Journal of Fiber Bioengineering and Informatics 12:2 (2019) 73–80
doi:10.3993/jfbim00320

Study about Hydrophilic Modification of PTFE Membrane

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Abstract

Polytetrafluoroethylene (PTFE) membrane is widely used in medicine, clothing, chemical, electronics and other fields. However, due to the highly symmetrical structure of the PTFE, the absence of reactive radical, high crystallinity, low surface energy and poor surface wetting, these properties of PTFE affect its compound with other materials. In order to improve the adhesion property of PTEF membrane, the surface must be modified. In this paper, the surface melting deposition method was used to improve the hydrophilicity of PTFE membrane. The PTFE membrane is immersed in a suspension of nano-TiO_2, and then deposited by melting at a high temperature. Sintering and depositing TiO_2 particles on the surface of the PTFE membrane. The molecules of the viscous substance enter the surface layer of the PTFE membrane to form a modified surface layer. The interface strength of PTFE membrane is increased, and the surface activity of PTEF membrane is increased, and the hydrophilicity of the PTFE membrane is improved. It is easier that PTFE membrane is combined with other materials. The best treatment process for the modification by melting deposition is as follows: the optimum treatment temperature is 350 °C, and the optimum treatment time is 30 min.

Keywords: PTFE Membrane; Surface Modification; Surface Melting Deposition Method; Contact Angle Infrared

1 Introduction

In the late 1970s, with the advent of the second-generation Gore-Tex membrane, a large number of PTFE membrane products were developed and put on the market. Waterproof and moisture permeable fabric is one of its important applications. This waterproof and moisture permeable laminate fabric is formed by laminating a PTFE microporous membrane with a common fabric. The laminated fabrics are widely used in medicine, hygiene, sportswear, and other areas. Compared with high-density fabrics and coated fabrics, it has obvious technical advantages [1]. However, the extremely low surface activity and poor adhesion property of the PTFE membrane limit its compounding with other materials and often cause peeling off between the membrane and the fabric after washing several times, which affects the appearance and durability.

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Jun. 2019

The adhesion property of the PTFE membrane is poor, due to wetting ability of PTFE membrane is not good. The contact angle of PTFE membrane to water is relatively large, which can reach more than 110° [2]. PTFE is a high crystalline material and therefore it is chemically stable. Its swelling and dissolution are more difficult than the amorphous polymers. When forming bonding with solvent-based adhesives, it is difficult for a polymer chain to chain intermolecular domain diffusion and entanglement where it is unable to form a strong adhesion bond [3]. Because PTFE membrane structure is highly symmetrical and it does not contain active groups, contains high crystallinity, has low surface energy as well as very poor wettability, it is difficult for PTFE membrane to interfusion with other materials, and so it is difficult to produce tight adhesion with other materials [4]. In order to improve its adhesion performance, it is advantageous to compound it with other materials. There are various methods to change the surface structure of PTFE membrane. In order to achieve the purpose of surface modification, the current treatment methods can be divided into two categories; one is chemical method: surface chemical grafting and superficial treatment; the other is physical methods: including mechanical coating method, flame method, Plasma Jet method, Corona treatment method [5].

In this paper, surface deposition and fusion method is used to treat the surface of PTFE membrane. The TiO_2 particles are deposited on the surface of PTFE membrane, forming a layer of modified layer which is embedded with adhesive. As the molecule of the adhesive enters the surface molecule, the interface strength increases, the wettability increases, the surface activity improves, and it becomes easy to be compounded with other materials [6].

2 Experimental

2.1 Experimental Materials

PTFE microporous membrane, Xinxiang Huayuan God-Care Co., Ltd. production. Tetrafluoroethylene (PTFE) microporous film is a lightweight, flexible film that is obtained using a special biaxial stretching process. There are about 9 billion micropores per square inch, 20 times the pore size and 20 thousand times smaller than the water droplet. It has excellent waterproof and windproof property along with great moisture permeability, thermal insulation and corrosion resistance. It is an ideal material for making advanced composite fabrics. At the same time, its water pressure resistance and special micro porosity are also widely used in the field of membrane permeation, such as construction and water treatment. TiO_2 powder, manufactured by Degussa company; PEG6000, chemically pure; PTFE emulsion; NaOH, analytical grade/analytically pure, Wuhan Yatai Chemical Reagent Co., Ltd.; Acetone, industrial use.

2.2 Experimental Equipment

Ultrasonic cleaning machine, TEA/1006, Shenzhen Times/era Ultrasound Equipment Co., Ltd. production; Marv/MUFU Furnace, Wuhan element technology production; Contact angle measuring instrument, Shanghai JC2000A static drop contact angle measuring instrument; Infrared spectrometer, TENSOR27, Germany Bruker spectrometer company; X-ray diffractometer, Ultima3 type, manufactured by Rigaku Corporation.