The preparation and modification of Teflon film

Polytetrafluoroethylene (PTFE) is known as "king of plastics". It is composed of tetrafluoroethylene by polymerization of polymer compounds, it has excellent chemical stability, high corrosion resistance, sealing, lubrication is not sticky, electric insulation and good anti-aging endurance, excellent heat resistance, can be made into film coated on the surface device. Choose preparation way depends on the nature of the film needed, according to different raw materials, experimental conditions and the nature of the film, this study compared the several kinds of Teflon film coating method, and summarizes the advantages and disadvantages of various methods.

1. The preparation method of Teflon film

1.1 Laser pulse deposition crystallization Teflon coating

Using 248 nm UV excimer lasers radiation, and use powder compacting PTFE and PTFE polished block as target material, under the high deposition temperature, laser via melt crystallization PTFE heat transfer the particles to substrate, forming continuous smooth surfaces. Polished block in PTFE cut out from the PTFE rods. PTFE powder compacting (pressure is $3.8\times10^{8}N/m^{2}$) particles is 6 ~ 9 micron, PTFE powder pressing need under the (275 ±10)℃ condition of annealing for 24 h.

The film thickness of PTFE deposited by powder pressing is in the same laser pulse condition (p (Ar) = 0.3 mbar, laser energy density of Φ = 4 J/cm2] is far more than the film deposited by polishing PTFE. Thin film deposits at temperature below 340 ℃, it can form many particles and pores of the rough surface. When the deposit more than 340 ℃, will be formed without the surface of the particles, and firmly adhere to the substrate, through the "tape pull off" experiment particles will not fall off. This method of unpolarized light generated film has high transparency, the resistivity is higher than $10^{12}\Omega$.

Made of polished block in PTFE deposition film surface is very rough, and covers many particles. Under the condition of same deposition rate is much lower than by PTFE powder compacting. Membrane attached to the substrate well, but cohesion is poor, through particles in the "tape pulled off" the experiment will fall off. Film thickness decreases when high temperature deposition. The method of thin film is lower for visible light transparency. The resistivity is lower than the suppression of PTFE powder deposition of thin film.

1.2 Pyrolytic amorphous PTFE precipitates to form an amorphous fluoropolymer film

DuPont recently developed Similar to PTFE fluorinated copolymers, including Teflon AF 1600, tetrafluoroethylene polymers, which improve its transparency, strength and adhesion. Dielectric constant is also lower than the ordinary Teflon, achieve minimum of known plastic, under room temperature is 1.9.

Using Teflon AF 1600 respectively and ordinary Teflon (PTFE) as raw materials, pyrolysis precipitation form amorphous containing fluorine polymer film. Teflon AF is transparent, and is not pale yellow related to the unsaturated fluoride. Elliptic partial instrument measuring

refractive index is between 1.15 ~ 1.3 results published values consistent with the manufacturer. Ordinary Teflon refractive index from 1.35 to 1.6 the result is consistent with previous. Under scanning electron microscope observation using Teflon as raw materials to precipitate AF 1600 film, found that produces grating hole under high magnification. In this area will produce belongs to the electronic breakdown gas emissions generated in the process of large cracks. These phenomena in the use of ordinary Teflon precipitation as raw materials and also found in the film, but might be a slight degree.

X-ray diffraction scan compared the use of Teflon AF 1600 and common Teflon (PTFE) as raw materials to precipitate the thickness of the film. Contrary to Teflon film, within the scope of the diffraction Angle of 5 ~ 85 ° Teflon AF film did not detect the crystallization. All AF film surface with thickness larger are observed low Angle rings, consistent with the irregular amorphous microstructure.

Pyrolysis Teflon AF 1600 precipitation has many holes on the surface of thin film, reduce sedimentation rate and greatly reduced the depth of the hole, more important is the cross section of the film become smooth and holes on the low magnification plane image is still visible, but will be small and less severe. Moreover, even if the temperature as high as melting point, small hole will not disappear after low temperature annealing treatment. Pyrolysis, by contrast, ordinary Teflon precipitation of thin film is without hole. Under the sufficient heat, Teflon AF raw materials are melted. When cooling, it starts with a white opaque powder material condenses into 1 ~ 3 mm thickness of smooth and transparent material. After thermal cooling light transparent solid, it produces polygonal cracks. They are amorphous when materials into powder and by X-ray scanning. Solidification solutes in the infrared radiation spectrum are similar to raw materials, and no hole under high magnification.

1.3 Dip coating method

Dip coating method using the basement from the fluid movement, gravity drainage and evaporation of the solvent, then through further condensation reaction to get solid film .This method compared with other coating technology is simple and saving. The main advantage is that can change the deposition film microstructure.

PTFE super hydrophobic film preparation experiment by using polystyrene (PS) and PTFE2 kind of emulsion mixture, high-temperature roasting to remove PS and other additives, super hydrophobic PTFE membrane was prepared successfully.40ml styrene , 160 ml deionized water and 3 g Tween - 80 (emulsifier T - 80) add to the three beakers, then quick stir to form oil-in-water emulsion, with 500 r/min rate continue to stir, and pumped in nitrogen to the three beakers, slowly add 10 ml ammonium persulfate solution, under the condition of 70 ℃ water bath get PS emulsion polymerization 7 h. According to the above method preparation of PS emulsion and PTFE emulsion by certain volume mixing at room temperature. At a speed of 2 ~ 3 cm/min with dipping pulling method coating, drying at room temperature after repeated the operation three times, dry in the oven to 80 ℃ for 1 h. Then, in the resistance furnace roasting, insulation at 330 ℃ and 420 ℃ for 30 min. Experiments have directly affects the ratio of PS and PTFE super hydrophobic PTFE film, by changing two emulsion mixture ratio to obtain the thin film that static contact Angle is 152.4°with water .

Dip coating method can get the thicker film, more fluorescent, more suitable for the coating of large area. Can be used for coating with different materials and shapes of components, such as silicon, glass, aluminum, smooth surface, and glass tubes, can also be coated on the bending of the lateral wall.

2. Modification of Teflon film

For Teflon film which has been formed, the following methods can be used to change or increasing the some properties of thin films, in order to achieve the experiment or industrial demand.

(1) The PTFE impregnated in some metal hydroxide colloid solution, such as iron hydroxide and hydroxide tin hydroxide colloid, gel ion deposition in PTFE membrane surface, can increase the wetting Angle.

(2) Iron hydroxide colloid adsorbed to the PTFE membrane, and polymerization of acrylic acid (AA) hydrophilic monomers, hydrophilic strong PTFE microporous membrane can be obtained.

(3) With the inert gas such as argon, helium plasma processing PTFE membrane, cohesive force than before treatment increased 10 times. PTFE membrane after plasma treatment, and then AA chemical treatment, AA of strong hydrophilic is grafted to the surface of PTFE, and makes the PTFE film is of good surface infiltration characteristics.

3. Conclusion

This paper reviews laser pulse deposition, pyrolytic amorphous PTFE precipitation method and impregnated method of coated Teflon film. In addition to these three methods, method of spin coating is commonly used with Teflon film, which obtain the quickest method, it is not the limitation on the sedimentary materials without a substantial, the thickness of thin film gets below the dip coating method. Through the above analysis, in the laser pulse deposition method, using different membrane characteristics of target material to produce slightly different. Powder compacting of PTFE as a target material, the thin film in high resistivity, and high temperature of unpolarized light has high transparency; polished block of PTFE as a target material, the thin film is lower for visible light transparency, in the form of cohesion is very poor. Pyrolysis of PTFE amorphous precipitation, the thin film has many holes, but after condensation formed by light transparent film with amorphous structure, and no hole under high magnification. Method of dip coating can change the deposition of thin film microstructure, operation is easy, high cost performance is higher. These methods have their advantages and disadvantages, in practice, should according to different conditions and demand to choose different coating methods. For example, in the double liquid zoom lens experiments, choose the tantalum pentoxide zoom lens as a double liquid dielectric layer, dielectric layer outside should be coated with a layer of hydrophobic membrane. According to the above advantages and disadvantages of various coating method, considering the base is a special cylindrical, this study thinks that dip coating technique is more suitable for double liquid zoom lens.