Modified metal-polymeric track-etched membrane surface characterization

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Number of project participants: 1 – 3

Abstract

Investigation of surface changes before and after magnetron sputter surface modification of PET track-etched membranes.

Introduction

Track etched membranes (TM) are thin polymer films with an "engineered" pore structure, formed by irradiating the polymer film with swift-heavy-ions. PET TMs have several exceptional structural features that distinguish them from other traditional polymers and native PET membranes, such as well-defined and modulated pore-geometry, pore-diameter, and a controlled ratio of pores vs. unit surface area. TMs are typically applied in medicine, for example, in purification of drugs and viral suspensions (vaccines), in obtaining blood plasma (plasmapheresis treatment), and in bacteriological quality control of food and water.

The need for finer filtration is increasing in processes using microfiltration, ultrafiltration, nanofiltration, or reverse osmosis, primarily due to operational needs of the pharmaceutical and biopharmaceutical, microelectronics, life sciences, and analytical industry. Track etched membranes have been recognized as one of the only available technologies to achieve and verify the required level of filtration. However, surface modifications are often required without altering the bulk of the TM structure.

The two main routes for customizing TM properties are to either synthesize a new polymer composition or by physicochemical modification of the TM itself. An efficient method for surface modification of polymeric TMs is through the deposition of thin films of various materials (metal/ceramic) upon its surface. This could be achieved through Chemical vapor Deposition or Physical vapor Deposition. For the purposes of this study, a magnetron that makes use of planar targets, a direct current (DC) power supply, and unbalanced magnets was chosen.

Currently, magnetron sputtering is not being used on an industrial scale for the surface modification of PET-TM, because of the specific requirements and peculiarities related to TMs. There are problems, both scientific and engineering related, to be solved before implementing this method in the TM industry. Polymer materials generally have a low surface energy and, consequently, low adhesion characteristics. For better adhesion of coatings to the polymer, pre-activation of the surface is recommended.

Degassing is a major problem when sputtering on a TM, especially at a large scale. The treatment of the TM in a low-pressure plasma is accompanied by the release of absorbed water from the polymer, resulting in the formation of various impurities and gaseous by-products formed through the interaction between the plasma, the vacuum, and the polymer. Temperature regulation is imperative due to the potential difference in the expansion coefficient between TM and metals/ceramics during deposition.

Magnetron sputtering offers several advantages: versatility, adaptability, and control. Titanium (Ti) has been chosen as the target coating as it is possible to deposit both Ti and Titanium dioxide (TiO2) from the same target without breaking vacuum. Advantages of metallized polymeric TMs over their native counterpart include improved chemical resistance, increased mechanical strength, higher thermal stability, and the formation of asymmetrical pores due to single-sided metallization.

In conclusion, the study aims to partially fill the knowledge gap by determining how the properties of the resulting thin films being deposited on TMs depend not only on the deposition conditions but also on the specific features and the chemical nature of the porous-polymer TM.

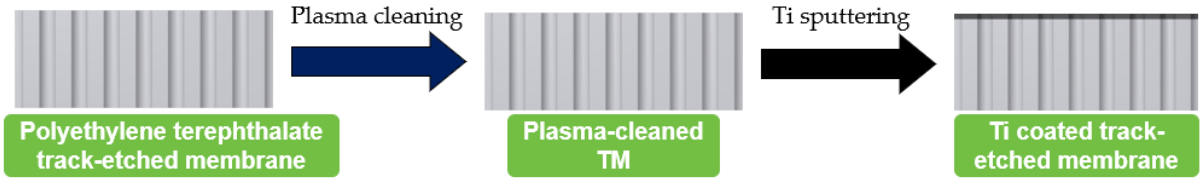

Fig.1. Production of hybrid/multifunctional membranes using 1 sputter target

Tasks

1. Understanding of scientific problem.
2. Analytical measurements.
3. Data processing and cleaning.
3. Data fitting and analyzing.
4. Compilation report.

Preliminary schedule by topics/tasks

The duration of this project is 3 weeks.
Week 1 – Introductory lectures, literature review, acquaintance with analytical equipment.
Week 2 – Project work.
Week 3 – Task completion and report writing.

Required skills

1. Engineering basic knowledge of magnetron sputter deposition and analytical methods.
2. Material Science: basic knowledge of surface modification and data interpretation.
3. Computer skills: MATLAB, JMP, Latex.

Acquired skills and experience

1. Understanding the problems of hybrid membrane creation and surface modification.
2. Skills in AFM, SEM, RAMAN, FTIR, UV-VIS, Bubble-point, Contact Angle.
3. Understanding of report writing and public speaking.
4. Experience at data processing and fitting of data with physical model.

Recommended literature

1. https://doi.org/10.1016/j.surfin.2022.101975