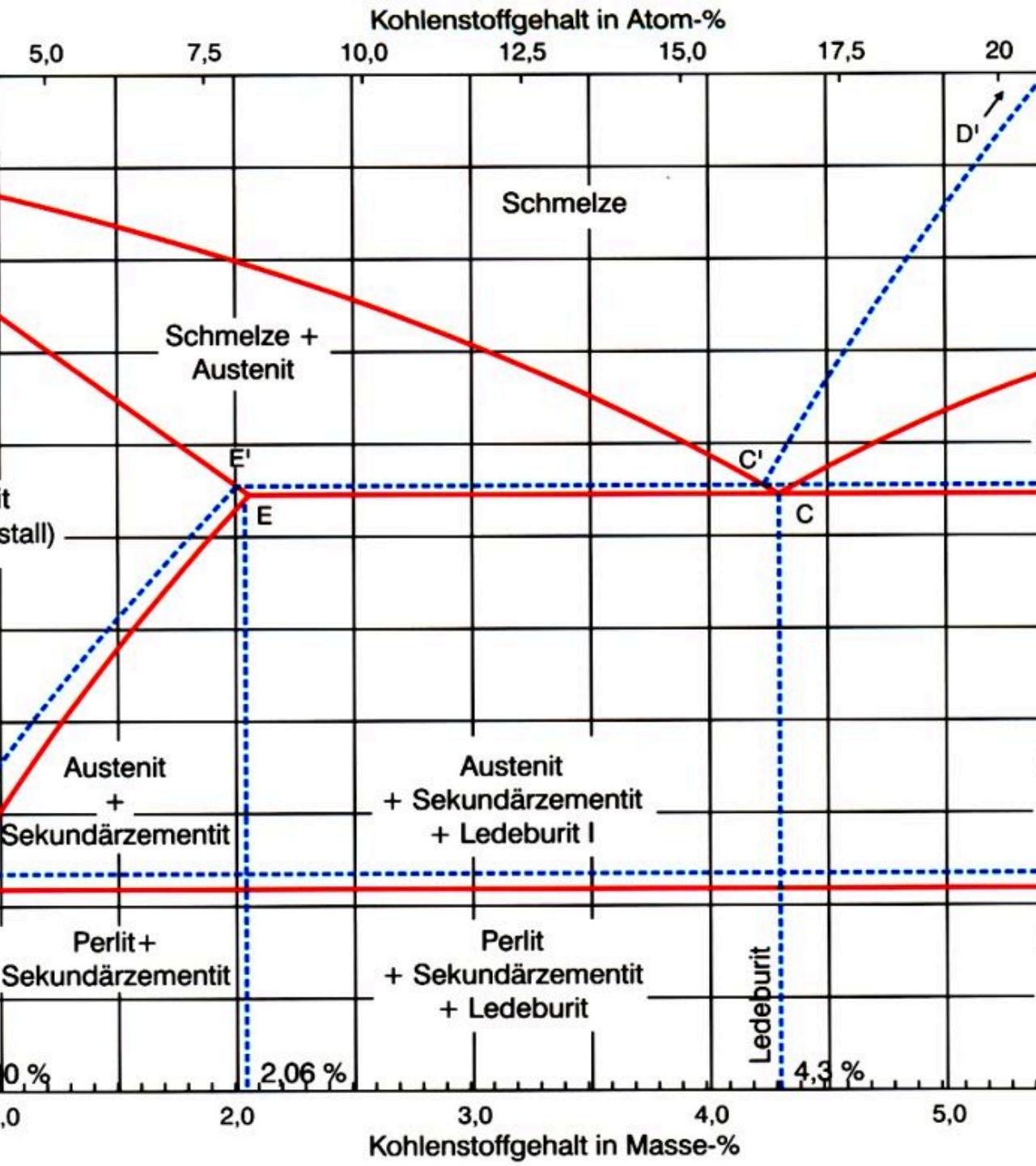


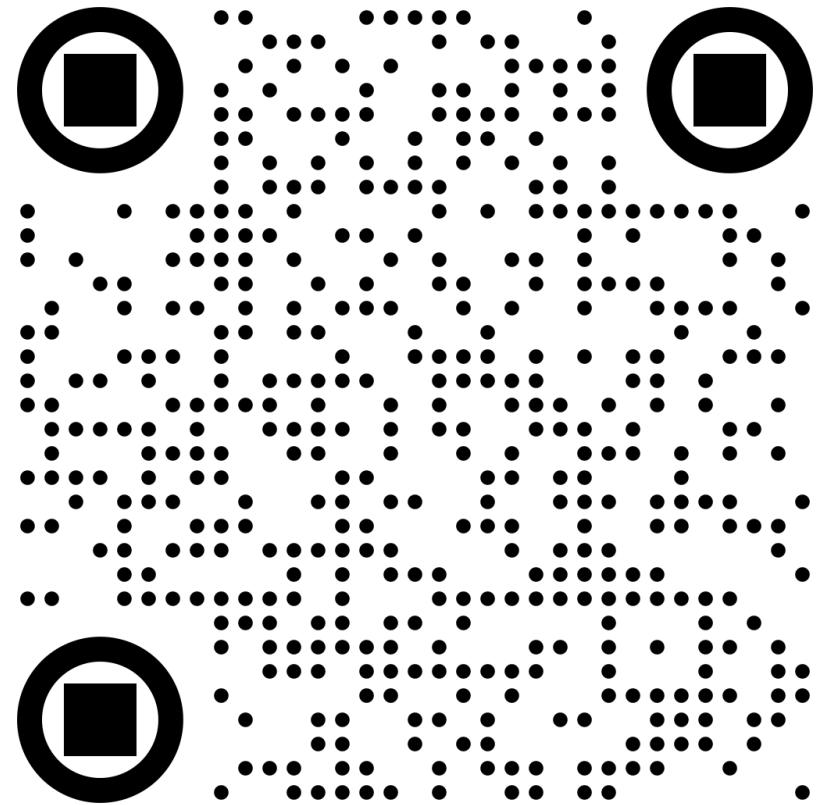
Corrosion

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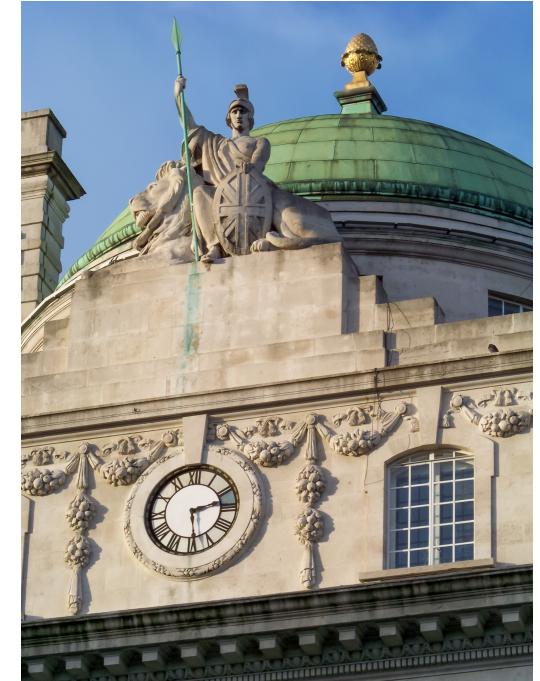


Contents



Corrosion

- divided into chemical, electrochemical, or physical reactions of metals with the environment
- affects the material properties
- most corrosion damages are electrochemical



[Further Reading](#)

Chemical Corrosion

- immediate reaction of metals with the environment
- involves direct electron exchange
- reaction partner is usually oxygen O₂

Example:



- mostly occurs at higher temperatures (process: scaling)

Electrochemical Reaction

- most corrosion damages are electrochemical
- two partial reactions, often spatially separated
- both reactions require an exchange of charge carriers
 - metals enable this through their conductivity
 - outside the metal, the circuit is closed by an electrolyte

Electrolyte

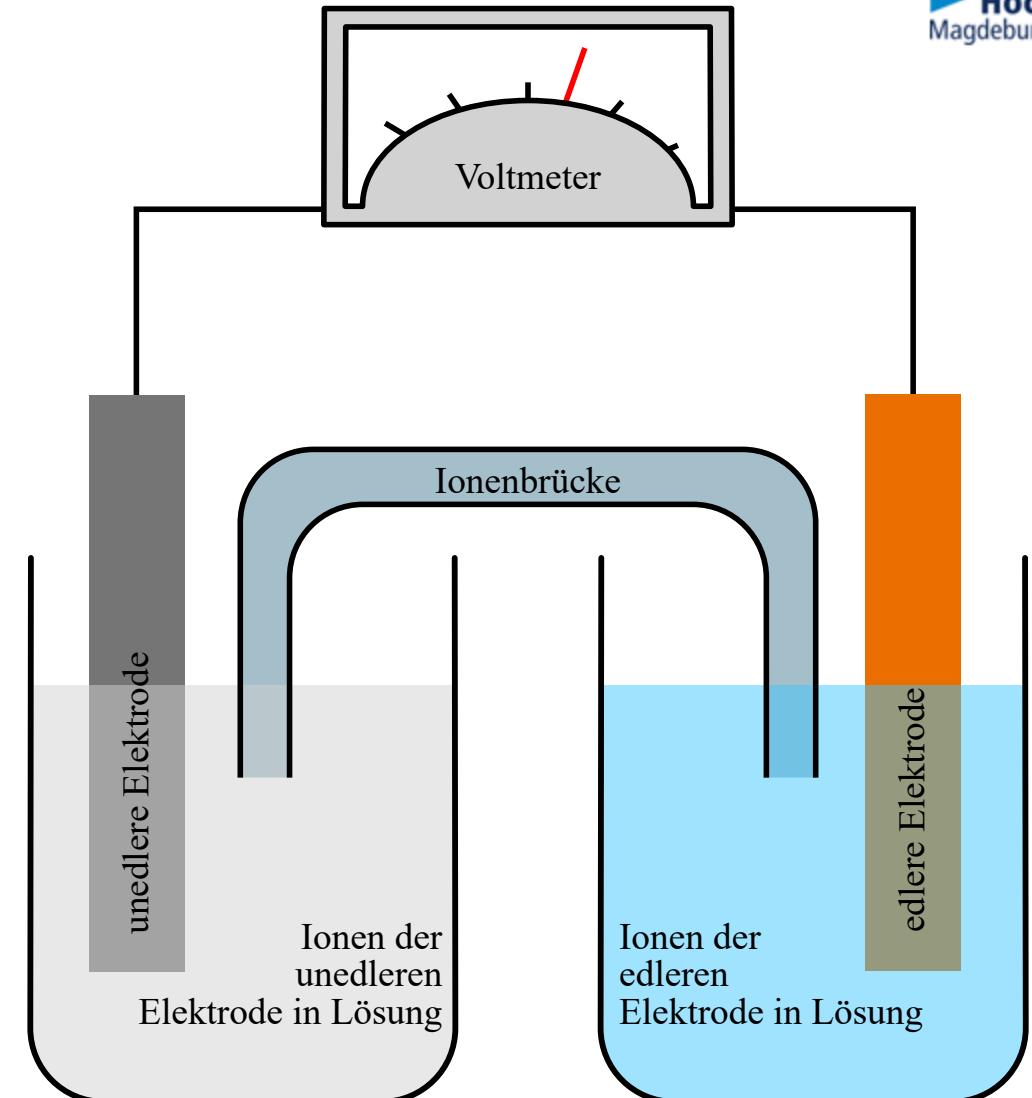
- a medium in which ions can move (*ion conduction*)
- mostly aqueous solutions
- also includes soil, molten salts, or solids (used in fuel cells)

Degree of Dissociation

- determines the aggressiveness of the electrolyte
- the further the ion concentration deviates from the concentration in water, the more aggressive the electrolyte
- can be represented by pH value.
 - pH < 7 acidic
 - pH = 7 neutral
 - pH > 7 basic (alkaline)

Schematic of a Galvanic Cell

- Anions - negative ions
- Cations - positive ions
- under direct current, negatively charged ions migrate to the anode
- Spatial separation (Anode, Cathode)



Galvanization

- the cathode reaction is a reduction

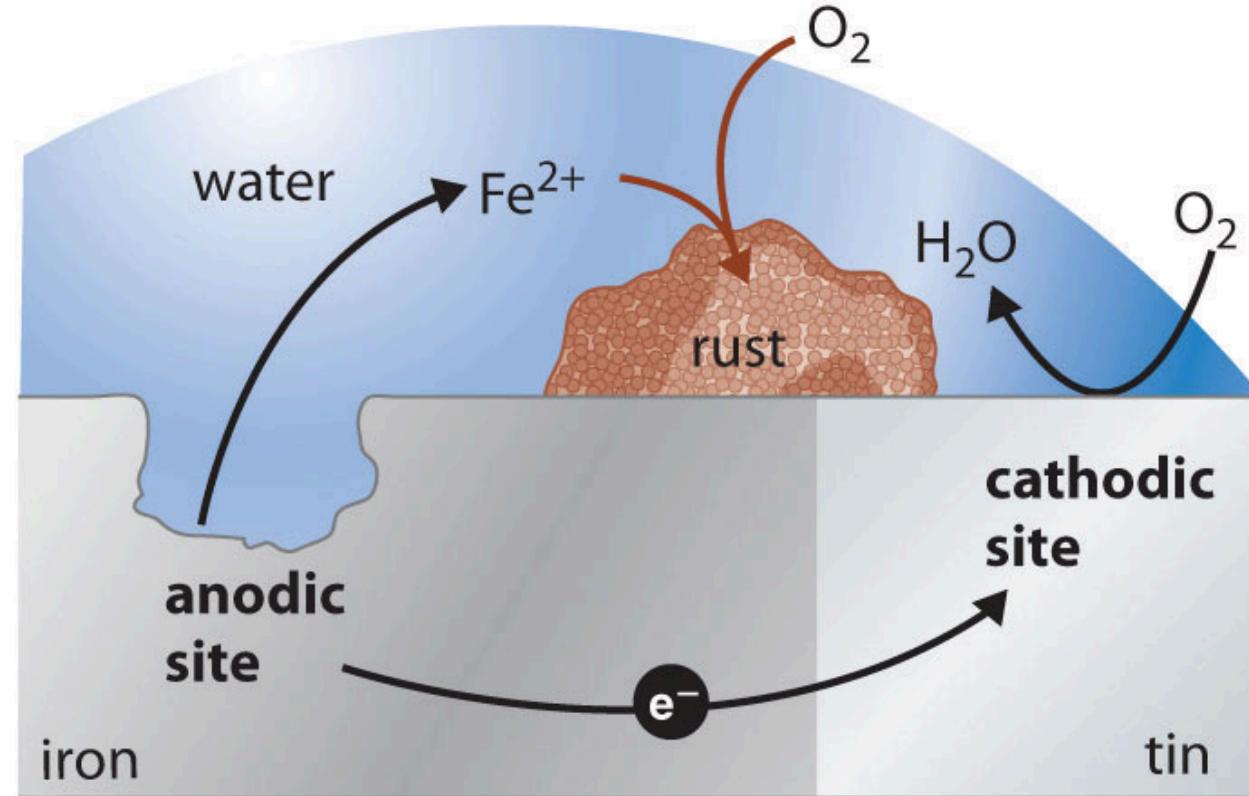
Metal ion + Electron → Metal atom

- a deposit forms on the surface
- principle of electroplating
- at the anode, oxidation occurs (release of electrons)



Schematic of Corrosion Element

- two components
- conductively connected areas
 - two metals
 - identical metals with different electrical potentials
- Electrolyte wetting



- the nobler material becomes the cathode
- the less noble electrode becomes the anode
 - as in galvanization, the anode releases electrons
 - $\text{Metal} \rightarrow \text{Metal}^{++} + 2e^-$
 - it dissolves and corrodes
- At the cathode, a metal-metal ion reaction cannot occur
 - a redox reaction takes place
 - hydrogen corrosion or oxygen corrosion

Metal	Potential	Corrosion behavior
Gold	+1.50 V	noble
Platinum	+1.18 V	
Silver	+0.80 V	
Copper	+0.34 V	
Hydrogen	+0.00 V	neutral
Tin	-0.14 V	
Iron	-0.41 V	
Zinc	-0.76 V	
Titanium	-1.75 V	

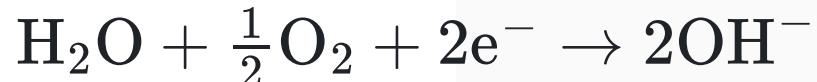
Hydrogen Corrosion

- only possible in very acidic electrolytes
- occurs in the presence of water but in the absence of oxygen

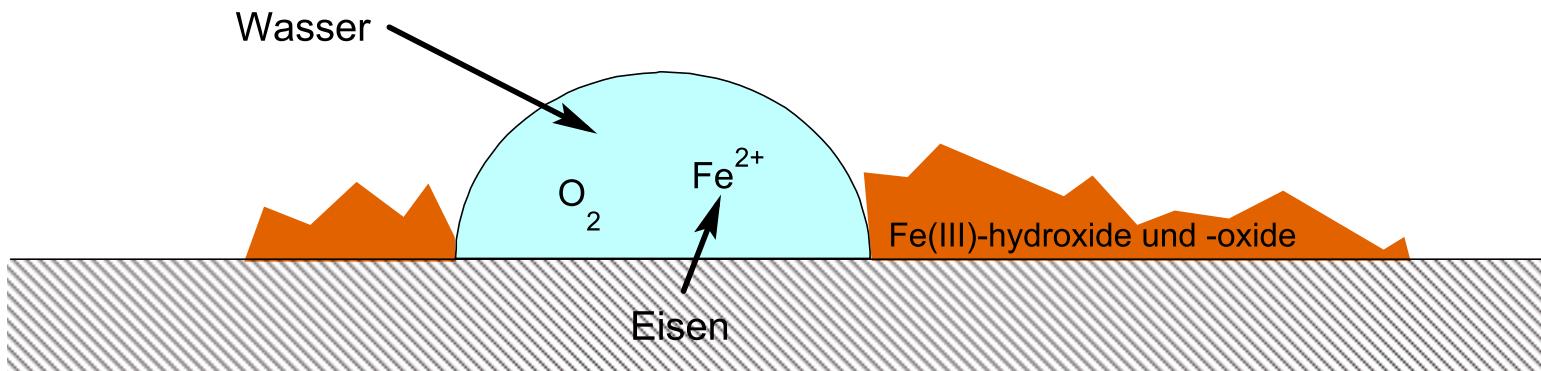
Acid corrosion

Oxygen Corrosion

- free electrons react with water to form hydroxide ions



- can decompose further



Physical Corrosion

- Microcracks or dislocations form due to stress, where corrosion can begin
- Corrosion occurs in combination with a mechanical load (static or dynamic - oscillating)

Types of Corrosion

- 36 types of corrosion according to [DIN EN ISO 8044](#)

Surface Corrosion

- large area corrosion
- easily visible and relatively harmless
- the coating layer provides corrosion protection



Types of Corrosion

Pitting Corrosion

- often goes unnoticed for a long time
- can expand in a trough shape in depth



Types of Corrosion

Crevice Corrosion

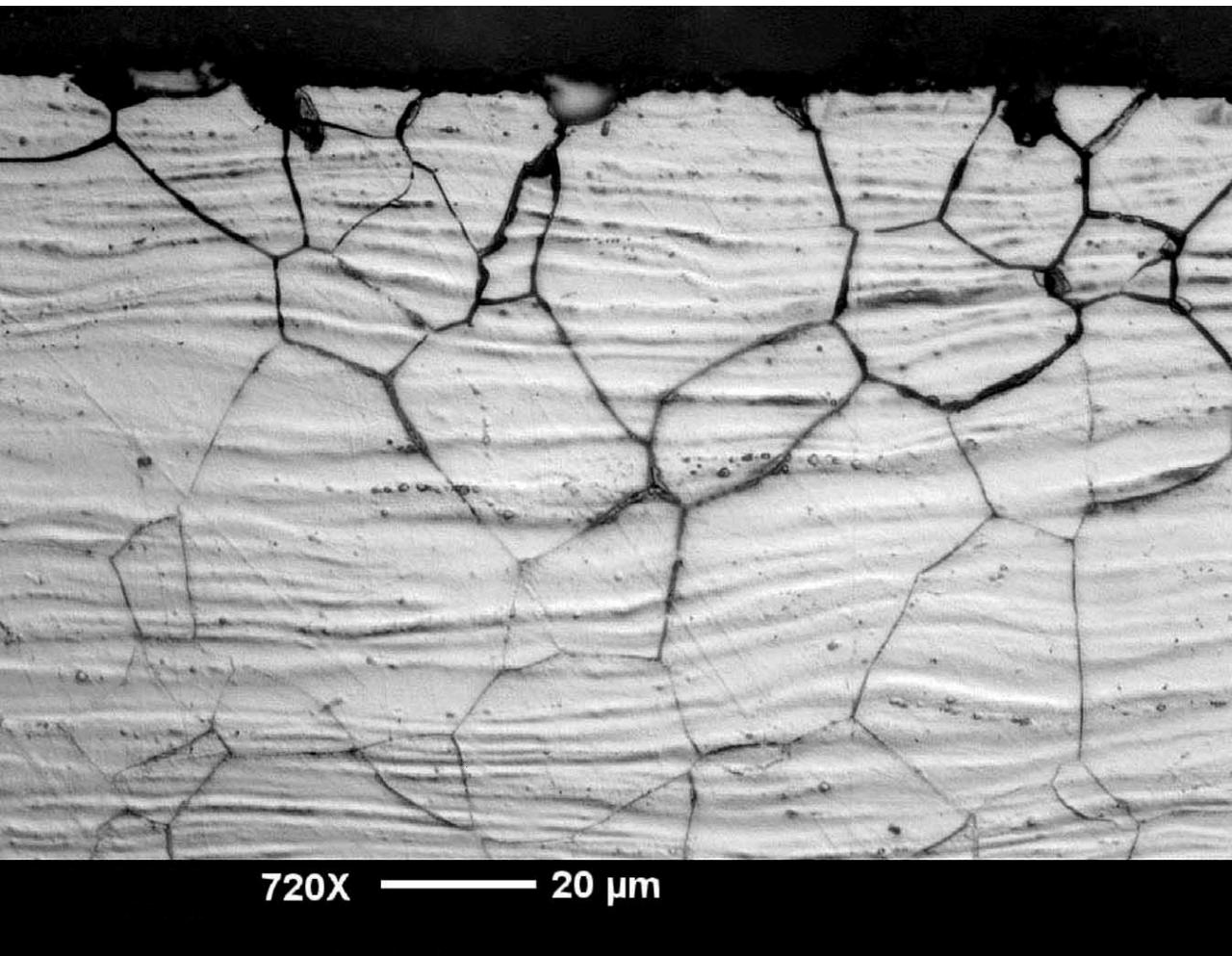
- occurs on metal parts in narrow, non-closed crevices like overlaps, applied ridges, and in non-continuously welded seams
- difficult to detect
- should be structurally avoided in critical areas

also known as grain boundary corrosion

- occurs at grain boundaries
- Reminder: Influence of the crystal lattice - aggressive media attack preferential planes

Other Types of Corrosion

- Microbial Corrosion
 - Sewage
 - Aviation fuel
 - Fungal infestation
- Undermining Corrosion
- High-Temperature Corrosion
- Stress Corrosion Cracking



Corrosion Protection

- Distinguishable between passive and active protection
- Passive: Separation of metal and electrolyte / corrosive medium
- Active: Complete separation is not necessary

Corrosion Protection Activity

- Work in small groups, 10–15 minutes of research
- 2 groups:
 - Identify 3 passive methods
 - Identify 3 active methods
- Brief presentation of results (use the board if needed)
 - Highlight the main takeaways