passivity

Faraday published a theory in which he suggested that the metal surface of certain passive metals was oxidized and the oxide layer was very thin If a metal is converted to an oxide and the oxide which is formed is stable, the metal is considered passive as this oxide forms a barrier between the metal and the environment.The important point is that once a film isformed, the corrosion rate sharply declines. The passivity on the metal surface which develops due to film formation on metal surface causes inhibition of the anodic dissolution process.

For example,
iron is not attacked in concentrated HNO3, as a very thin film of an oxide is formed on its surface and causes loss of reactivity.

Difinition :-

Passivity is a phenomenon where certain metals form a thin, protective oxide layer on their surface, significantly reducing their chemical reactivity and corrosion rate. This passive film acts as a barrier, preventing further interaction between the metal and its environment.

Active–Passive Metals and Conditions for Passivation

Metals that can transition between active (corroding) and passive (protected) states are termed active-passive metals. for instance, the case of 18-8 stainless steel placed in an aqueous solution of H2SO4. If the electrode potential is increased then the current density rises to a maximum, with the accompanying dissolution of the metal taking place in the active state. The current density associated with the dissolution process indicates the magnitude of corrosion. At a certain potential, the current density is drastically reduced as the metal becomes passivated because of the formation of a thick protective film.

The formation and maintenance of passivity depend on several factors:

1- Electrode Potential: Applying a more positive potential can induce passivation, leading to the formation of a protective oxide layer

2- Oxidizing Agents: Strong oxidants in the environment can facilitate the formation of passive films on metal surfaces.

3- Environmental Conditions: Factors such as pH, temperature, and the presence of specific ions (e.g., chlorides) influence passivity. For instance, stainless steel exhibits passivity in oxidizing environments but may become active in reducing conditions

Kinetics of Passivity

The kinetics of passivity involve the rate at which passive films form and grow on metal surfaces. Key aspects include:

1- **Film Formation Mechanisms:** Passive films can form through direct oxidation of the metal surface, precipitation from solution, or anodic oxidation of metal ions.

2- **Growth Dynamics:** The thickness and uniformity of the passive film are influenced by factors such as temperature, electrolyte composition, and applied potential

Stable Passivity

Stable passivity refers to the condition where the passive film remains intact and protective over time. Characteristics include:

1- **Durable Passive Film:** The film is continuous, adherent, and resistant to environmental changes.

2- **Resistance to Localized Corrosion:** Stable passive films prevent localized corrosion phenomena such as pitting and crevice corrosion

Unstable Passivity

Unstable passivity occurs when the passive film is compromised, leading to increased corrosion rates. Factors contributing to instability include:

1- **Mechanical Damage**: Physical disruptions to the passive film can expose the underlying metal to corrosive agents.

2- **Aggressive Ions:** Species like chloride ions can penetrate and destabilize passive films, initiating localized corrosion