4.5PROTECTIVE COATING

Paints

Paint is a dispersion of one or more finely ground solids (pigments and extenders) in a medium or vehicle.

Characteristics of good paint

- It should spread easily on the surface .
- It should have high covering power.
- It should dry quickly.
- It should not crack on drying.
- The colour of the paint should be stable.
- It should be washable.
- It should give a glossy film.

Constituents of Paint

1) Pigments

Constituents

Solid and colour producing substances in a paint.

Function

- It provides desired colour.
- It gives strength to the film.
- It protects from UV light.

Example

White lead, red lead & carbon black.

2) **Vehicle (or) drying Oil**.

Constituents

- It is the film forming constituent in paint .
- It is non-volatile.

Function

- It holds the pigment together.
- It forms a protective film.
- It imparts water repellency , toughness and durability to the film.

Example

Linseed oil & castor oil.

3) Thinners

Constituents

- It is the volatile substance in the paint.
- It evaporates when paint is applied on the surface.

Function

- It dilutes the paint.
- It increases the elasticity of the film
- It helps in drying of paint by evaporating.

Example

Turpentine, Sprits.

4) Filters (or) extenders

Constituents

It is the inert materials which improve the properties of paint

Function

- It reduces the cost.
- It helps to fill the voids.
- It prevents shrinkage and cracking.

Example

Talc , Gypsum & Chalk.

5) Driers

Constituents

Driers are O_2 carriers.

Function

- It accelerates the drying process.
- It acts as a catalyst.

Example

Metallic Soaps, Borates of Pb , Zn etc.

6) Plasticizers

Constituents

Plasticizers are substances added to provide elasticity to the film.

Function

- It prevents cracking of the film .
- It gives elasticity.

Example

Triphenyl phosphate , tricresyl phosphate.

7) Anti skinning agents

Constituents

It prevents peeling.

Function

- They are added by prevent the peeling off of the paint.
- They also prevent gelling.

Example

Poly hydroxyl phenol.

Surface coating - Surface preparation for metallic coatings

Surface preparation is a critical step in the application of metallic coatings. Proper preparation ensures that the coating adheres well, performs effectively, and achieves its intended protective or aesthetic purposes. Here's a comprehensive guide to surface preparation for metallic coatings:

1. Cleaning

Objective: Remove contaminants that can interfere with coating adhesion.

- **Oil and Grease Removal:** Use solvents, alkaline cleaners, or degreasers to remove oils, greases, and other organic contaminants.
  - **Methods:** Solvent cleaning, steam cleaning, or ultrasonic cleaning.
  - **Products:** Trichloroethylene, acetone, or commercially available degreasers.
- **Dirt and Dust Removal:** Clean surfaces to remove loose dirt and dust.
  - **Methods:** Use compressed air, brushes, or cloths.
  - **Considerations:** Ensure the surface is dry and free from residues before proceeding to the next steps.

2. Surface Preparation

Objective: Create a suitable surface profile for the metallic coating to adhere effectively.

- **Mechanical Abrasion:** To enhance surface roughness and remove rust or old coatings.
  - **Methods:** Sandblasting (abrasive blasting), grinding, or sanding.
  - **Materials:** Abrasive materials like aluminum oxide, garnet, or steel shot.
- **Chemical Cleaning:** For removing rust, scale, or other inorganic contaminants.
  - **Methods:** Use acid solutions (like phosphoric or hydrochloric acid) or rust removers.
  - **Considerations:** Follow safety guidelines and neutralize acids after use.
- **Surface Profiling:** Achieve the desired roughness to ensure good adhesion.
  - **Methods:** Sandblasting creates a rough surface profile ideal for coating adhesion.

    - **Profile Standards:** Use standards like the "NACE" or "ISO" profiles to ensure correct roughness.

3. Inspection

Objective: Ensure the surface is properly prepared and free from defects.

- **Visual Inspection:** Check for visible defects, contaminants, or irregularities.
- **Surface Cleanliness Tests:**
    - **Tape Test:** Check for residual contaminants by applying and removing adhesive tape.
    - **Water Break Test:** Ensure the surface is free from contaminants by observing how water spreads or beads on the surface.

4. Surface Treatments

Objective: Enhance adhesion and protect the surface before coating.

- **Priming:** Apply a primer to improve adhesion and provide additional protection.
    - **Types:** Epoxy primers, zinc-rich primers, or other types depending on the base metal and coating system.
    - **Application:** Follow manufacturer instructions regarding application thickness and curing times.
- **Passivation:** For stainless steel or other corrosion-resistant alloys, passivation can enhance the formation of a protective oxide layer.
    - **Methods:** Use solutions containing nitric or citric acid.
    - **Purpose:** Remove free iron and enhance the natural corrosion resistance of the metal.

5. Final Preparation

Objective: Ensure the surface is in optimal condition right before coating.

- **Surface Dryness:** Ensure the surface is completely dry before applying the metallic coating.
    - **Methods:** Allow time for drying or use heated air if necessary.
- **Avoid Contamination:** Prevent contamination of the prepared surface by handling it carefully and avoiding exposure to pollutants or moisture.
    - **Protection:** Use covers or barriers if there is a risk of environmental contamination before coating application.

Metallic Coating

Coating a metal surface by a noble metal is called metallic- coating --- The article to be coated --- Base metal --- The metal used for coating --- coat metal.

Types of Metallic Coating

1) Electroplating
2) Electroless plating

Definition

The process by which coat metal is deposited over base metal by passing electric current .

Process of Electroplating

- Pre-treatment (removing impurities) is given to the coat metal.
- Article to be coated is taken as cathode
- The coating metal is taken as anode.
- Anode and cathode are dipped in an electrolyte.
- Direct electric current is passed
- Electrolysis occurs and coat metal is deposited over the article.
- To get bright deposits, brightening agents are used.
- Additives are added to electrolytic bath to get smooth & uniform deposits.
- The favorable conditions are
  - i) Low metal in concentration
  - ii) Optimum current density
  - iii) Nature of electrodes.
  - iv) Optimum Temperature.

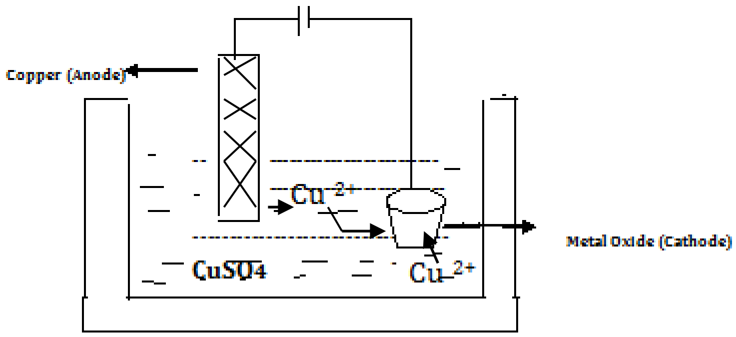
Electro Plating of Copper

It is the process of depositing a thin layer of Copper on the Surface of an article.

Process

- Article to be coated is cleaned with dil.HCl.
- Pure Copper is taken as anode .
- Article to be coated (any article) is taken as cathode .
- Copper Sulphate soln. is taken as electrolyte .
- Optimum temperature is 40-45^{o} C.
- Current density is 30-40 mA / cm^{2}.

\+ -



Reactions

During electroplating, the following reaction occurs.

$$CuSO_4 \longrightarrow Cu^{2+} + SO_4^{2-}$$

At cathode: $Cu^{2+} + 2e^- \longrightarrow Cu$

At Anode : $Cu + So_4^{2-} \longrightarrow CuSO_4 + 2e^-$

Applications

- Used as undercoat for Ni-Cr electro deposit.
- Used protective coating for steel
- Used in bottom of stainless steel cooking utensils.

Electro less Plating

Definition

The process by which the coat metal is deposited over base metal using a reducing agent without using electricity.

Ingredients of Electroless Plating bath.

i) Source metal –Soluble salt of metal
ii) Reducing agent
iii) Complexing agent – To improve quality.
iv) Exalent - To increase plating rate .
v) Stabilizer – To prevent decomposition.
vi) Buffer – To maintain pH.

Electroless Nickel Plating

Step -1 Pre- Treatment

The surface to be coated is degreased by organic solvents or alkali followed by acid treatment

Step -2 Preparation of Plating bath

i) Coating Solution	$NiCl_2$
ii) Reducing agent	Sodium hypophosphite
iii) Complexing agent	Sodium Succinate
iv) Exaltent	Sodium Succinate
v) Buffer Solution	Sodium acetate
vi) PH	4.5
vii) Optimum Temperature	93^oC

Step -3 process of Plating

The Pre – treated article is immersed in the plating bath for sufficient time.

Reactions

Anode : $H_2PO_2^- + H_2O \longrightarrow H_2PO_3^- + 2H^+ + 2e^-$

Cathode: $Ni^{2+} + 2e^- \longrightarrow Ni$

Net Reaction: $Ni^{2+} + H_2PO_2^- + H_2O \longrightarrow Ni + H_2PO_3^- + 2H^+$

Applications

- Used in electronic appliances
- Used in Jewellery
- Used in tops of perfume bottles
- Used in aircraft

Advantages of Electro less plating over electroplating

- No electricity is needed
- Semiconductors and insulators are coated.
- Irregular shapes can be plated
- Greater corrosion resistance

ceramic coatings

A Ceramic Coating is the liquid polymer which can provide high-performance oxide layers on metals and alloys to solve the problems of corrosion, wear, heat, insulation and friction. Orginally, the Coating was invented for the steel industry. The reason for this was the molten metal being produced was causing the machinery to melt. Therefore, Ceramic Coating was invented.

Ceramic coatings are two-dimensional layered structures that are applied to the surface of a substrate to increase the durability and performance of engineering materials that are exposed to various corrosive environments.

Uses:

- The Ceramic coating will protect the vehicle's exterior and interior from deteriorating for a life time.
- The resale market value will be substantially higher.
- Less maintenance.
- Act as a protection.

Physical properties

- Hygienic(Easy-to-Clean).
- High temperature resistance.
- Environmental Corrosion resistance.
- High hardness (Scratch and abrasion).
- High chemical Corrosion resistance
- Sun light resistance (Colour stability).

Types of ceramic coating

- Plasma spray coating.
- Sputter spray coating.
- Dry-film lubricants.
- Thermal spray coating.
- Wet chemical and Electrochemical Coating.

Applications

Space

1.Protect spacecraft and satellites from extreme temperatures encountered in space.

2.Shield spacecraft and equipment from harmful radiation in space

3.Protect components from wear and erosion due to space debris or micrometeoroids.

4.Provide electrical insulation for components exposed to high voltages and electrical currents.

5.Protect components from oxidation and chemical attack in the harsh space environment.

6.Regulate temperatures of spacecraft and instruments.

Automobile

1. Provides a long-lasting protective layer that resists scratches, chips, and chemical damage.
2. Repels water and prevents water spots, making it easier to clean and maintain the vehicle.
3. Shields the paint from harmful UV rays that can cause oxidation and fading.
4. Improves the depth and clarity of the paint, giving the vehicle a glossy, high-quality finish.
5.Reduces the accumulation of dirt and grime, making washing and maintenance.

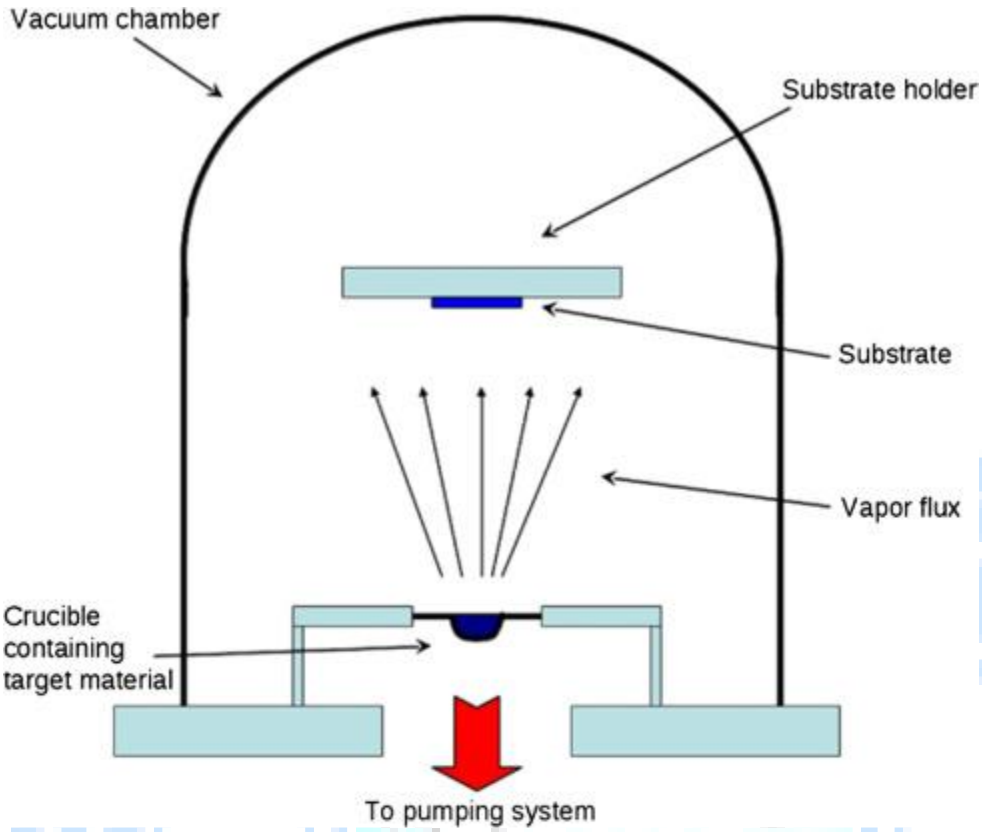
Marine

1. Protects metal surfaces from saltwater, humidity, and other corrosive elements.
2. Provides a hard, protective layer that resists scratches, abrasion, and impacts.
3. Repels water, reducing the formation of water spots and making cleaning easier.
4. Shields surfaces from harmful UV rays that can cause degradation and discoloration.
5. Reduces the adhesion of marine organisms like algae and barnacles.

Thermal vaporization coating

Thermal evaporation is one of the commonly used Physical Vapour Deposition (PVD) techniques. This is a type of thin film deposition, a vacuum-based technique for coating various materials' surfaces with pure materials. The coatings, also known as films, can be made of a single material or a combination of materials arranged in layers. Their typical thickness ranges from angstroms to microns. Thermal evaporation techniques can be used to apply compounds like oxides and nitrides as well as pure atomic elements, including both metals and non metals.

Thermal vaporization coating is a process used to apply thin films or coatings to various surfaces.



Process :

1. **Material Selection:** The coating material, typically a metal, alloy, or compound, is chosen based on the desired properties of the coating, such as hardness, corrosion resistance, or conductivity.
2. **Vaporization:** The material is heated until it evaporates or sublimates in a vacuum or controlled environment. This is often achieved using techniques such as:
   - **Thermal Evaporation:** Material is heated in a vacuum until it evaporates.
   - **Electron Beam Evaporation:** Material is heated using an electron beam in a high vacuum.
3. **Deposition:** The vaporized material travels through the vacuum and condenses on the surface of the substrate, forming a thin film or coating. The thickness of the coating can be precisely controlled by adjusting the deposition parameters.
4. **Cooling and Solidification:** As the vaporized material condenses, it cools and solidifies into a thin, uniform layer on the substrate.

Applications:

- **Optical Coatings:** Used to enhance the reflectivity or transmission properties of lenses and mirrors.
- **Protective Coatings:** Applied to metals or ceramics to improve wear resistance, reduce friction, or protect against corrosion.
- **Electronic Devices:** Used in semiconductor manufacturing to create thin conductive or insulating layers.
- **Decorative Finishes:** Employed to provide aesthetic finishes to various products.

Advantages:

- **Uniform Coatings:** Capable of producing smooth, uniform films with high precision.
- **Control:** Allows fine control over film thickness and composition.
- **Versatility:** Suitable for a wide range of materials and substrates.

Disadvantages:

- **Cost:** Equipment and operational costs can be high.
- **Complexity:** Requires careful control of process parameters and vacuum conditions.

HVOF coating

HVOF (High-Velocity Oxygen-Fuel) Coating is a thermal spray coating process used to apply protective or functional coatings to surfaces. HVOF coating is a process used in surface engineering to apply hard coatings to surfaces for protection against wear, erosion, and corrosion.It involves the combustion of a mixture of fuel gas and oxygen in a combustion chamber. The resulting hot gases are expelled through a nozzle at supersonic speeds, along with fine particles of the coating material (typically metals or ceramics).

Coating Materials: Common materials used for HVOF coatings include tungsten carbide, chromium carbide, nickel alloys, ceramics like alumina, and cermets (ceramic-metallic composites).

Process:

1. **Fuel Combustion:** A mixture of fuel and oxygen is combusted in a high-pressure chamber, creating a high-velocity stream of hot gases.

2. **Powder Injection:** Coating material powder is injected into this hot gas stream.
3. **Spray and Deposit:** The powder particles are accelerated to high speeds and impact the substrate, where they rapidly cool and bond to form a dense, durable coating.

Applications:

1. **Industrial Equipment**: Used in components exposed to abrasive wear, such as pump shafts, turbine blades, and hydraulic pistons.
2. **Corrosion Protection**: Provides protection against chemical attack in harsh environments, such as offshore platforms and chemical processing plants.
3. **Dimensional Restoration**: Used to rebuild worn-out components to their original dimensions.

Advantages:

1. **High Density Coatings**: HVOF produces dense coatings with low porosity, which enhances resistance to corrosion and wear.
2. **High Bond Strength**: Coatings adhere strongly to the substrate due to the high kinetic energy of the particles upon impact.
3. **Low Oxidation**: The high combustion efficiency minimizes oxidation of the coating material, preserving its properties.

Disadantages:

- **Cost:** Equipment and operational costs can be high.
- **Complexity:** Requires precise control of parameters for optimal results.