UNIVERSITI TEKNOLOGI MARA

PREPARATION AND CHARACTERIZATION OF SEMICONDUCTING PROPERTIES OF HDPE AND LDPE POLYMERS INDUCED BY ELECTRON BEAM IRRADIATION

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ABSTRACT

In this study, high density polyethylene (HDPE) and low density polyethylene (LDPE) sheets were prepared by compression moulding technique. Both sheets were irradiated by electron beam irradiation at 100 to 800 kGy of irradiation dose. Unfortunately, the HDPE sheet showed degradation above 700 kGy of irradiation dose. On the other hand, LDPE can withstand higher irradiation dose up to 800 kGy without showing any degradation. Both sheets became harder after irradiation due to the formation of crosslinking in the polymer structure. This has been confirmed from the thermal gravimetric and differential scanning calorimetry analysis in which the decomposition and the melting temperatures of these irradiated systems were higher than in their un-irradiated systems. The formation of crosslinking in these irradiated HDPE and LDPE system were further confirmed from the formation of interpenetrating structure which were observed from the electron micrograph of these irradiated polymers. From the hot-point probe measurement, both irradiated HDPE and LDPE were *p*-type semiconductors. The presence of charge carriers in these systems were due to the delocalization of electrons from the conjugated C=C bonds that formed in these irradiated systems. The formation of these conjugated C=C bonds in these irradiated HDPE and LDPE systems has been confirmed from the FTIR analysis in which the C=C bonds of *trans*-vinylene and *end*-vinyl were detected at 965 cm^{-1} and 888 cm^{-1} respectively. However, it was found that irradiated HDPE system exhibited higher concentration of conjugated bonds than LDPE due to the closer chain arrangement in the HDPE system that in turn enhance the electrons delocalization along the HDPE chain hence giving lower band gap energy of 2.75 eV compared to LDPE which was 3.97 eV. Interestingly, it was found that the band gap of irradiated HDPE was lower than the polyphenylene and silicon carbide semiconductor.

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TABLE OF CONTENTS

Page

CHAPTER 1

INTRODUCTION

Polymers, as giant organic molecules with their sophisticated structure represent one of the most organized type of materials, leading up to the functions of life. For example, thermoplastic polymers have a wide variety of properties which allows an even wider range of uses such as packaging materials, industrial containers, automotive parts, wire and cable insulation, toys and numerous other consumer products. However, in the field of electrically conducting material, these polymers have long been known as insulating materials. With the advancement of knowledge and technology, these insulating polymers can be transformed into conducting material or new conducting polymers can be synthesized.

1.1 Classification of Conducting Polymers

There are at least four major classes of semiconducting polymers that have been developed:

a) Electronic conducting polymers

This type of conducting polymers is base on the delocalization of electrons along the polymer backbone that occurred in conjugated polymers. Various conjugated polymers had been synthesized since 1970s that had showed excellent electrical properties such as polyacetylene (Shirakawa *et al*., 1977) and polyaniline (MacDiarmid, 2001). These conjugated polymers also posses interesting optical and magnetic properties (Skotheim *et al*., 1998). These unusual optoelectronic properties allow conjugated polymers to be used for a