Surface protection progresses: A paradigm shift on composite deposition and matrixes

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Abstract.
In searching for solutions to minimize the challenge of metallic corrosion, surface treatment becomes profitable tool. Electrochemical deposition has, over recent decades, evolved from an art to an exact science. This development is seen to be responsible for the ever-increasing number and widening types of applications of this branch of practical science and engineering. Composite and nanocomposite alloys have been the focus of interest for many manufacturing systems, a great curiosity started with automobile industry, food industry, aeronautic and aerospace industries, where the weight to density fraction was of necessity. This paper seeks to unveil deposition novel engineering materials and technology by various author.

Keywords: Surface protection; progresses; composite; failure

1. Introduction
Surface Engineering is a science of surface improvement. It is the treatment of metallic surface through an application of surface active agent or metallic coatings by electrochemical or electrolytic means either for altering the appearance, to provide a protective coating; to give special surface properties or to improve engineering or mechanical properties [1]. Surface protections are divided broadly into two categories metallic or nonmetallic (organic or inorganic). With either of two the intent is the same, that is, to isolate the underlying metal from the corrosive media.

Protective coatings are perhaps the most extensively used system for corrosion control. They are used to provide long-term protection under a broad range of corrosive environments, ranging from atmospheric contact to the most demanding chemical processing conditions. Protective coatings in themselves provide little or no structural strength, yet they protect other materials to preserve their strength and integrity [2]. Isolation of structural activeness of protective coating also gives proactive resistance against environmental corrosiveness. Though, surface coatings must provide a continuous barrier to a substrate, and any imperfection can become the focal point for degradation and corrosion of the substrate if not carefully fabricated. The quality of a coating depends on many factors besides the nature of the materials involved. Coating and metal finishing operations are intended to increase corrosion or abrasion resistance, alter appearance, serve as an improved base for the adhesion of other materials, enhance wear and frictional characteristics, add hardness and improve electrical properties [3]. Surface coating is believed to be an engineering solution for enhancement of surfaces counter to wear, corrosion degradation and other surface linked occurrences. Acceptable coatings are generally characterized by good adhesion, substrate compatibility, and low porosity [4]. Coating must also be compatible with the physical constraints of the substrate such as temperature instability. With organic coatings the primary function in corrosion protection is to detach the metal from the corrosive environment. In addition to forming a barrier layer to stifle corrosion, the organic coating can contain corrosion inhibitors [5]. Many organic coating formulations exist, as do a variety of application processes to choose from for a given product or service condition. Inorganic coatings include porcelain enamels, chemical-setting silicate cement linings, glass coatings and linings, and other corrosion resistant ceramics. Like organic coatings, inorganic coatings for corrosion applications serve as barrier coatings. Some ceramic coatings, such as carbides and silicide, are used for wear-resistant and heat resistant applications, respectively [6]. Hence, this study brings to view the paradigm shift in composite deposition and the surface protection progresses from several authors’ perspectives.

2. Open perspective on protective coating
The challenge faced by metal due to corrosion activities has made coatings a house hold protective measure for failure prevention. In the past years, coatings applied using various techniques were done to improve the performance and lifetime of component for properties such as chemical stability, wear resistance and hardness performance. Protective coatings can be broadly divided into different aspect as metallic coating, organic coating inorganic coating etc. Metallic coatings involves the deposition of novel metal coatings by electroplating process, electroless plating, spraying, hot dipping, chemical vapor deposition, and ion vapor deposition. Some important materials for coatings are cadmium, chromium, nickel, aluminum, and zinc. They are used in applications requiring significant reflection and strong adhesion of metallic materials. Metallic coatings are known to show improved performance with lower cure temperature and significant corrosion resistance [7]. Inhibitive coatings In most advance coatings where corrosion resistances are paramount, inhibitor are added to the bath to act as barrier to the environment. Such inhibitor plays an active part in the curing, adhesion and surface appearance of the produced alloy. Inhibitors such as cinnamic acid are added to the paint bath to prevent degradation of steel in neutral and acidified media [8]. With inorganic coatings, this involves ceramic and glass fabricated through chemical action, with or without electrical support. They are usually impervious to water solution. Sometimes these coatings are applied as pre-coating before the co-deposition proper i.e treatments can also be a preparatory step prior to painting. The treatments change the immediate surface layer of metal into a film of metallic oxide or compound that has better corrosion resistance than the natural oxide film and provides an effective protection such as anodizing [9]. The development of organic coating is to reduce the environmental distortion such as often occur to carriage vessels in industries. Paints and high-performance organic coatings were developed to protect equipment from these challenges especially in petrochemical settings. Obviously the petroleum cracking product dislodge often contains unsaturated workable compounds. Epoxy, polyurethane, chlorinated rubber and polyvinyl chloride coatings are extensively used today in manufacturing industry to attack to water, oxygen, and prevent the occurrence of a cathodic reaction beneath the coating. The barrier properties are further increased by addition of inhibitors, such as chromate in the primer [10].

3. Composite materials and its functional matrices
Composite materials are known with their intriguing properties and numerous functionalities. They are materials made from two or more essential materials with significantly difference in their physical or chemical properties, that when combined; give a pool of unique characteristics different from that of the individual components [11]. The individual components remain separate and distinct within the finished structure. The new material may be preferred for many reasons: materials with higher strength, lighter and high stiffness, less expensive and high damping capacity when compared to traditional materials. The existence of composite material can be found in two constituent: matrix and reinforcement. Each portion of this constituent is required. In fact, matrix materials surround and provide backing to the reinforcement materials by upholding their virtual places [7]. The reinforcement imparts their special mechanical and physical properties to enhance the matrix properties.

Metal matrix composites are composite materials with at least two constituent parts, one being a metal and other with ceramics or metallic particles characteristics. Some are hybrid composite in nature. MMCs are prepared by diffusing a reinforcing material into a metal matrix. Most bolstering surface can be coated to prevent a chemical response with the matrix. For instance, carbon fibers used in aluminum or polymer matrix to create composites display low density and high strength. Hence, they provide long time function in automobile, wear processes and thermo-mechanical management [12, 13]. MMCs are almost constantly expensive than the more predictable materials they are substituting. In view of this, there usages are for improved properties and performance which can justify the extra cost. The applications are often in automobile, aerospace, space system electronics and civil structure [14].

Ceramic matrix composites are a subdivision of composites materials. They contain ceramic fibers inserted in a ceramic matrix; thereby forming a ceramic fiber reinforced ceramic (CFRC) material. Most time, reason for enhancing and developing CMCs was to overcome the problems associated with the conventional ceramics such as alumina, silicon carbide, aluminum nitride, silicon nitride and zirconia [15]. This ceramic based alloy fractures easily with intense mechanical or thermal-treatment loads because of cracks initiated by small defects or scuffs. The crack resistance is often very low when considering individual properties. Sometime to increase the crack confrontation or fracture toughness, particles of monocristalline whiskers
or platelets are sometimes embedded into the matrix. The major applications are for hard material production and in fabrication of ceramic cutting tools [16].

Metal ceramics composite is made from metal and ceramics proportion, in which a metallic particulate material is reinforced with ceramic hardened particles. This combined effort makes it possible to combine the low weight of the metal with the resistance of ceramics [17]. The productions often are for light-metal components which are meant especially for automotive and aerospace engineering. Nevertheless as significant as its rare properties with respect to higher demand might be, these components must work under ever more harsh and severe mechanical conditions. The general aim is to reinforce the lightweight particles with advanced ceramics in order to withstand most tribological, mechanical or thermal stress.

4. Concept on Deposition Process and Technology

In selective coating, electro-deposition can be made on the desired localized areas without the need for masking and without immersion of components. The anode is mounted in an insulated handle and covered by an absorbent pad soaked in the electrolyte. The work is connected to the negative side of a DC power source and circuit is completed by the contact of absorbent pad with the work piece. The process makes masking unnecessary. The deposition rate is higher than vat plating and this process enjoys the benefit of portability.

In electroless plating, the process involves an autocatalytic reduction reaction of metallic ions in an aqueous solution and the subsequent deposition of cathode metal without the use of electrical energy source. The electroless plating does not use electrodes, rather the process use an immersion plating solution with displacement of the surface skin of the cathode substrate by a novel noble metal that is in solution. Electroless has outstanding advantages which include better deposit quality, improved physical and mechanical properties. The electroless deposit often gives distinct advantages when plating irregularly shaped objects, holes, recesses, internal surfaces, valves, threaded parts, and so forth. In all, most electroless process uses variable that are desirable for better performance such as pH, concentration of the bath, temperature. For perfect electroless deposition bath must contain a source of ions, reducing agent, stabilizer, buffering agent, complexing agent and wetting agent [18].

With flame spraying, the aim is to melt the coating material and blow it on to the surface to be coated. The coating material is in the form of very small molten particles or droplets. Four methods based on the form of the coating material are generally used: an electric arc [19]. The resulting molten metal is blown out of the arc by an auxiliary gas stream, as droplets. The process is versatile with low capital investment. In the electrostatic spraying process, the particles released from the spray gun are electrostatically charged and propelled at low velocity by air or revolving spray head. Too much air pressure is to be avoided [20].

Pack cementations techniques are well-known to convene oxidation resistance on ferrous alloys. They are relatively expensive. They are also known as diffusive coatings and they exhibit a compositionally graded layer with the provision for a strong bonding between the coating materials and based substrate. The coating process is cost effective and mass production can be done even for complex shapes compared to other coating routes like plasma and cold spraying coatings. Pack cementation processes include aluminizing, chromizing, and siliconizing. Components are packed in metal powders in sealed heat-resistant retorts and heated inside a furnace to precisely control temperature-time profiles [21].

The hot dip galvanizing process is a distinctive coating technique with significant advantage over other protective measures especially for corrosion protection route. They are utilized in major fabrications and large scale production in iron and steel industry. Galvanizing can be found in almost every major application and industry where iron or mild steel is used. The technique provides electrochemical protection for steel by zinc coatings galvanizing process. In fact, all produced components rely on the cathodic protection provided by zinc to prevent corrosion of exposed steel at cut edges [22].

In vacuum deposition, the effective coating process is determined by the effective optimization of the process parameters such as vapor pressure, the atomic weight, metallizing concentration of the deposited particulate and the evaporated temperature through current passage. The operation chamber is maintained in a high vacuum. The surface is often at room temperature or relatively lower temperature. The vaporized
aluminum is condensed on the surface of the work piece. Coatings of the order of 0.021-0.075 mm are generally applied [23].

Vapor deposition is a gas process where a reactant precursor gas forms a solid coating on a heated substrate in a reaction chamber. In this process, vapors of a metal bearing compound are brought into contact with a heated substrate and a metal compound is deposited on the surface. Steel is exposed to dry aluminum chloride in a reducing atmosphere at 1000°C and metallic particulate is deposited on the surface. The property often obtained from vapor deposition includes high resistance to abrasive and adhesion wear, fine grains and high purity [24].

Conclusion
Detailed information on surface coatings and modifications are necessary knowledge for recent application in materials manufacturing design. Materials that range from ceramics, composites, biomaterials and metals are of great benefits for suitable surfaces enhancement properties and achieving interfacial multi-functional system where necessary. This study has attempted to collate the technology behind this phenomenal.

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