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Research on Modern Surface Physical and Chemical Treatment Technology

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Abstract

In the current study, through the surface physical and chemical treatment of materials, such as chemical electrochemical deposition, the thermal spraying, ion implantation technology, surface modification of laser beam or electron beam, chemical and physical vapor deposition and so on, the surface of materials has a special composition structure and performance, to meet a variety of specific engineering needs.

Keywords

Physical treatment, chemical treatment.

1. Introduction

Material science, information science and life science are the three frontiers of the 21st century technology revolution. With the use of tools, materials have been associated with human production and life since the Stone Age. In the process of using materials, ancient human beings had already started the surface treatment and research of materials. The thermal diffusion technology originated from the warring states period of China was mainly used to strengthen the blade surface of swords and other weapons.

With the development of the industrial revolution and the progress of science and technology, human beings have higher and higher requirements on materials. Through the surface treatment of materials, including surface physical technology and surface chemical technology, such as chemical electrochemical deposition, the thermal spraying, ion implantation technology, surface modification of laser beam or electron beam, chemical and physical vapor deposition and so on, the surface of materials or parts has a special composition structure and performance, to meet a variety of specific engineering needs [1].

2. Modern Surface Physical and Chemical Treatment Technology

2.1. Chemical Electrochemical Deposition

Electrochemical deposition mainly includes composite plating, brush plating, electroless plating and laser plating. Electroplating is an electrodeposition process in which the surface conductive parts contact with the electrolyte solution and act as the cathode to form a solid combination with the substrate under the action of external current. Composite plating is the deposition of metal with insoluble nonmetallic solid particles (or other metal particles) in electrolyte solution by electrochemical or chemical means to obtain composite material layers. Composite coating can be used for abrasion resistance, self - lubricating dispersion and decorative purposes. Brush plating is a special way of electroplating, no plating tank, only in the condition of continuous supply of electrolyte, with a pen on the working surface to rub, so as to obtain electroplating, so also called slot-less plating or coating. Electroless plating technology has the characteristics of uniform coating thickness, low porosity, deposition on non-metal, and

better deep and uniform plating capability, and is increasingly widely used in industrial technology [2].

2.2. The Thermal Spraying

Thermal spraying technology is mainly through the flame, or plasma arc heat source, will be a linear or powdery material heated to melt or semi-molten state, and accelerate to form high speed drop, spray to the substrate is formed on the coating, can be on the material surface properties (such as wear resistance, corrosion resistance, high temperature resistant, thermal insulation, etc.) for strengthening or regeneration, protection, and the components caused by corrosion or wear processing out-of-tolerance size decreases. At the same time, the material surface can be endowed with special properties (such as electrical and optical properties). Since the application of flame wire spraying at the beginning of this century, thermal spraying technology has developed for more than 80 years. At present, it has been widely used in aerospace, aviation, metallurgy, machinery, papermaking, petrochemical and almost all industrial fields.

2.3. Ion Implantation Technology

Ion implantation is an ion beam technique in which the atoms of an element are ionized, accelerated in an electric field, and shot into the surface of a solid material at a high speed to change the physical, chemical, and mechanical properties of the material. Ion implantation surface modification is a new edge technology developed by many disciplines in 1960s. This technique is one of the methods to manufacture single-phase solid solution surface alloys without the constraint of equilibrium phase composition, and it has the advantages of firm bond between injection layer and matrix and not easy to fall off, and has been widely used in research and production practice. Ion beam has the characteristics of high temperature, strong penetration, high power density, short action time, fast heating or cooling speed, etc., and belongs to non-contact heating with good controllability. Technically, an ionizer is a small accelerator that USES an ion implanter to ionize certain elements into charged ions, accelerate them with an electric field into an ion beam, and then inject them into a solid material. From the point of view of material science, ion implantation is a technology that changes the surface material of solid materials and then modifies the surface of materials. The ion implantation layer is so shallow that sometimes you won't see much change from the surface, but it does make a difference in the material's properties. Ion implantation technology is applied in semiconductor industry, large scale integrated circuit and very large scale integrated circuit, aerospace and so on [3].

2.4. Surface Modification of Laser Beam or Electron Beam

Surface modification of laser beam or electron beam includes solid-state phase change, enhanced microcrystalline treatment and liquid phase change, in which liquid phase change includes surface fusion, surface coating and surface alloying. They belong to high energy density surface hardening technology, its energy density can reach 102-103kw /cm2, far greater than the traditional flame surface quenching and induction surface quenching heating energy density. The birth of laser was marked by the successful development of ruby laser, the first solid state laser in 1960, and he-neon laser, the first gas laser, in 1961. The laser has the characteristics of uniform phase, good direction and single wavelength, so it has the superior concentrative property and can obtain high energy density. Laser surface modification is the use of high energy laser irradiation to the metal surface, through the interaction of laser and metal to achieve the purpose of improving properties of metal, it is a comprehensive technology, including laser phase transformation hardening, laser surface alloying, laser coating, laser crystallization chemical deposition and laser, etc, especially suitable for various kinds of metal

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surface modification. Laser surface modification technology is widely used in aviation, aerospace, machinery, weapons and automobile manufacturing industries.

The surface modification of electron beam refers to that the electron stream of high speed and beam bombardments the surface of the processed metal. The electrons pass through the surface of the metal and enter a certain depth away from the surface. The energy is transferred to the metal atoms, which intensifies the vibration of the metal atoms. Electron beam has the characteristics of high power, easy to control and adjust. There are many similarities between electron beam surface intensification and laser surface intensification, but there are still differences: apart from the essential difference in beam coupling efficiency, the biggest difference is the difference between the depth at which the maximum temperature is generated and the depth at which the minimum fusion layer is generated. When the electron beam is irradiated, the melting layer is at least several microns thick, which affects the velocity of the solid-liquid interface during cooling. Meanwhile, the energy deposition range of electron beam is larger than that of laser, and the temperature of liquid phase is lower than that of laser irradiation, so the temperature gradient is smaller.

2.5. Chemical and Physical Vapor Deposition

Surface deposition is a thin film deposition technique, including chemical vapor deposition (CVD) and physical vapor deposition (PVD). Chemical vapor deposition (CVD) is the formation of a solid film by chemical reaction on the substrate surface with one or more gaseous compounds or elemental gases containing thin film elements. Vitreous film and crystal film with high purity and complete structure Angle can be deposited by CVD technology. Compared with other film preparation technologies, CVD technology is easy to accurately control the chemical composition and structure of films in a large range. CVD is applied in microelectronics manufacturing process to manufacture surface passivation film, insulation film, epitaxial layer, solar cell, etc. In recent years, CVD technology has developed pyrolysis chemical vapor deposition, plasma-enhanced chemical vapor deposition, laser-induced chemical vapor deposition, microwave plasma chemical vapor deposition and metallic organic chemical vapor deposition (labeling). Chemical vapor deposition (CVD) is a promising method for surface modification of materials, which is developing towards the direction of low temperature and high vacuum. With the emergence of various new techniques of chemical vapor deposition, the thin film materials and the matrix materials that can be selected by this technique will have a great development.

Physical vapor deposition technology refers to the physical form such as evaporation or sputtering to remove materials from the target source, and then these energy-carrying steam particles are deposited on the surface of substrate or parts through vacuum or semi-vacuum space to form a film layer, which mainly includes vacuum evaporation, ion deposition and sputtering deposition. PVD developed from the early resistance heating and evaporation to the heating and evaporation of electron beam, laser beam and ion beam. After the appearance of ion plating in 1963, it rapidly developed the deposition plasma plating technology of hollow cathode, multi-arc, ion beam assisted, reactive beam and ion group beam, while the sputtering deposition technology was magnetron, rf and ion beam sputtering.

3. Conclusion

At present, some achievements have been made in the research of surface physics and surface chemistry at home and abroad. Therefore, with the further research on the surface and interface of materials, various materials will be more widely used.

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