UNIVERSITI TEKNOLOGI MARA

MCMB AND SUPER P
FOR
ELECTRICAL CONDUCTIVITY
IMPROVEMENT IN
MEH-PPV POLYMER
AND
SnO_2 NANOCOMPOSITES

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ABSTRACT

This research is focused on the fundamental work of the conductivities of two types of solids, that is the poly [2-methoxy, 5-(2-ethyl-hexyloxy)-*p*-phenylene-vinylene (MEH-PPV) polymer and ceramic tin oxide (SnO_2). The low electrical conductivities of these two types of solids can be modified with a technique of mixing carbonaceous additives. For this reasons, the effects of the carbonaceous additives on the conductivities and band gaps of the materials were studied. Carbon (C) is chosen as additives for the improvement of the conductivity of the materials because it can contribute electrons and increase the electronic conductivities of the composites. The aim in this study is to obtain new functional materials with good electrical properties and determine the band gap values. These new modified materials can be used such as in solar cells, gas sensors, optoelectronic devices and etc. This research is divided into two parts. The first part is the composite films. Here, mesocarbon microbeads (MCMB) and Super P (SP) were chosen as the additives. This is due to their unique microstructures which will enhance the conductivity of the composites better than the more crystalline forms of graphite. The composite films were prepared using a solution cast method. Different weight percents of carbon were used in the preparation of the composite films. The conductivities of these films were measured using impedance spectroscopy. Results show that the more carbon contents in the composites the higher the conductivity of the films. This is due to MEH-PPV/C composite blends are formed through wrapping of the conjugated polymer or pi-pi (π-π) interaction between the polymer and the sidewall of carbons. This molecular interaction do reflected on the band gaps. It is observed that composite film with low band gap value show a better electronic conductivities performance. However, for MEH-PPV polymer there was a limit to the additive content because it affected the good characteristics of the films such as smoothness, homogeneity and flexibility. Too much additive will cause the films to either become brittle, inhomogeneous or rough. The second part of the research is focused on the conductivity of ceramic SnO_2 nano powders. This work investigated the conductivities of the SnO_2 nanopowders and the relationship between size, crystal structure and band gap with conductivity values of the materials. Results showed that there is a relationship between sizes of the nanocrystals and the band gaps with the conductivity of the samples. The decrease of the band gap of smaller crystallite size synchronizes well with the increase of conductivity of the SnO_2 powders. Furthermore, the SnO_2 nanocomposites were also investigated at different weight percents of carbon additives added in the samples (SnO_2/C). It is observed that Super P is a better additive for increasing the conductivity of the SnO_2 nanocomposite compared to MCMB. This is due to Super P carbon has thinner grain boundaries thus provide a more efficient path for the electrons to move *via* interstitials through the SnO_2 structure.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

1.1.1 Polymer

A polymer is a large molecule, or macromolecule that composed is of many repeated subunits in a regular sequence. The simplest example is polyethylene, where ethylene is the repeating unit. Repeating units are often made of carbon and hydrogen and sometimes oxygen, nitrogen, sulfur, chlorine, fluorine, phosphorous, and silicon. To make the chain, many links are chemically hooked or polymerized together forming large macromolecules.

Polymers are well known as electrically insulating materials. For many years, polymers have been used as an insulator in electrical wiring as a cable sheathing material, corrosion protection on electronic circuit boards, low dielectric coatings, etc. (Kar, 2001). The so called insulating polymers generally have a surface resistivity higher than 10^{12} Ω.cm. In these polymers, the non-availability of free electrons is responsible for their insulating behavior (Kar, 2001). However, the idea that polymers can be made conducting is relatively new. Several strategies are now available to achieve this objective.

Approximately four decades ago, scientists like A. J. Heeger, Alan Macdiarmid and H. Shirakawa have made a discovery that a type of conjugated polymer called “polyacetylene” can be made conductive almost like a metal through a chemical doping process. The conductivity value obtained was higher than any previous known polymers. This discovery has opened up the field of “plastic electronics” where the practical prospects of cheap and lightweight electronic devices with polymers is possible. In the year 2000, Alan J. Heeger, Alan G. MacDiarmid and Hideki Shirakawa were awarded the Nobel Prize in Chemistry for their ground breaking work in conducting polymers (Bounioux, Katz, & Yerushalmi – Rozen, 2012). Other polymers such as polypyrrole, polyphenylenevinylene, polyaniline, polythiophene and its derivatives have since been extensively studied.