

A REVIEW ON COATING PROCESS

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Abstract:

The Coating enhances and extends the range of functional performance properties of textiles. Coating has now become a very important technique for adding value to efficiency of material. Surface coating is a reliable and cost effective process, used for the production of tools, materials, and machine components that requires desired surface properties like corrosion, erosion and wear resistance. The main purpose of applying the coating may be decorative, functional, or both. To improve surface properties such as adhesion, erosion, corrosion and wear resistance, functional coating may be used. Whereas, decorative coating such as artist's paints are applied to make the product/material more attractive. Now days, number of coating methods are applied to achieve the desired functional or decorative properties. erosion. This paper briefly explains various coating process, their basic principles. In addition to this features, characteristics of coating methods and various corrosion prevention methods are briefly described. Thermal spray is a collective term for a set of processes in which coating material is heated rapidly in a hot gaseous medium, and simultaneously projected at a high velocity onto a prepared substrate surface, where it deposits to produce the desired thickness of coating.

Key words: Coating, Corrosion, coating properties, Thermal spray.

1) INTRODUCTION:

1.1 Coating

A coating is a covering that is applied to the surface of an object, usually referred to as the substrate. The purpose of applying the coating may be decorative, functional, or both. The coating itself may be an all-over coating, completely covering the substrate, or it may only cover parts of the substrate.

Coating is a protective layer applied to the surface of an object. In many cases coatings are applied to improve surface properties of the substrate, such as appearance, adhesion, corrosion resistance, wear resistance, and scratch resistance. An industrial coating is a paint or coating defined by its protective, rather than its aesthetic properties, although it can provide both. The most

common use of industrial coatings is for corrosion control of steel or concrete. Other functions include high build coatings for fire resistance. The most common material used in industrial coatings are ceramic, Al₂O₃, acrylic, polyester, polyurethane, epoxy and silicone. A major consideration for most coating processes is that the coating is to be applied at a controlled thickness, and a number of different processes are in use to achieve this control, ranging from a simple brush for painting a wall, to some very expensive machinery applying coatings in the electronics industry. A further consideration for 'non-all-over' coatings is that control is needed as to where the coating is to be applied. Coating is a process in which a polymeric layer is applied directly to one or both surfaces of the fabric. The polymer coating must adhere to the textile and a blade or similar aperture controls the thickness of the viscous polymer. The coated fabric is heated and the polymer is cured (that is, polymerized). Where a thick coating is required this may be built up by applying successive coating layers, layer on layer, Interlayer adhesion must therefore be high Finally, a thin top layer may be applied for aesthetic or technical enhancement of the coating. The formulation of a coating is complicated, and it can contain a wide range of chemicals depending upon the nature of the polymer, the necessary additives for the specific end use, whether the coating has to be foamed prior to application, and the type of coating machinery to be used. Coatings may be colored, translucent or opaque, fluorescent, photo-luminescent or retro-reflective, according to the end user requirements. Some thermoplastics are used as they allow the material to be used as they allow the material to be used as hot melt adhesive and in some cases for welding techniques.

1.2) Coating Properties:

A coating must exhibit a variety of properties to fulfill its role as a protective coating. Desirable properties include:

Chemical Resistance: The coating must resist breakdown from the chemicals to which it is exposed. Chemical resistance is primarily a function of the resin used.

Water Resistance: Water affects virtually all coatings. Greater water resistance equates to more effective corrosion control.

Ease of Application: Ease of application is a vital characteristic, especially with intricate structural details. The more difficult the application, the more opportunity for defects to be created, leading to premature failure.

Adhesion to Substrate: Adhesion is based on physical and chemical interactions between the coating and the substrate. Poor adhesion equates to poor performance.

Cohesive Strength: Coatings must be able to withstand the stresses of the curing process and changes in temperature and moisture content.

Flexibility and Elongation: The ability to expand and contract with the substrate is critical in some coating applications.

Impact Resistance: The coating may have to resist impact loads.

Abrasion Resistance: Coatings in some areas may have to be abrasion-resistant.

Temperature Resistance: The environment may expose the coating to extremes of temperature, usually elevated.

Dielectric Strength: A key variable in the barrier coatings and when using coatings in conjunction with cathodic protection

2. CLASSIFICATION OF COATING PROCESS:

- Vapour deposition coating
- Electro deposition coating
- Roll to Roll coating process
- Spraying process

2.1) Vapour deposition coating:

It is a family of processes used to deposit layers of material atom by atom or molecule by molecule on a solid surface. This process is operating at below atmospheric pressure.

Types of Vapour deposition coating

1. Physical Vapour deposition: In this process the material that is introduced onto the substrate is introduced in solid form. It is based on separating atoms from surfaces and accumulating (atomic or ionic) them to sub material surface to be coated, by evaporating or sloping materials under vacuum. Coating material, in

PVD method, is transmitted to surface in atomic, molecular or ionic form, obtaining it not chemically but physically from solid, liquid and gas source. Chemical reactions can exist on main material surface too colder than CVD coating (50500 °C) however such a reaction formation is no necessary. It is more interesting that PVD operation is performed in relatively lower temperatures. In addition, after completion of coating micro structure and properties of main material are not affected. PVD Method is carried out by three methods called as evaporating, dispersion and ionic coating.

2. Chemical Vapour deposition: In this process the material that is introduced onto the substrate is introduced in a gaseous form. [7,8]

2.2) Electro-deposition Coating (E-coat):

2.2.1) Plating:

2.2.1.1) Electro plating

In electroplating, an ionic metal is supplied with electrons to form a non-ionic coating on a substrate. A common system involves a chemical solution with the ionic form of the metal, an anode (negatively charged) which may consist of the metal being plated (a soluble anode) or an insoluble anode (usually carbon, platinum, titanium, lead, or steel), and finally, a cathode (positively charged) where electrons are supplied to produce a film of non-ionic metal

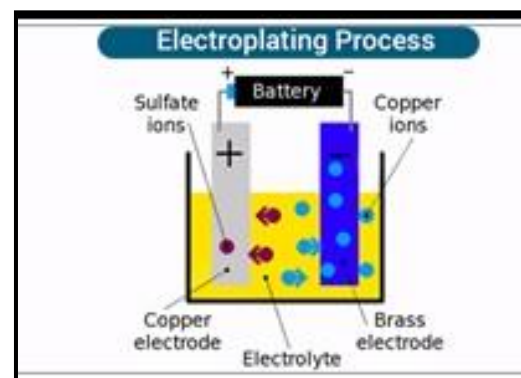


Figure 1. Electroplating process

2.2.1.2) Electro less plating:

Electro less plating, also known as chemical or auto-catalytic plating, is a non-galvanic plating method that involves several simultaneous reactions in an aqueous solution, which occur without the use of external electrical power.

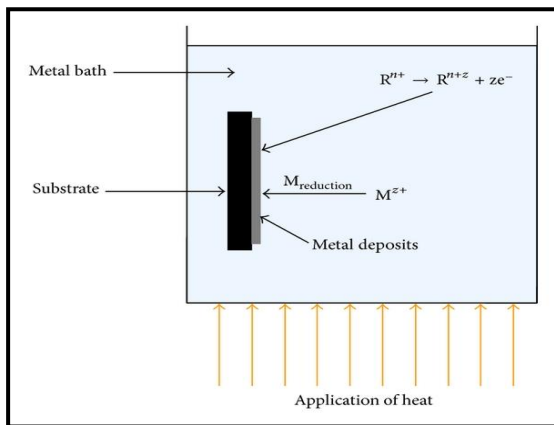


Figure 2. Schematic diagram of Electroless plating process.

The reaction is accomplished when hydrogen is released by a reducing agent, normally sodium hypophosphite or thiourea, and oxidized, thus producing a negative charge on the surface of the part. The most common electroless plating method is electroless nickel plating, although silver, gold and copper layers can also be applied in this manner, as in the technique of Angel gilding.

2.3) Roll-to-Roll coating process:

In the field of electronic devices, Roll-to-roll processing, also known as web processing, reel-to-reel processing or R2R, is the process of creating electronic devices on a roll of flexible plastic or metal foil. In other fields predating this use, it can refer to any process of applying coatings, printing, or performing other processes starting with a roll of a flexible material and re-reeling after the process to create an output roll. These processes, and others such as sheeting, can be grouped together under the general term converting. When the rolls of material have been coated, laminated or printed they can be subsequently slit to their finished size on a slitter reminder.

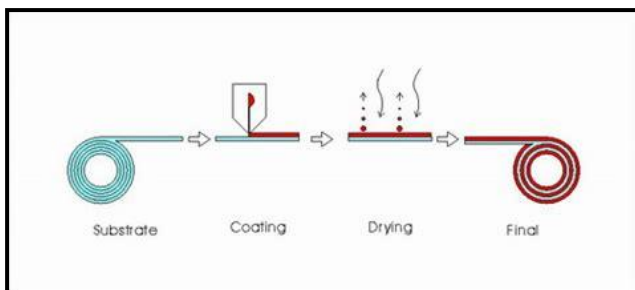


Figure 3. Roll to Roll process

2.4) Spraying process:

2.4.1. Powder coating process:

The powder coating process is very similar to a painting process except that the “paint” is a dry powder

rather than a liquid. The powder sticks to the parts due to electrostatic charging of the powder and grounding of the parts. Any substrate can be used that can tolerate the heat of curing the powder and that can be electrically grounded to enhance charged particle attachment. The powder flows and cures during the application of heat. Several advantages of powder coating over paints are:

- 1) Powder recovery for reuse
- 2) No VOC generation therefore no VOC destruction required
- 3) Can be more durable than paints (powder chemistry dependent) [10].

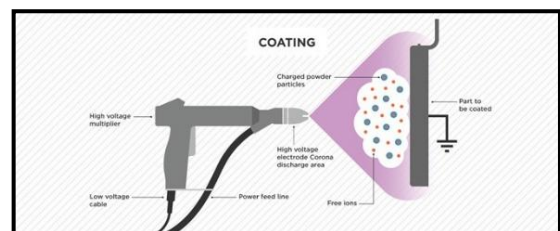


Figure 4. Powder coating process

2.4.2. Thermal spray coating process

In the simplest terms possible, thermal spray coating involves heating a material in powder or wire form to a molten or semi-molten state. The material is propelled using a stream of gas or compressed air to deposit it, creating a surface structure on a given substrate. The coating material may consist of a single element, but is often an alloy or composite with unique physical properties that are only achievable through the thermal spray process. Generally speaking, thermal sprayed coatings are a highly cost effective way to add superior performance qualities to a given substrate. [1,3]

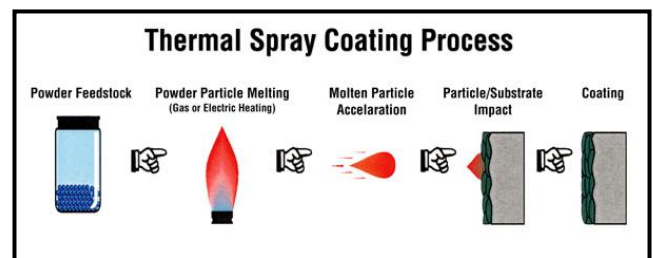


Figure 5. Schematic diagram of thermal spray process for forming a coating

2.4.3. PLASMA SPRAYING

Plasma spraying is one of the most widely used thermal spraying technique which finds a lot of applications due to its versatility of spraying a wide range of materials from metallic to nonmetallic and

hence more suitable for spraying of high melting point materials like refractory ceramics material, cermet's etc. The plasma spray process is shown on the Figure 6. When the plasma jet is formed, a powder through nozzles carried by the "carrier" gas is injected into it. Accelerated and melted powder particles leave the plasma jet in the form of molten particle stream. The molten particles bombard the substrate surface where they cool forming a coating. Also particles may be cooled and collected in the form of spheres. Every molten particle has a high thrust which leads to high bond strength of the coat. The temperature of the substrate remains below 100 °C. Thickness of the coat varies between 0.3 and 1 mm, but it may be also up to 3 to 4 mm. The basic function of the plasma jet is to heat the powder particles to the melting point and to accelerate them to the highest possible speed. The whole spraying process of the formation of a coating can be divided into three sub processes powder feeder, powder feeder, Environment for spraying. [1]

The equipment consists of following module.

The plasma Tron: It is the device which houses the electrodes and in which the plasma reaction takes place. It has the shape of a gun and it is connected to the water cooled power supply cables, powder supply hose and gas supply hose.

The power supply unit: Normally plasma arc works in a low voltage (30-60 Volts) and high current (300-700 Amps), DC ambient. The available AC power of 3 phase, 440Volts must be transformed and rectified to suit the reactor. This is taken care of by the power supply unit.

The powder feeder: The powder is kept inside a hopper. A separate gas line directs the carrier gas that fluidizes the powder and carries it to the plasma arc. The flow rate of the powder can be controlled precisely.

The coolant and water supply unit: It circulates water into the plasma Tron, the power supply unit and the power cables. Units capable of supplying refrigerated water are also available.

The control unit: Important functions (current control, gas flow rate control etc.) are performed by the control unit. It also consists of relays and solenoid valves and other interlocking arrangements essential for safe running of the equipment. For e.g. an arc can only be started if the coolant supply is on and water pressure and flow rate is adequate [2].

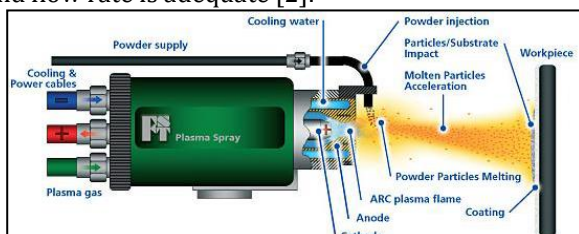


Figure 6. Plasma spray process

CONCLUSION: -

Coating improves the life of the component and reduces the cost of replacement. The purpose of surface technology is to produce functionally effective surfaces. A wide range of coatings can improve the corrosion, erosion and wear resistance of materials. We can conclude that thermal spray coating is one of the most important techniques of the surface modification method. This study was an effort to give basic information regarding some of the main thermal spray techniques. By using thermal spray technique uniform coating thickness, continuous layer of coating and high hardness can be obtained. It has more advantages over the high strength, hardness, porosity, wear and corrosion as compared to other process.

REFERENCES:

1. Jovan Ruzic, Miroljub Vilotijevic, Dusan Bozic, Karlo Raic, "Understanding plasma spraying process and characteristics of dc-arc plasma gun." Scientific paper no. 6676343, department of material science, vinca university, Serbia, 2012
2. Ajit Behera, "Processing and characterization of plasma spray coating of industrial waste and low grade ore mineral on metal substrates." ISSN NO. 769008, department of metallurgical & material engg. Rourela University, May 2012.
3. Baljit Singh, "Recent advancements in thermal spray coatings", ISSN NO.: 2249-5770 Vol. 3, Department. Of Mechanical Engineering, DBFGOI, Moga, Punjab, OCT 2013.
4. Sagar Amin and Hemant Panchal "A review on thermal spray coating processes", ISSN 2455-1392, Vol 2, Metallurgical and Materials Engineering Department, Faculty of Technology and Engineering University of Baroda, Vadodara, India, April 2016.
5. Grainger and J. Blunt, "Engineering coatings: Design and application", Wood head Publishing Ltd, UK, 2nd ed., 1998, ISBN 978-1-85573-369-5

6. C. Leyens and M. Peters, Wiley-VCH, "Overview of several coating systems and fabrication processes for titanium alloys and titanium aluminides", ISBN 3-527-30534-3. coatings in the turning of austenitic stainless steels", Science Direct, Procedia Engineering 63 (2013) 133 –141, 2013
7. Vishakha S. Pahade, Pankaj S. Chavan, Vaishali P. Baisane. "A review paper on A Vapour deposition coating", ISSN: 2394-3661, Volume-3, June 2016
8. A.I. Fernández-Abia, J. Barreiro, J. Fernández-Larrinoa, L.N. López de Lacalle, A. Fernández-Valdivielso, O.M. Pereira1 "Behavior of PVD
9. Zhongyan Du, Shaoguo Wen, Jihu Wang, Changle Yin, Dayang Yu, Jian Luo, "The Review of Powder Coatings", College of Chemistry and Chemical Engineering, Shanghai University of Engineering Science, Shanghai, China, msce.2016.43007
10. Mondal. S. "Phase change materials for smart textiles – An overview", Applied Thermal Engineering,2008, 1536–1550