

CHAPTER 2: ELECTROCHEMISTRY

2.8 CORROSION

Decoding the invisible galvanic cells
that destroy metals.

What is Corrosion?

The slow, spontaneous coating of metallic surfaces with oxides or other salts due to metal oxidation. It causes massive structural and economic damage to buildings, bridges, and ships globally.



Rusting of Iron
(**Iron Oxide**)



Tarnishing of Silver
(**Silver Sulfide**)

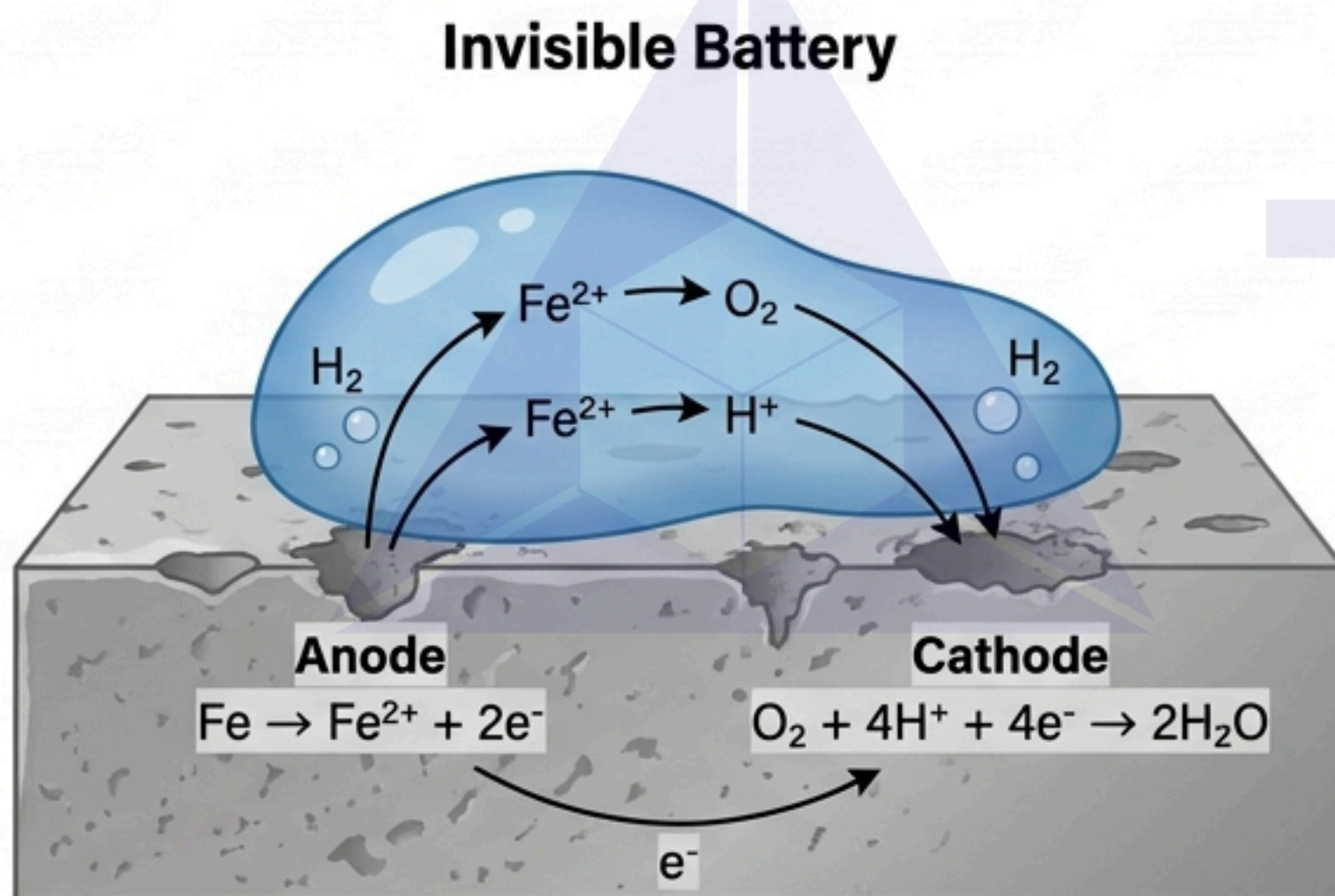


Green Coating on
Copper/Bronze
(**Copper Carbonate**)

Rusting of Iron as an Electrochemical Process



Concept Mapping



Anode	→	A specific oxidation spot on the solid Iron object.
Cathode	→	Another reduction spot on the Iron object.
Electrolyte	→	The water droplet containing dissolved CO_2 (H_2CO_3) and atmospheric acidic oxides (source of H^+).
Wire	→	The solid Iron metal itself, allowing electron flow.

[Spontaneous Process]

The Gibbs Free Energy (ΔG°) is negative, functioning exactly like a spontaneous Daniell cell.



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$$E=mc^2$$



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Anodic and Cathodic Spots on Iron Surface

The Anodic Spot (Oxidation)

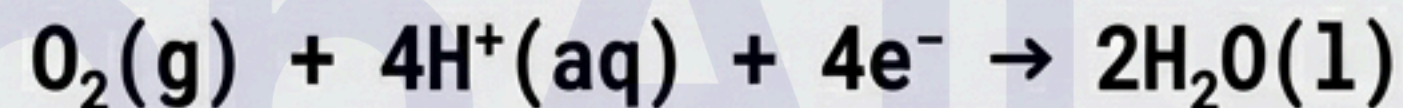
Iron is oxidized, releasing electrons into the metal.



$$E^{\circ} = -0.44 \text{ V}$$

The Cathodic Spot (Reduction)

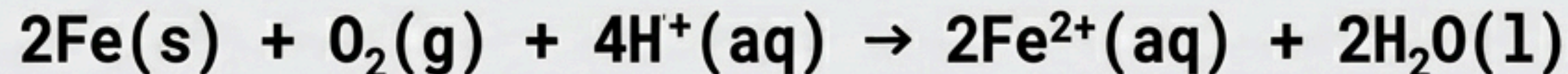
Electrons travel through the iron to reduce atmospheric oxygen in the presence of H^{+} ions.



$$E^{\circ} = 1.23 \text{ V}$$

Overall Cell Reaction

Formula Strip



$$E^{\circ}_{\text{cell}} = 1.67 \text{ V}$$

(Positive potential proves spontaneity)

Formation of Rust

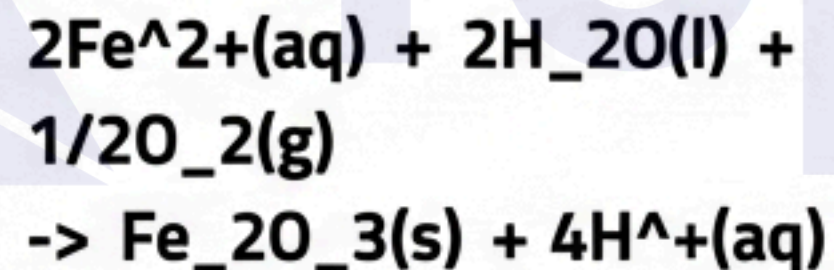
1. Migration

Fe^{2+} ions migrate through the water droplet electrolyte.

Atmospheric Oxidation Phase

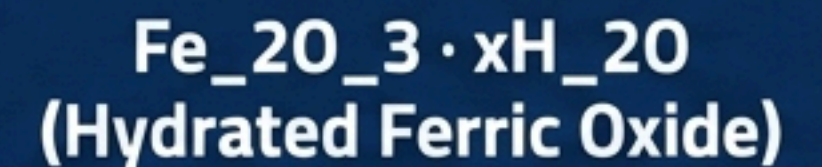
2. Atmospheric Oxidation

Fe^{2+} reacts with dissolved atmospheric oxygen to form Ferric (Fe^{3+}) ions.



3. The Rust

Hydration into visible rust.



! Feedback Loop Alert

Step 2 produces 4H^+ . This actively fuels the initial cathodic reduction reaction, creating an accelerating cycle of destruction.

Methods of Prevention

Barrier Protection

Isolating the metal from the atmosphere (breaking the electrolyte/oxygen connection).

[Paint]

[Bisphenol (Chemicals)]

[Sn (Inert Metal Coating)]

Sacrificial Protection

Providing a stronger reducing agent to act as the preferred anode.

[Mg Coating]

[Zn Coating
(Galvanization)]

Exam Smart: Why Magnesium & Zinc?

Mg and Zn have lower standard reduction potentials (E°) than Fe. When connected, they force Iron to act as the cathode, corroding themselves to 'sacrifice' their electrons and save the structural iron.

Final Recap: Corrosion as a microscopic galvanic cell

Key Takeaways

- 1. Nature of Rusting:** It is not just decay; it is a spontaneous electrochemical reaction ($E^\circ_{\text{cell}} = 1.67V$).
- 2. Cell Architecture:** The iron acts simultaneously as the wire, the anode, and the cathode. Water is the electrolyte.
- 3. The Trigger:** Dissolved O_2 and H^+ ions drive the cathodic reduction, pulling electrons from the iron.
- 4. Prevention:** Achieved by either physically breaking the circuit (barriers) or shifting the anode role to a more reactive metal (sacrificial E°).



Iron Block



Flowing Electrons



Red Rust Flakes



Prevention



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