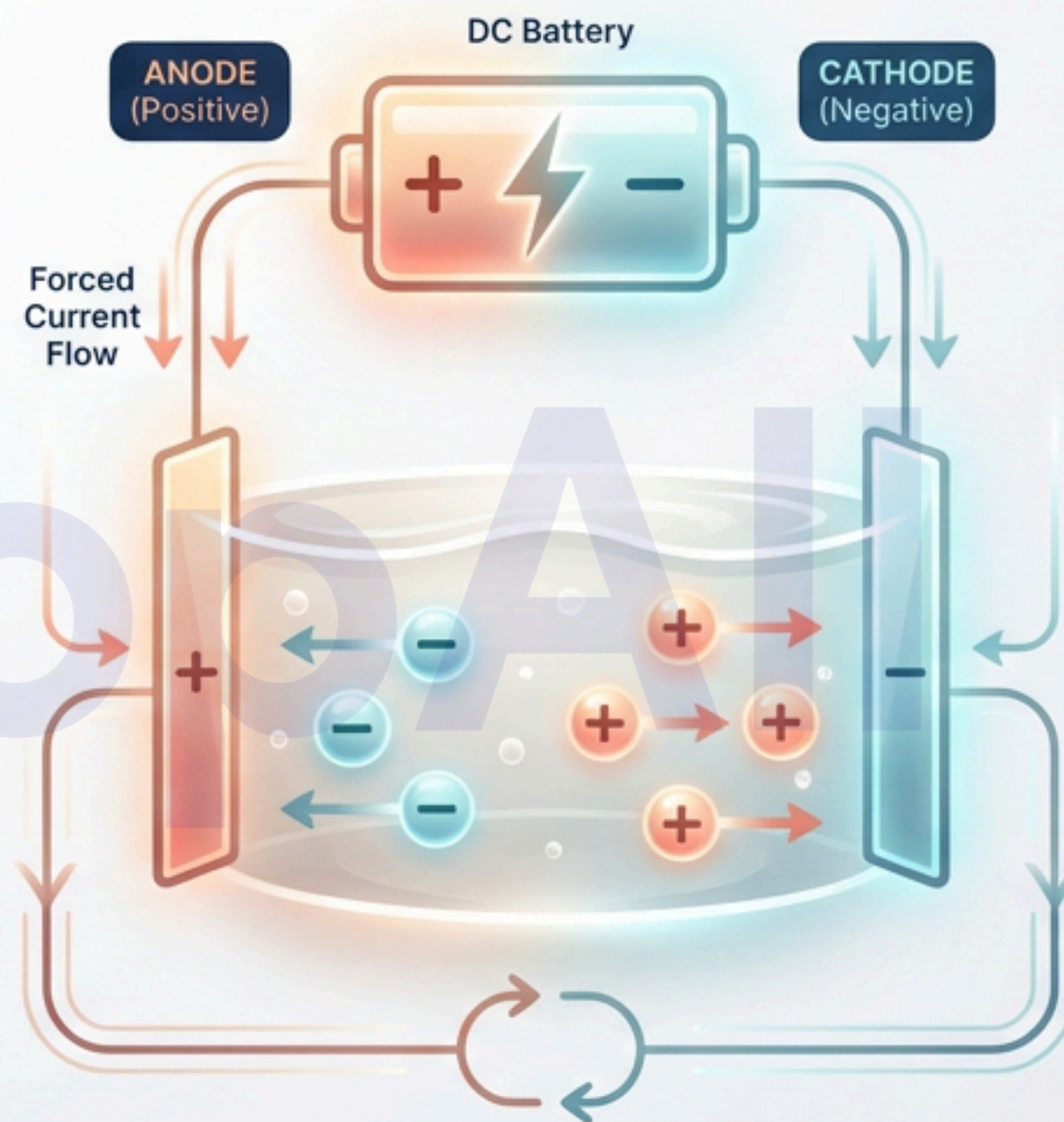


2.5 Electrolytic Cells and Electrolysis

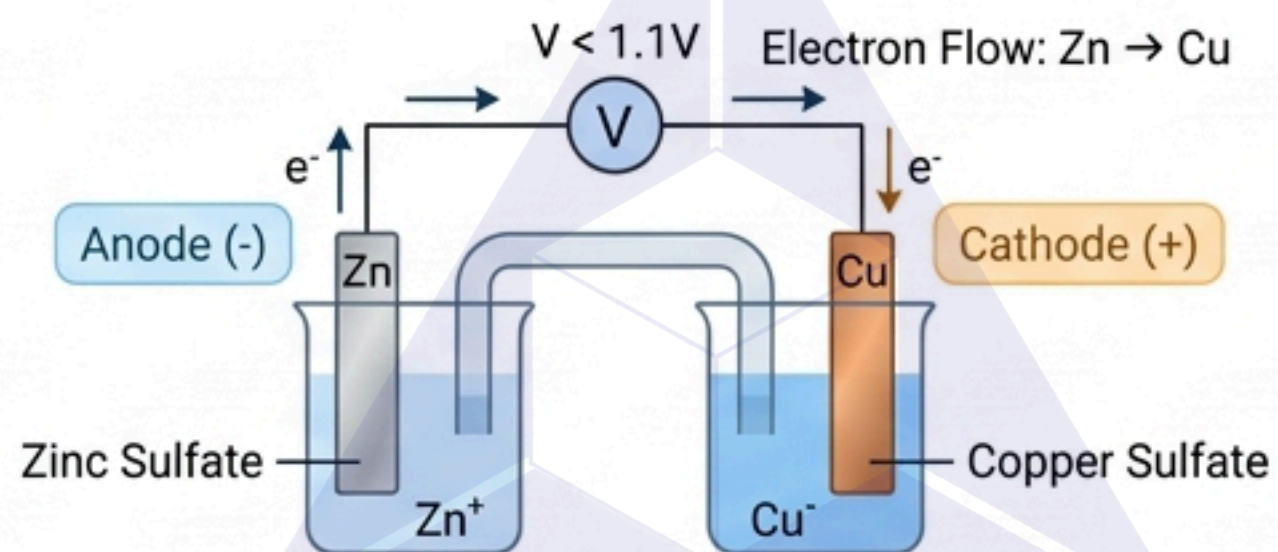
Converting electrical energy into chemical transformations.



GALVANIC VS. ELECTROLYTIC CELL POLARITY SWITCH

The Threshold: When an external voltage $E_{\text{ext}} > 1.1\text{V}$ is applied to a Daniell cell, the spontaneous reaction is overpowered and reverses.

GALVANIC CELL



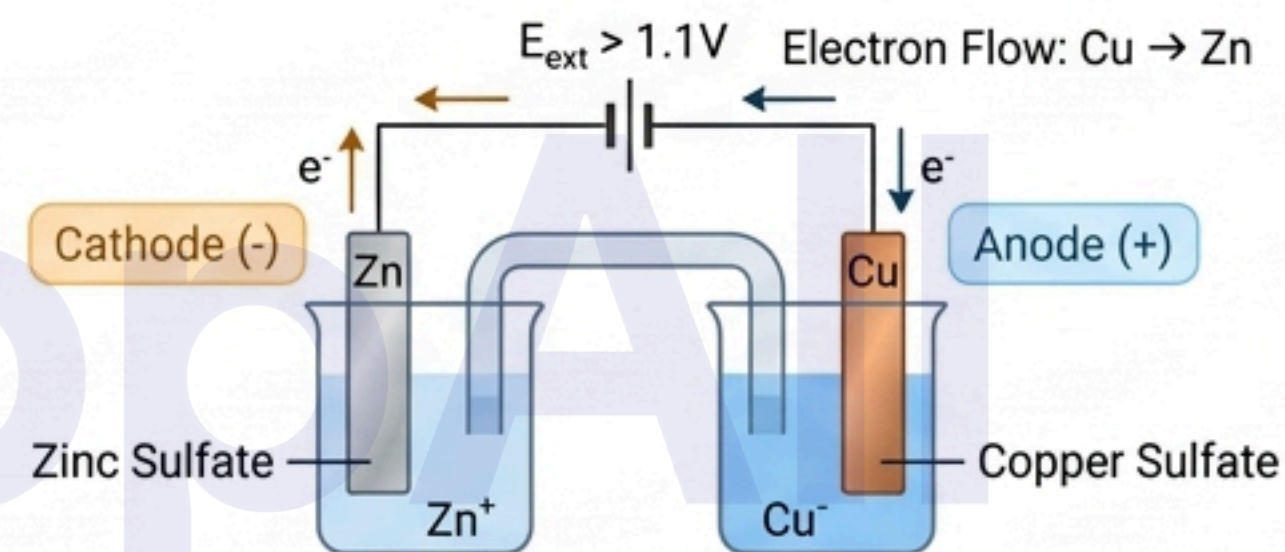
Process: Spontaneous

$$\Delta G < 0$$

Energy Flow: Chemical → Electrical

Polarity Rules: Anode is Negative (-), Cathode is Positive (+)

ELECTROLYTIC CELL



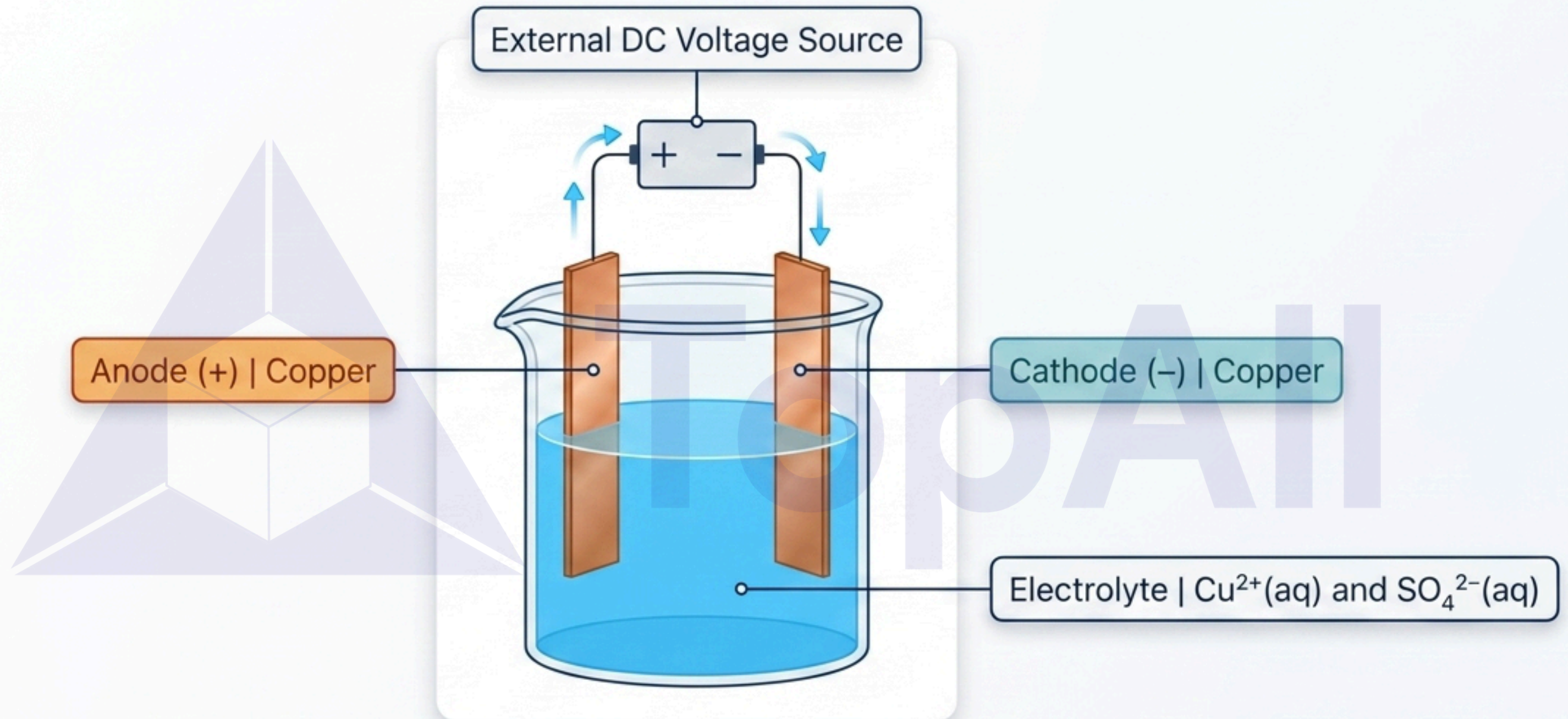
Process: Forced (Non-spontaneous)

$$\Delta G > 0$$

Energy Flow: Electrical → Chemical

Polarity Rules: Anode is Positive (+), Cathode is Negative (-)

Copper Sulphate Cell with Copper Electrodes



Unlike the Daniell cell, both electrodes here are made of the exact same metal dipping into their own salt solution.



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$$E=mc^2$$



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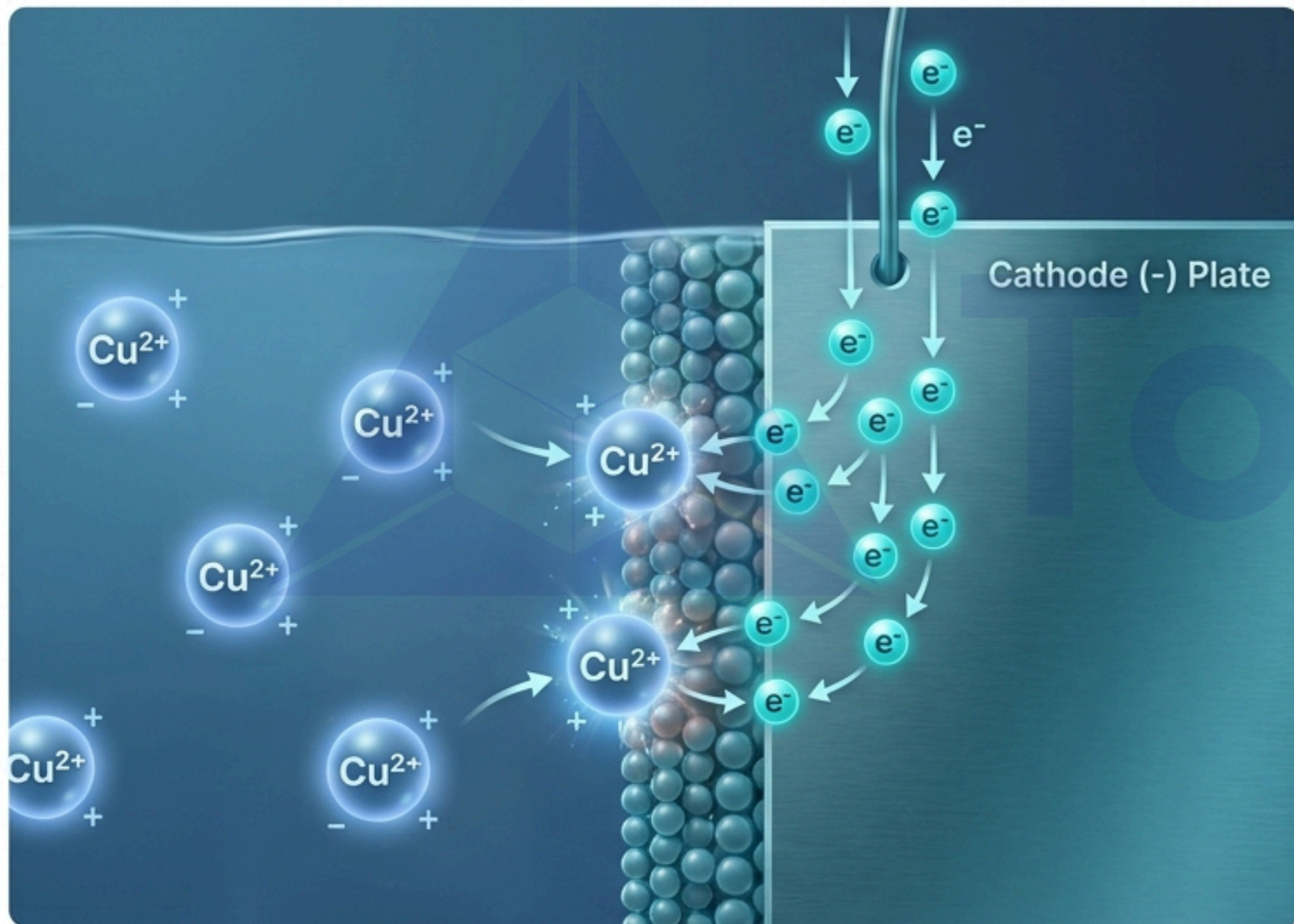
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Cathode Deposition of Copper



Cathode (Reduction): $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

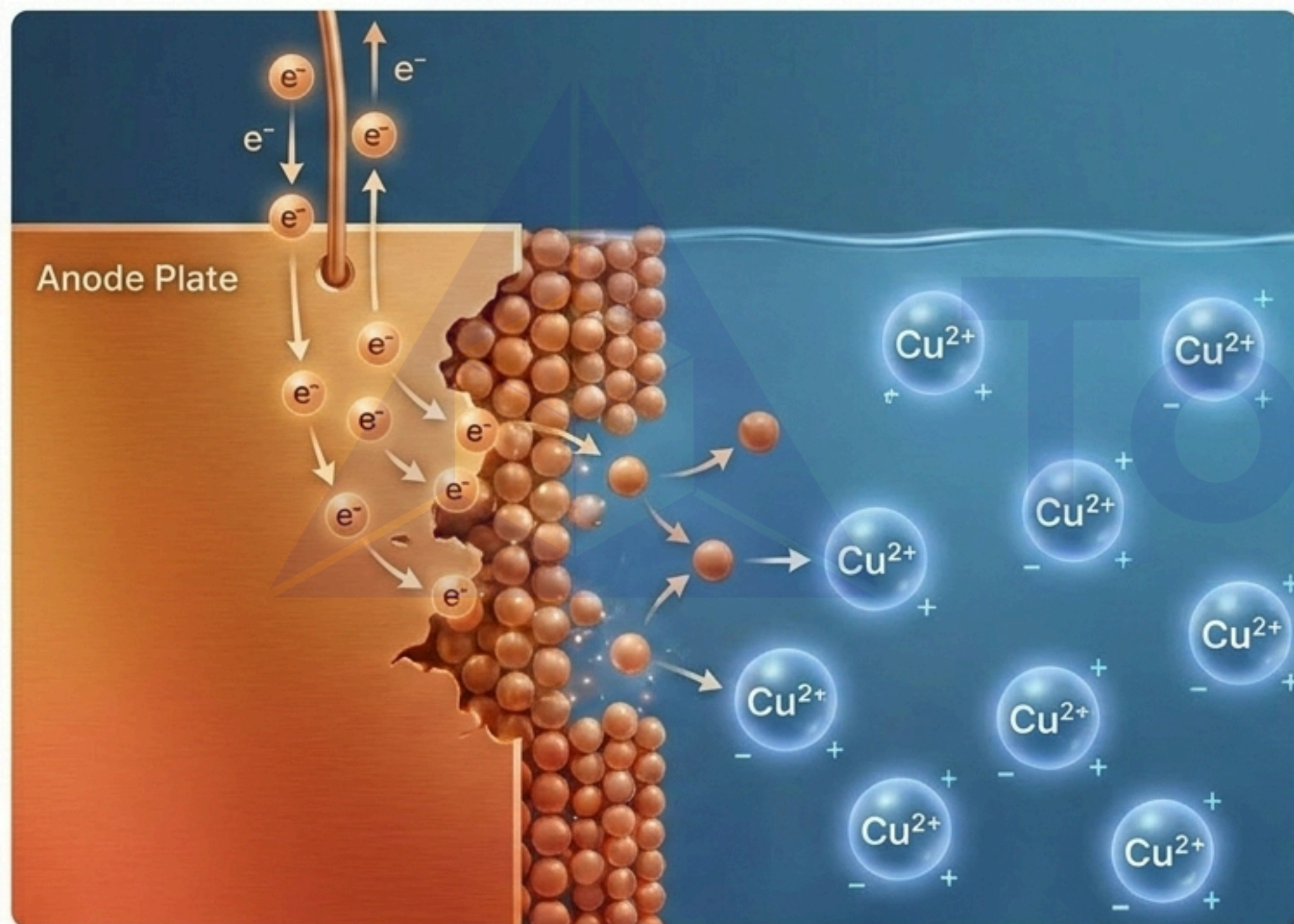


Key Takeaway Badge



Universal Rule: Reduction always occurs at the cathode, regardless of whether the cell is Galvanic or Electrolytic.

Anode Dissolution of Copper



Anode (Oxidation): $\text{Cu(s)} \rightarrow \text{Cu}^{2+}(\text{aq}) + 2e^-$

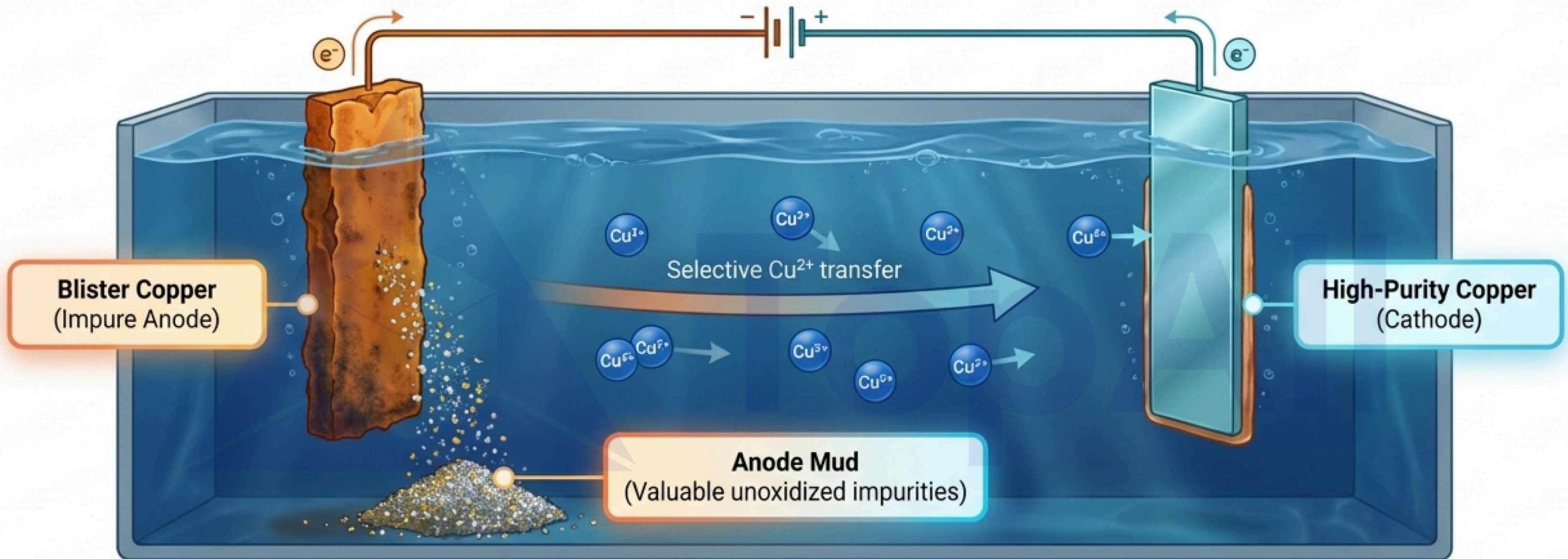


Diagnostic Note Badge



System Balance: The concentration of CuSO_4 remains constant. Rate of anodic dissolution = Rate of cathodic deposition.

Industrial Use: Electrorefining of Copper



Summary Chip

Industrial Electrorefining: Using forced electron flow to selectively dissolve and rebuild copper, leaving elemental impurities behind.

Final Recap: Electrical energy drives non-spontaneous reaction

The Energy Requirement

Because the standard cell potential is negative, $\Delta G > 0$. The reaction actively resists occurring. E_{ext} must be applied to force the system uphill.

Net Reaction: $\text{Cu(s) [Impure]} \rightarrow \text{Cu(s) [Pure]}$

Chemically, the net reaction is zero. However, electrical work was expended to physically relocate and purify the metal mass.



1. Forced Chemistry: Electrical energy drives non-spontaneous reactions.



2. Reversed Polarity: Anode becomes (+), Cathode becomes (-).



3. Industrial Scale: Foundation for metal purification (Na, Mg, Al, Cu).



You've Learned the Theory.

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