



Types of corrosion

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THAPAR INSTITUTE
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1. Uniform/general attack Corrosion
2. Galvanic or two-metal Corrosion
3. Pitting Corrosion
4. Crevice Corrosion
5. Intergranular Corrosion
6. Stress Corrosion
7. Erosion Corrosion
8. Cavitation Damage
9. Fretting Corrosion
10. Selective Leaching
11. Hydrogen Damage

1. Uniform/general attack Corrosion

1. The chemical reaction proceeds uniformly on the entire metal surface exposed to the corrosive environment. It often leaves behind a scale or deposit.
2. Represent greatest destruction of metals!
3. The most common form of corrosion. It is also the least objectionable because it can be predicted and designed for with relative ease.
4. E.g., general rusting of steel and iron and the tarnishing of silverware

Prevention:

1. Protective Coating
2. Inhibitors
3. Cathodic Protection

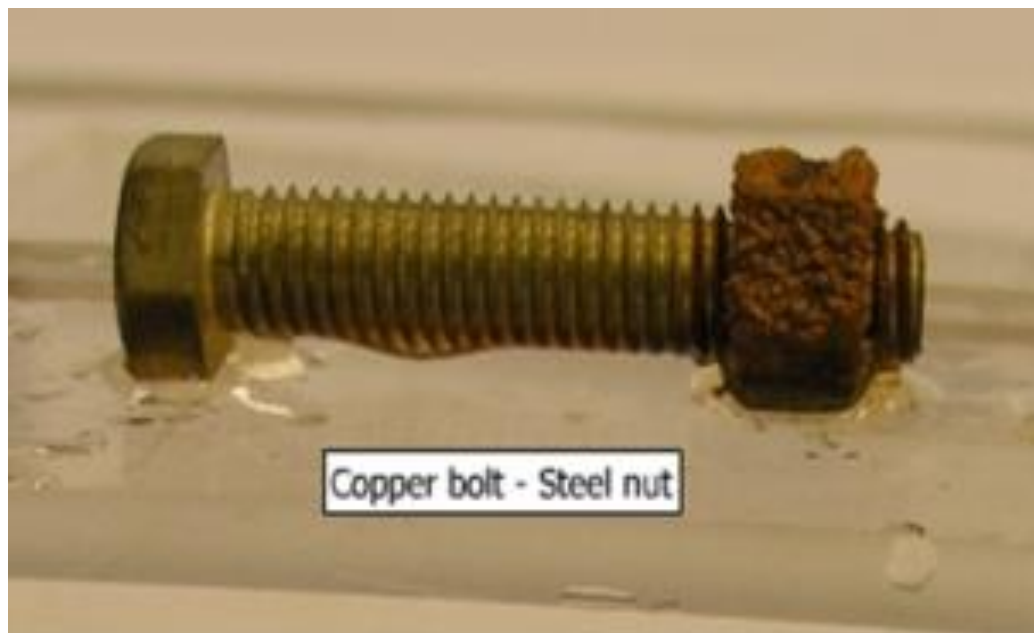


2. Galvanic or two-metal Corrosion

Galvanic corrosion occurs when two metals or alloys having different compositions are electrically coupled while exposed to an electrolyte. The less noble or more reactive metal in the particular environment will experience corrosion; the more inert metal, the cathode, will be protected from corrosion.

For example:

- steel screws corrode when in contact with brass in a marine environment.
- copper and steel tubing are joined in a domestic water heater, the steel will corrode in the vicinity of the junction.



Prevention:

- 1.If coupling of dissimilar metals is necessary, choose two that are close together in the galvanic series.
- 2.Avoid an unfavourable anode-to-cathode surface area ratio; use an anode area as large as possible.
- 3.Electrically insulate dissimilar metals from each other.
- 4.Electrically connect a third, anodic metal to the other two; this is a form of **cathodic protection**.

The rate of galvanic attack depends on the cathode-anode area ratio; that is, for a given cathode area, a smaller anode will corrode more rapidly than a larger one.

Reason: corrosion rate depends on current density, the current per unit area of corroding surface, and not simply the current. Thus, a high current density results for the anode when its area is small relative to that of the cathode.

3. Pitting Corrosion

- Localized corrosive attack which produces holes or pits in a metal.
- Depth and number of pits vary.
- Generally requires an initiation period.
- Once started the pits grow at an ever increasing rate.
- Grow in the direction of gravity and on lower surfaces of the equipment.
- Very destructive! leads to perforation of the metal.
- Pits are initiated at places where local increase in corrosion rates occurs (Local structural and/or compositional heterogeneities).



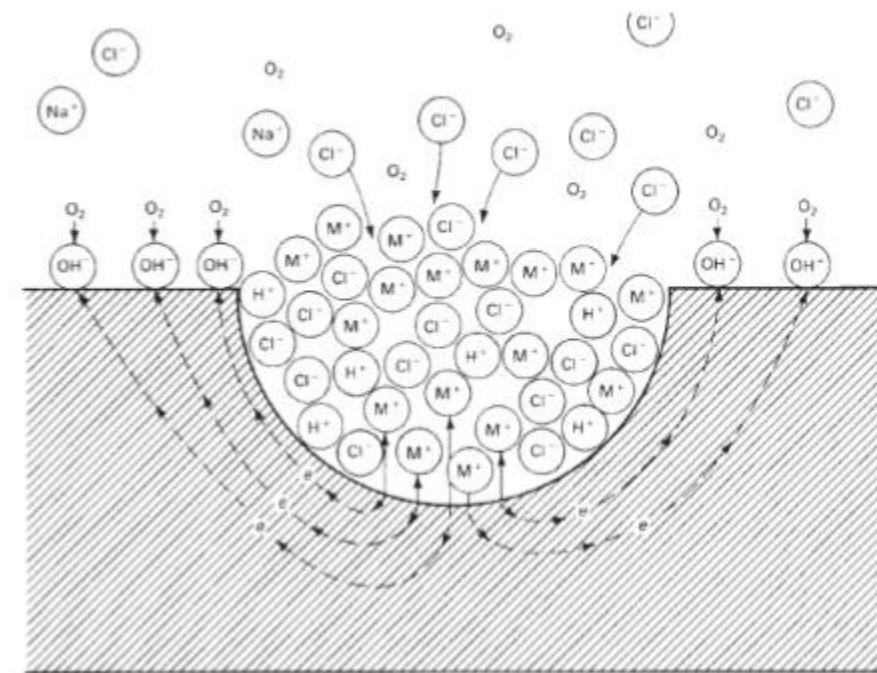
Prevention

- Use materials with non-pitting tendency.
- Best resistance (2% molybdenum Steels) Always do corrosion test before final selection.



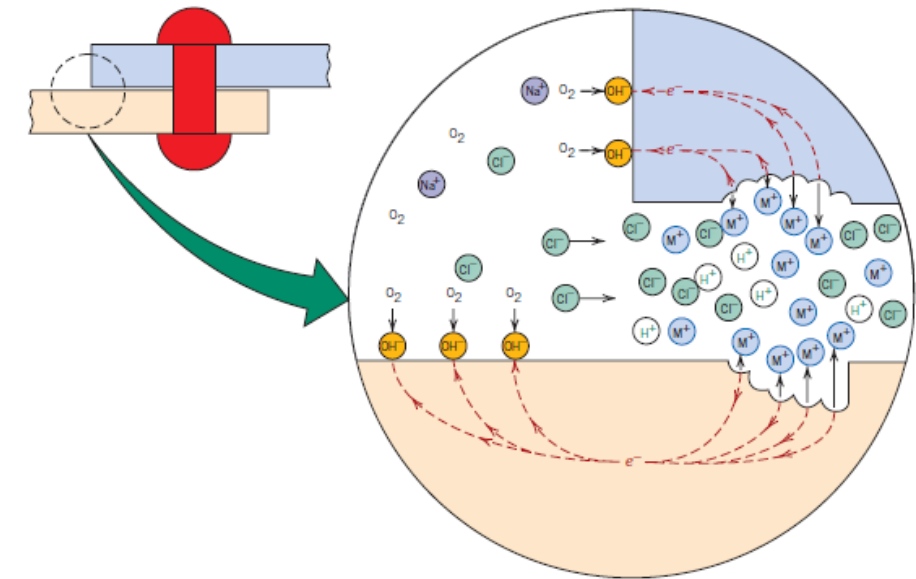
Mechanism of Pitting

Example: Metal in NaCl solution



4. Crevice Corrosion

- Crevice corrosion is a **localized corrosion** in recesses especially in overlapping zones for **riveting, bolting or welding**.
- These zones also called crevices and are **very tiny** and difficult to access for the aqueous liquid that is covering the rest of the readily accessible surfaces.
- This type of corrosion is also known as deposit attack.

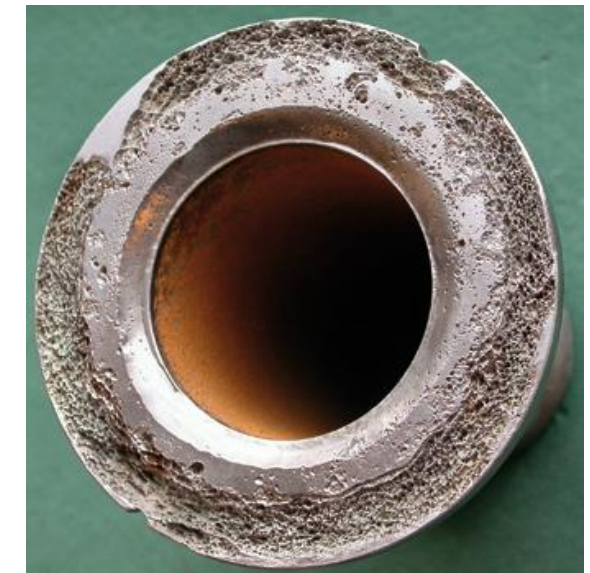


In many aqueous environments, the solution within the crevice has been found to develop high concentrations of H^+ and Cl^- ions, which are especially corrosive. (Stainless steel, Ti, Al and Cu alloys)

Many alloys that passivate are susceptible to crevice corrosion because protective films are often destroyed by the H^+ and Cl^- ions.

Prevention

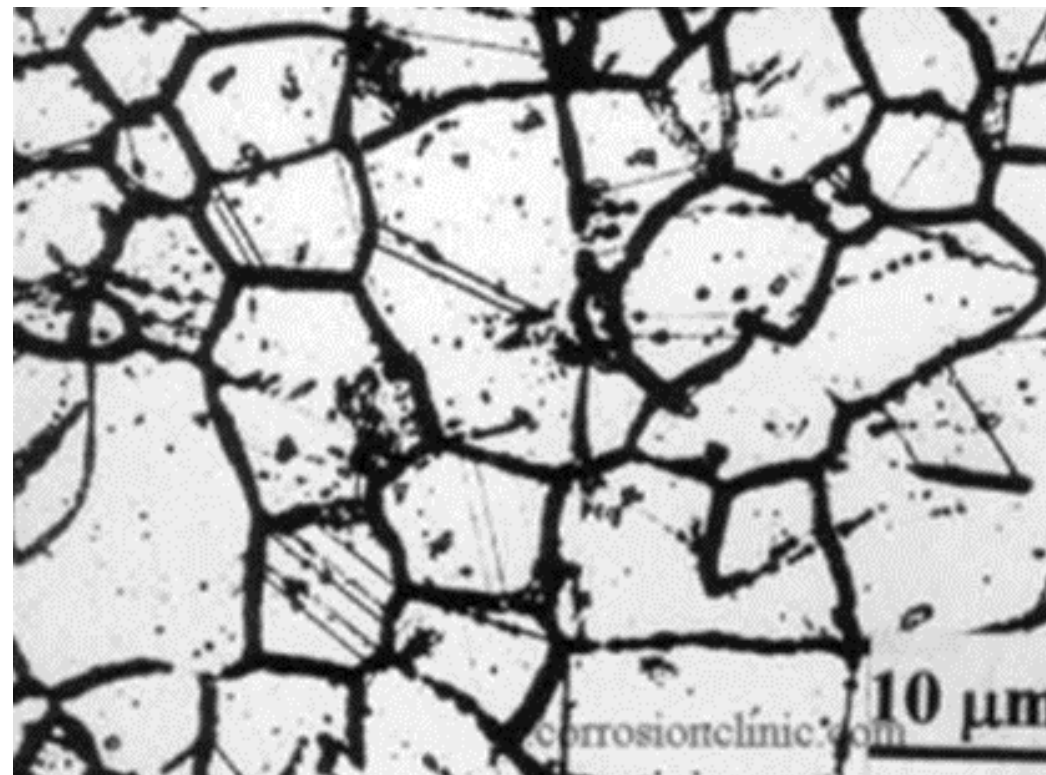
1. Using welded instead of riveted or bolted joints,
2. Using non-absorbing gaskets (like Teflon) when possible,
3. Removing accumulated deposits frequently, and
4. Designing containment vessels to avoid stagnant areas and ensure complete drainage.



5. Intergranular Corrosion

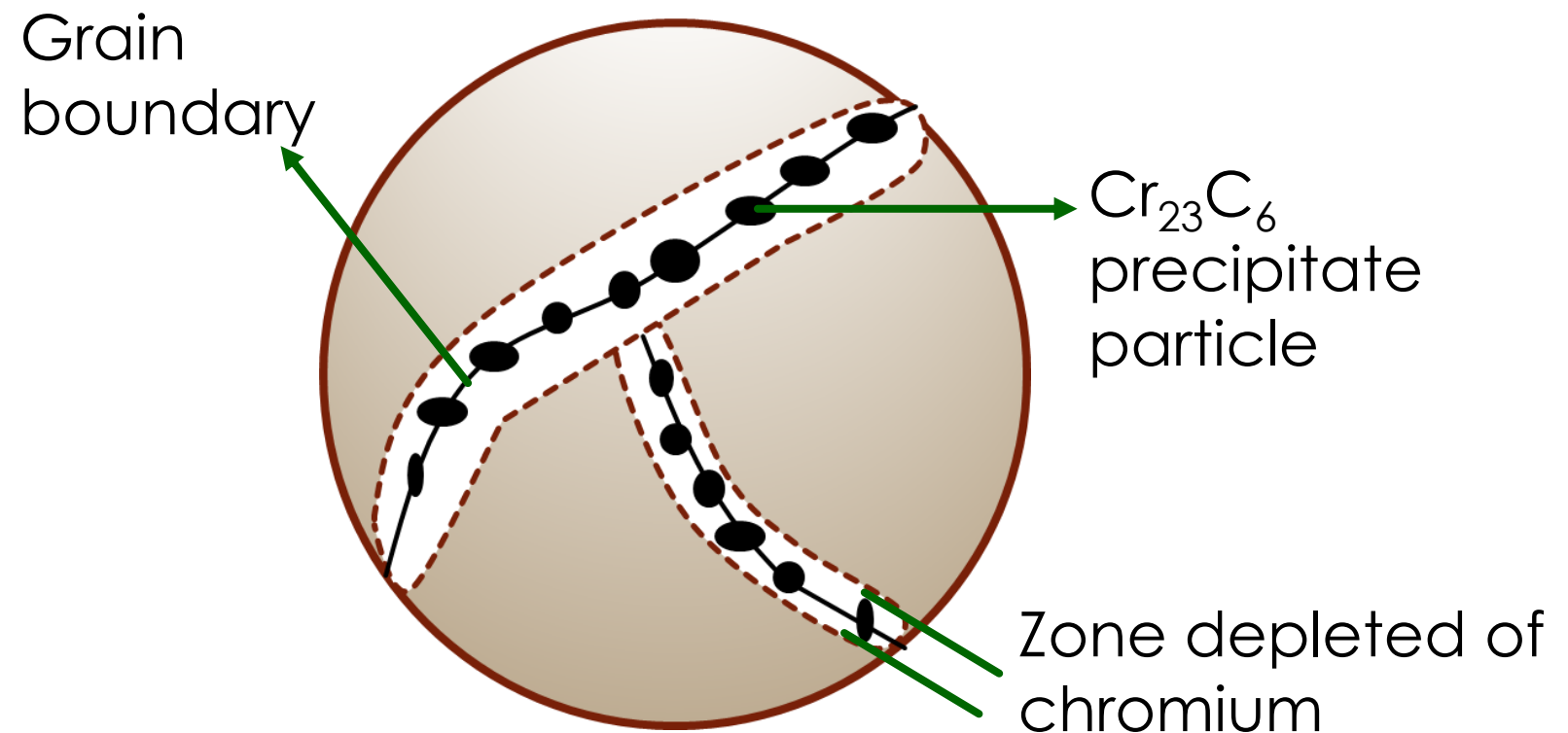
It occurs preferentially along grain boundaries for some alloys and in specific environments. The net result is that a macroscopic specimen disintegrates along its grain boundaries.

This type of corrosion is especially prevalent in some stainless steels. When heated to temperatures between 500 °C and 800 °C for sufficiently long time periods, these alloys become **sensitized** to intergranular attack. Temperature range is called as **sensitizing temperature range**.



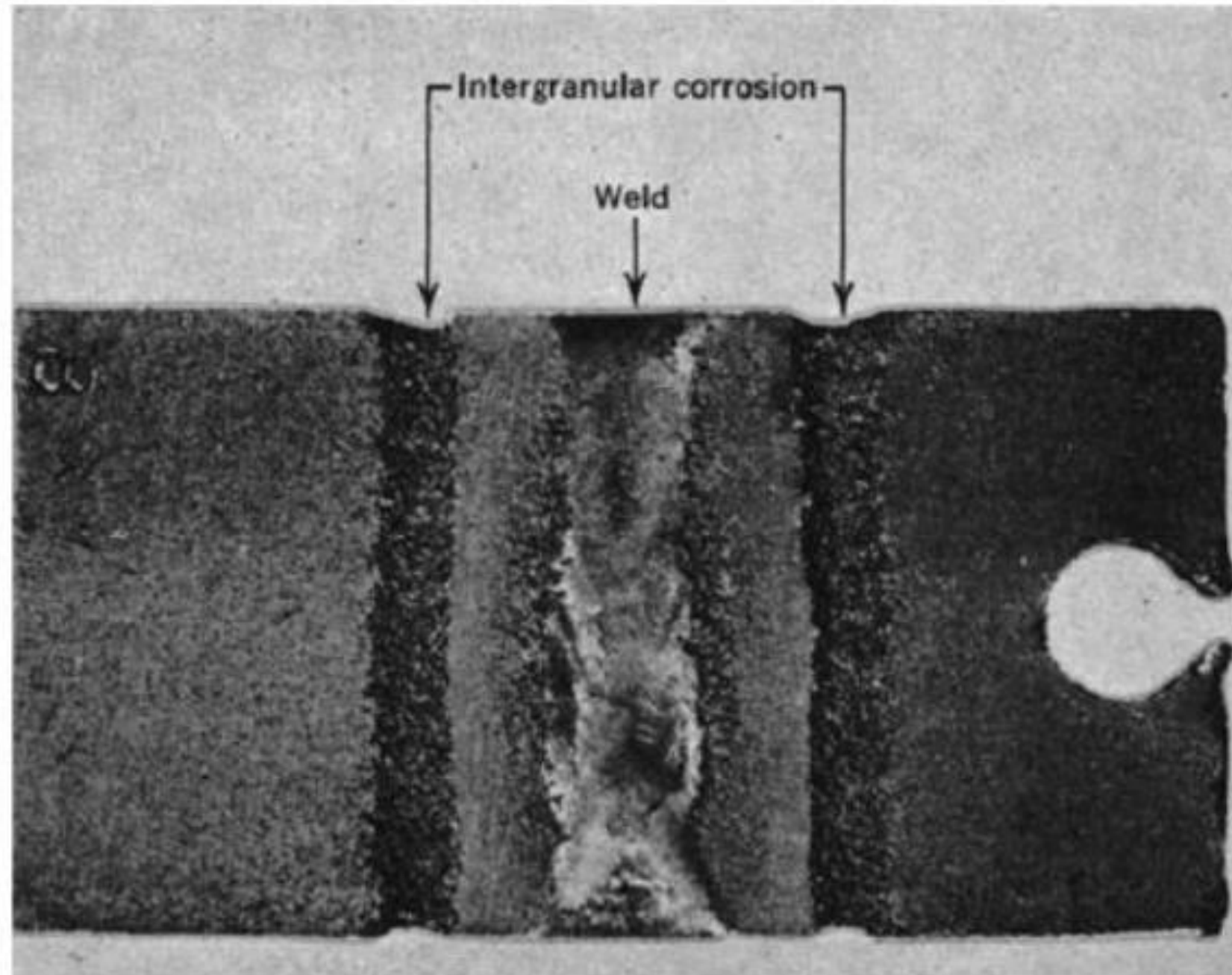
This heat treatment permits the formation of small precipitate particles of chromium carbide (Cr_{23}C_6) by reaction between the chromium and carbon in the stainless steel. These particles form along the grain boundaries.

Both the chromium and the carbon diffuse to the grain boundaries to form the precipitates, which leaves a chromium-depleted zone adjacent to the grain boundary. Consequently, this grain boundary region is now highly susceptible to corrosion.



Weld Decay

Figure 17.19 Weld decay in a stainless steel. The regions along which the grooves have formed were sensitized as the weld cooled. (From H. H. Uhlig and R. W. Revie, *Corrosion and Corrosion Control*, 3rd edition, Fig. 2, p. 307. Copyright © 1985 by John Wiley & Sons, Inc. Reprinted by permission of John Wiley & Sons, Inc.)



Prevention

Intergranular corrosion is an especially severe problem in the welding of stainless steels, when it is often termed weld decay.

Stainless steels may be protected from intergranular corrosion by the following measures:

- subjecting **the sensitized material to a high-temperature heat treatment** (heating followed by water quenching) in which all the chromium carbide particles are re-dissolved.
- **Lowering the carbon content** below 0.03 wt.% C so that carbide formation is minimal.
- Alloying the stainless steel with **another metal such as niobium or titanium**, which has a greater tendency to form carbides than does chromium so that the Cr remains in solid solution.

1. Uniform corrosion is most common type of corrosion.
2. Crevice corrosion is due to the overlapping layers between two metals.
3. Pitting corrosion cannot be avoided once started.
4. Smaller anode area will have more corrosion than larger anode area.
5. Weld decay is the corrosion due to sensitization at high temperature (500 °C - 800 °C)