

CHAPTER I

INTRODUCTION

1.1 Background on problems of interest

Nuclear tracks or ion tracks was first observed by D.A.Young in 1958 [1]. He found microscopic track formations in the surface of a lithium fluoride crystal that had been irradiated with fission fragments and etched in a mixture of hydrofluoric and acetic acids. One year later, Silk and Barnes observed with the electron microscope damaged regions in mica which marked the paths of heavy charged particles such as those from fission fragments or cosmic rays. Since 1962 particle tracks in solids have been the subject of intensive research. In 1975, Fleischer, Price and Walker published an extensive and definitive text on "Nuclear Tracks in Solids" [2].

The passage of heavily ionizing, nuclear particles through most insulating solids creates narrow paths of intense damage on an atomic scale. These damage tracks may be revealed and made visible in an ordinary optical microscope by treatment with a properly chosen chemical reagent that rapidly and preferentially attacks the damaged material. It less rapidly removes the surrounding undamaged matrix in such a manner as to enlarge the etched holes that mark and characterize the sites of the original, individual, damaged regions [3].

The applications of nuclear tracks have been developed and applied in a wide variety of technical fields such as nuclear fusion, cosmic rays, molecular identification with nanopores, imaging X-ray astronomy, magnetic studies with nanowires, polymeric nanowires, radon and neutron dosimetry, and thermochronology [4]. D. Nikezic and K.N. Yu mentioned in their paper "Analyses of light scattered from etched alpha-particle tracks in PADC" that there were only a few references in the literature on scattering of light from etched tracks in SSNTDs [5]. In most of the cases, scattered light was used to measure track densities from experiments related to neutron dosimetry by Harvey and Weeks, 1987; Popov and Pressyanov, 1997; Meyer et al., 1997 and Groetz et al., 1999. Groetz et al. (1998) developed a model for laser light scattering by nuclear tracks in CR-39 detectors. Nikezic et al., 2005; Yu et al., 2007 studied the optical characteristics of etched tracks in PADC films using the *ray tracing method* were performed (Nikezic et

al., 2005; Yu et al., 2007). Based on geometrical optics, a computer program called TRACK_VISION 1.0 (Nikezic and Yu, 2008) was used.

In this research, the light filter from neutron induced track-etched polymer was developed. The aim of this study was to create proton tracks in thin sheet of polymer to be used as light filter or light diffuser. This is based on light scattering by nuclear tracks which are dependent mainly upon track density and track size. The track density is directly proportional to number of neutrons falling on the plastic sheet while the track size is dependent upon type and energy of charged particles as well as the etching condition.

1.2 Thesis objectives

The objectives of the dissertation are:

1.2.1 To prepare track-etch polymer films by neutron irradiation.

1.2.2 To investigate properties of track-etch polymer films on transmission and scattering of visible light, ultraviolet (UV) and infrared (IR).

1.2.3 To investigate experimentally and theoretically the effects of track density and sizes on transmission and scattering of visible light, ultraviolet (UV) and infrared (IR).

1.2.4 To develop a track-etch polymer film preparation method for industrial production.

1.3 Scope of work

1.3.1 Track formation process on films uses neutrons from radioisotope source via $^1\text{H}(n,n)^1\text{H}$ and $^1\text{H}(n,n')^1\text{H}$ reactions.

1.3.2 Investigate properties of track-etch polymer films on transmission of visible light, ultraviolet (UV) and infrared (IR).

1.3.3 Investigate experimentally and theoretically the effects of track density and sizes on transmission of visible light, ultraviolet (UV) and infrared (IR).

1.3.4 Design and develop a track-etch polymer film preparation method for industrial production.

1.4 Expected benefit

The developed track-etch polymer film from neutron irradiation can be used as UV, visible light and Infrared filter or diffuser.

1.5 Research Methodology

1.5.1 Select the polymer film materials such as Polystyrene, Polycarbonate, or Polyethylene etc.

1.5.2 Design and conduct experiment to produce proton tracks on polymer of different track densities at different etching conditions

1.5.3 Investigate properties of track-etch polymer films on transmission and scattering of visible light, ultraviolet (UV) and infrared (IR)

1.5.4 Test physical properties of track-etch polymer film

1.5.5 Research conclusion and discussion

1.6 Organization and chapter contents

This dissertation consists of five chapters. The chapters are organized principally to focus on the development of light filter or diffuser using proton track etch polymer by neutron induction from radioisotope source.

Chapter 1 deals with background and problem of interest, objective, scope, expected benefits and research methodology of the study.

Chapter 2 mentions the principles and applications of track etched detector, neutron interaction, theory of light, the review literature including previous work.

Chapter 3 describes the design and construction of the equipment. Parameters that might affect density, size distribution and shape of track and the measurement of light transmission have been evaluated.

Chapter 4 describes the experimental result of the relationship of the track density and track size distribution to temperature of etchant, transmission of light in three ranges: Ultraviolet, Visible light and Infrared.

Finally in Chapter 5, the overall findings of the studies are concluded and discussed.