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A Recent Trend In Surface Modification: An Introduction

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Abstract

To improve the original surface properties always require modification so that enhanced surface property is obtained. So many techniques are available for improving the surface properties of the original substrate, which comes under the area of the coating. Some of them are ion implantation, laser alloying, dipping, diffusion, and melting method, electrolysis based and mechanical methods. In recent years surface modification through non-traditional machine i.e. EDM is also possible. EDM is a very well-known advanced machining process. Since in the process of machining by EDM there is always wear of tool is noticed which leads to the further invention of material transfer on the workpiece. This new method is known as an electric discharge coating. This paper describes the introduction of the electric discharge coating process and its recent research.

1. Introduction

Surface engineering deals with the scientific terminology within the surface for solid matter. All solids are bounded with the solid phase. To improve the further properties of the surface there is a need for the advanced method and also less costly. Surface modification is the act of modifying the surface of the substrate or material by bringing it to physical, chemical or biological

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characteristics that are altered one from the surface of a material or substrate. This modification was usually and initially offered to solid materials, but nowadays it is easily possible to find examples of the surface modification to the surface of some specific liquids. The modification of surface can be done by different methods with an aim to altering a wide range of basic characteristics of the surface, like as roughness, hydrophilicity, surface charge, energy, biocompatibility, and reactivity. There are many surface improvement technique is available for further improvement in the surface property. Some of them are like physical vapor deposition, chemical vapor deposition, electroplating, electron beam irradiation, laser coating, sputtering. Mainly solids are composed of a bulk material covered by a surface. The surface which bounds the bulk material is called the surface phase. It acts as an interface to the surrounding environment. The bulk material in a solid is called the bulk phase. Commonly phase of the surface of a solid gets contaminated with the open environment. This interaction can degrade the surface phase over time. Environmental degradation of the surface phase over time can be caused by wear, corrosion, fatigue, and creep.

Surface functionalization introduces the chemical aspects of the surface. Similarly, chemical functional groups material deposited on their surfaces can be intended from the surface substrates with standard bulk material properties. The best example of this kind found in the electronics or semiconductor sector and bioengineering applications.

2. Surface modification techniques

Various techniques are available for modifying the surface of the substrate. The most common coating techniques that are being utilized in the industry are Physical vapor deposition (PVD), Chemical vapor deposition (CVD), Electroplating, Electron-Beam Irradiation, LASER coating, and Sputtering, etc.

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a) ***Physical vapor deposition (PVD) –*** This technique is mainly used for different particle material on the workpiece or commonly known as substrate. This method is mainly done in the vacuum chamber at a temperature range in order of 400˚C.As the name suggests there is no chemical reaction occurs in the vacuum chamber.

b) ***Chemical vapor deposition (CVD) –*** As the name suggests that there is a direct chemical reaction happens inside the vacuum chamber. This method is also utilized to improve the corrosion and wear property of the substrate. The working temperature range in this process is 1000˚C approx. As compared to the PVD, the running cost of this process is high.

c) ***Plasma spray coating –*** in this type of coating the powder elements are introduced at high speed into the plasma brook for melting the material. After that this molten metal gets deposited on the substrate. This type of coating is widely used in the cloth and fiber industries.

d) ***Electroplating-*** It is also commonly known as the electrodeposition method. In this type of coating, the water-based electrolytic solution which contains both workpiece and the metal plate is used. The drawback of this process is that it is not useful to the precise coating of the mold and tool part.

e) ***Sputtering coating-*** It is also known as the sputtering coating process. In this type of coating method, an inert gas gets ionized by an electric field and the atoms of the coating get sputtered by a regular bombardment of positive ions. These atoms get compacted on the surface of the substrate. After this, the sample is heated for a little duration to strengthen the bonding.

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f) ***Laser coating-*** In this method, a powder of hard ceramic is deposited over the surface of the substrate followed by the high energy laser beam of definite power, a proper spot size of beam intensity composed focused upon the substrate sample at specific scanning speed. The substrate gets melted and accordingly the powder gets mixed with molten metal by the high energy of the laser. In this method deformation and generation of residual stress are absorbed.

3. Electrical Discharge Coating

Modification by Surface alteration by the EDM process is the most useful method nowadays to change the surface of the substrate. EDM is an established non-conventional machining process. High precision machining on the material of electrically conductive and also partially conductive materials commonly processed by this method. Generally in EDM during EDM machining there is always a tool erosion and after machining, there is a white layer deposition on the work piece. A hard layer of ceramic in nature gets deposited on the substrate with the addition of powder metallurgy made compacted tool is shaped by means of a common machine tool of EDM and the hydrocarbon oil which is for dielectric at some definite parametric combinations. This leads to the coating phenomenon by the EDM or well known as the electro-discharge coating. In EDC, our main is to do enhancement in properties (surface) of the selected substrate by application of new material deposition. This method is the opposite of the EDM process. In EDM the tool acts as negative and the workpiece acts as positive while in EDC workpiece connected to negative and tool as a positive terminal.

4. Parameters for EDC

There are four working parameters involved for the electric discharge coating which are as follow

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a) ***Composition of tool electrode –*** it is very important parameters for performing the edc.various composition of the tool that can be made through the powder metallurgy method because of the weak bond strength of the particle.

b) ***Particle size-*** the size of the powder directly affects the concentration combination of the tool electrode. A fine particle and good mesh size are required for the good electrode.

c) ***Compaction pressure-*** it is also an important parameter for EDC operation because more compaction pressure leads to good strength. But it should be at an adequate range.

d) ***Sintering temperature-*** the compact is sintered to enhance the strength of the compact. The powder material properties get changed when sintering temperature rises to recrystallization temperature.

Apart from the above parameters, the EDM process parameter also involved in the coating parameters. The main parameters for the electric discharge areas polarity, average current, discharge voltage, duty factor, frequency of the pulse, pulse off and on time.

5. Benefits and non-benefits of EDC method

a) The rate of coating is higher than the other method

b) No requirement of vacuum apparatus

c) Variety of coating material can be done

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d) Relatively less costly operation.

e) Wear resistance is high as compared to another method

In the process of electric discharge coating, micro-cracks and voids are identified as the main defects in the final deposition.

6. Application of EDC

Since EDC is a surface alternation or modification process so it is commonly used in the sector of the automobile, blade of turbine making company, mold and die making industries, rolling industry.

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