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QUALITY IN METALLIZED COATING APPLICATIONS

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Abstract: *Metalized coating is attained by atomizing the coating metal by melting with proper gas (propane, acetylene or others) and oxygen compound and then spraying it with compressed air all over the surface to be coated. Metallization in the application is the process of vaporization of the needed metal with tungsten in vacuumed media. This system among the PVD Coating groups is known as Evaporation Coating all through the world. Although the very fine metal layer that condenses over the product to be coated varies from sector to sector; it is generally used with aesthetic and decorative aims.*

The surface of the part to be coated is cleaned off the effects such as dirt, dust and oils etc. this cleaning method varies according to the size, shape and material of the piece to be coated. Surface cleaning before coating is very important in the sense of coating life, quality and strength. Otherwise, expected yield cannot be attained from the metalized and corrosion start can be observed shortly due to remnants on the places which are not thoroughly cleaned. Since metallization is a vaporization method; it is ionized by melting on all places which are in high-vacuumed. But there occurs an adsorption problem on some plastic types, therefore a smooth coating is attained applying an adherence through interlayer on these products before coating or with corona application.

In food packaging sector metalized coated products are used because of their barrier feature towards light, water vapor, oxygen and other gases. This method of packaging is widely used in such kinds of sectors due to being most economical in packaging sector. For example; food packaging sector which holds a great place in flexible packaging group uses metalized coating system due to their barrier feature of metalized film with the aim of preventing oxidation of food products, decreasing the need of protective addition agent and extending the shell-life. Moreover cosmetic packaging group and many other sectors uses metalized coating due to its aesthetic feature with the aim of its being supportive to product promotion and reveal the decorative feature of the product.

Metalized coating firms generally have quality and coating problems. In metalized coating processes done in series; expected amount and quality can not be attained generally. Therefore in this paper; how the quality is attained in metalized coating applications and the effective factors for this application will be explained.

Keywords: *quality,metalized,coating*

1. INTRODUCTION

As Coating is a covering that is applied to the surface of an object, usually referred to as the substrate. In many cases coatings are applied to improve surface properties of the substrate, such as appearance, adhesion, wetability, corrosion resistance, wear resistance, and scratch resistance. In other cases, in particular in printing processes and semi conductor device fabrication (where the substrate is a wafer), the coating forms an essential part of the finished product.

Otherwise, metallic coatings provide a layer that changes the surface properties of the workpiece to those of the metal being applied. The workpiece becomes a composite material exhibiting properties generally not achievable by either material if used alone. The deposition of metal coatings, such as chromium, nickel, copper, and cadmium, is usually achieved by wet chemical processes that have inherent pollution control problems. Alternative metal deposition methods have replaced some of the wet processes and may play a greater role in metal coating in the future. Metallic coatings are deposited by electroplating, electroless plating, spraying, hot dipping, chemical vapor deposition and ion vapor deposition.

Physical Vapor Deposition (PVD) is a kind of metalic coating method. PVD is a process to produce a metal vapor that can be deposited on electrically conductive materials as a thin highly adhered pure metal or alloy coating.

The process is carried out in a vacuum chamber at high vacuum (10-6 torr) using a cathodic arc source. Single or multi-layer coatings can be applied during the same process cycle. Additionally the metal vapor can be reacted with various gases to deposit Oxides, Nitrides, Carbides or Carbonitrides.

First step is cleaned for PVD process.The cleaning process varies depending on the level of quality from the electroplater, substrate material and geometry. The parts are loaded into the vacuum chamber on custom fixtures designed to optimize the chamber load size and insure coating uniformity.

The vacuum chamber is evacuated to 10-6 torr (high vacuum) to remove any contaminants in the system. The vacuum chamber is backfilled with an inert gas argon and ionized, resulting in a glow discharge (plasma). This is the gas cleaning stage and prepares the parts for the initial metal deposition.

A high current, low voltage arc is initiated on the target (solid material used for deposition). The metal is evaporated and instantaneously ionized. These metal ions are accelerated at high energies into the vacuum through an inert gas or reactive gas and subsequently deposited on the part. The basic properties of the metal being evaporated (target) remain unchanged during the metal deposition cycle. Changing the volume of gas and type of gas during the reactive deposition cycle changes the nature of the coating producing ceramics like carbides, nitrides or oxides. For instance, zirconium nitride (ZrN) is a hard, yellow-gold colored coating with exceptional wear and corrosion resistance. Zirconium nitride has become predominant in the plumbing and door hardware industry as a lifetime brass color. Introducing measured amounts of nitrogen into the chamber during the zirconium deposition cycle produces zirconium nitride.

Chromium nitride is produced in much the same way. Simply by adding an additional gas such as acetylene (C2H2), you can create chromium carbonitride. This is a gray to black color.The use and properties of the various coatings available from PVD coatings can, in many cases, be tailored to the individual customer application.

For example; "self-cleaning" windows, medical implants, cutting tools, decorative fittings and etc. In the areas of machining and tooling PVD coatings are widely used to increase the life and productivity of production tools saving companies billions of €. worldwide. PVD coated tools can be run faster reducing cycle times and enabling the production of more components in less time. Otherwise PVD coatings reduce wear and pickup reducing downtime due to tool replacement..Finally PVD coatings reduce the need for cutting fluid. Cutting fluids cost companies today up to 15% of their total production costs. PVD coatings can be run dry or with very limited amount of fluid.

In the area of machine components low friction coatings reduce energy losses and the need for lubricant. Hard (2000 VHN), wear resistant, low friction coatings can be deposited with a friction coefficient <1/2 that possible using oil lubrication therefore eliminating the need for lubricant. These coatings are used extensively in motor sport.

Tool coatings continue to represent a significant proportion of the applications for PVD technology. However recently, the application of low friction, wear resistant PVD coatings in the area of components has expanded. Typical specific applications are fuel injection systems, roller and plain bearings for harsh environments, gears, pumps and compressors.

2.QUALITY FACTORS ON PVD COATING APPLICATION

Generally we can mention three quality factors on PVD coating applications.These are; substrate material. coating and interface.For the characterisation of these parameters modern analytical techniques are used.

If a product fulfils the customer's expectations, the customer will be pleased and consider that the product is of acceptable or even high quality. If his or her expectations are not fulfilled, the customer will consider that the product is of low quality.This means that the quality of a product may be defined as "its ability to fulfil the customer's needs and expectations".

The quality of product directly affects its competitive position, profitability and credibility in the market. Thus, the major objective of quality management becomes that of achieving and maintaining the leadership in product quality and reliability.

Product quality requirements should be defined for each product based on factors related to satisfying the needs and expectations of those whom the product serves.The basic elements by the establishment of the general model of quality management in the development and introducing of PVD coatings on materials.

- Selection of the substrates ,
- Preparation of coatings,
- Testing of PVD coatings (in laboratory and workshop conditions),
- Industrial applications.

Although there are many kinds of substrates that can be potentially PVD coating, the most common materials are carbon, alloy, and stainless steels, cast irons, and aluminum alloys.

Variations in coating results can occur based on the chemical composition and surface properties of the substrate. Before committing to a particular coating, it is important to perform tests on the actual material to be coated.

To achieve acceptable adhesion, some PVD coatings require primer coatings, adding to cost. Metals usually require a primer coating or surface pretreatment.

All commercially available PVD coatings require either heating or UV curing to achieve hardness. The advantages of UV curable PVD coats are their short curing time and lower costs. Their disadvantages are less resistance to abrasion and scratching as well as shorter life of the applied coating.

On the other hand, heat cured coatings are typically more scratch resistant and, depending on substrate, will often last for ten or more years. The primary disadvantage to heat cured coatings is the curing time and the cost of ovens. Because of their shape, some items can only be heat cured.

The thickness of a coating and the amount of surface area that can be coated per unit volume of coating is determined by the amount of "solids" contained in the coating. Some coatings contain as low as 20% solids whereas others contain solids of 35% or more. As a rule, higher solid content will result in greater coating thickness and coverage. As coating runoff is recycled through repeated applications, solvents evaporate and need to be replaced to maintain a consistent solids percentage.

Dust and other foreign matter must be eliminated from the coating, and from the surface to be coated. Depending on the shape of the parts to be coated, cleaning prior to coating can be as simple as wiping with solvent, using a lint-free wiper. Complex shapes can be cleaned with high-pressure sprayers on in ultrasonic cleaning tanks, as needed.

3. QUALITY MANAGEMENT STEPS ON PVD APPLICATION

The first step of quality management is selection of appropriate PVD coatings (monolayer, multilayer, gradient, nanolayer, nanocomposite, CLC, DLC-coatings…) and their characterisation. At the end of the systems proporties are involving substrate-bulk material interface, surface coating or modified surface layer, and also surface, is very complex and, together, yields the system's properties which are required by the tool designer, with every part playing an important role. The complexity of the system is shown in Fig. 1

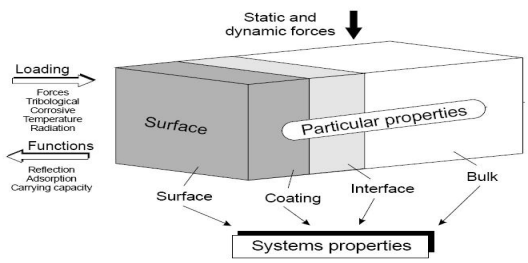

Figure 1.PVD coated systems properties (6)

If we can want to search quality of PVD coated materials ,at first we must define the structure.This structure partıcular proporties shown in Table 1.

The second step is selection and optimisation of PVD coatings **.**In the search for solutions to develop PVD coatings and improve manufacturing processes it is essential that the today's approach be replaced by new and innovative methods, which allow us, achieve a minimum of environmental contamination in conjunction with suitable technologies providing high process stability and reliability and acceptable economic conditions

Table 1.Partıcular properties of PVD coated materials (7)

Particular properties			
Bulk	**Interface**	**Coating**	**Surface**
• Composition • Microstructure • Mechanical properties • Physical properties • Fatigue limit f (ϑ)	• Composition • Microstructure • Thickness • Internal stresses • Bond strength	• Composition • Microstructure • Defects • Thickness • Strength • Hardness • Ductility • Toughness • Wear resistance • Chemical resistance • Temperature • Diffusivity f (ϑ)	• Topography • Reflectivity • Chemical reactivity • Surface energy

The third step is strongly connected with quality control of PVD coatings after producing and practical testing of coated tools in laboratory and workshop conditions. Quality assurance procedures have to be applied to maintain the standard achieved during development work, and need to be considered adequate

for the component. These procedures are of the same nature as the ones used during the production of substrate (bulk) and can be categorized as follows:

- Process parameter control
- Random sampling
- Non-destructive testing
- Monitoring in service

Process Parameter Control is the most important of procedures deals with control of all input materials and processes used during the tool surface coating (depositing). These parameters have to be strictly controlled and maintained within specific limits in order to obtain uniform quality over a product series and periods of time.

A random sample is one chosen by a method involving an unpredictable component. Random sampling can also refer to taking a number of independent observations from the same probability distribution, without involving any real population. A probability sample is one in which each item has a known probability of being in the sample. A method of determining thickness uniformity of a PVD coating, the coating being formed on the surface of an object, the method comprising determining PVD coating thickness data within portions of the surface, the portions including at least one generally concave portion and at least one generally convex portion, and presenting the PVD coating thickness data as a graphical representation for each portion. Nondestructive testing (NDT) is a wide group of analysis techniques used in science and industry to evaluate the properties of a material, component or system without causing damage.Because NDT does not permanently alter the article being inspected, it is a highly-valuable technique that can save both money and time in product evaluation, troubleshooting, and research.A method of PVD coating testing comprises applying a consistantly perpendicular minimum tension force to for testing to see if the adhesive bond strength between a PVD coating and a substrate meets a minimum specification for such bond.A method of monitoring the condition of a thermal barrier PVD coating on a materials is provided. Quality assurance not only means assuring the production quality before delivery, but also implies that surface coatings should not fail when in use, which could often result in expensive or catastrophic side effects.Quality management is the final step of implementation between the application requirements.User is the biggest factor in this regard. The suitability of a PVD coating tested by the user. Technical values helped him to decision in this regards

4. CONCLUSION

The most frequently encountered problem during the metalized coating applications is the problem of quality. This problem becomes more evident especially in serial applications.

The solution of this problem requires paying attention to quality control processes at every stage of metalized coating process.It is without doubt known that the method applied at this process is also effective.Among these methods PVD provides surfaces of much higher quality for the applicator.

PVD are widely used in the fields of cutting, drilling and treatment since they have advanced surface characteristics and they prolong the life of the set and increase the efficiency of it.If we want to improve the quality at this method, absolute application of quality management system in the total process is strongly recommended.

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