ABSTRACT

A study of optical properties of Diamond-like Carbon Thin Films deposited by DC-PECVD. The films was deposited on the corning with the ratio of Hydrogen, H_2 (97%) and Methane, CH_4 (3%). The temperatures were varied between 200°C to 600°C while maintaining other important variables such as DC voltage (1.5kV) and pressure (1×10^{-1} torr). From the light transmission using UV-Vis spectroscopy it was found that the type of optical transition is allowed indirect transition in the range of 3.8eV to 4.3eV. The ellipsometry is to determine the thickness, d. The thickness decreases with the increase of substrate deposition temperature. Photoluminescence properties were studied using photoluminescence spectrometer. The photoluminescence analysis was order to obtain the peak of excitation and emission range of the sample films. It has been found that the transition energy in the range of (3.06-3.22)eV.

ABSTRAK

Sebuah kajian sifat optik filem saput tipis, Diamond seperti Karbon dibwah pemendapan wap kimia, (DC-PECVD). Filem dipendapkan pada slid kaca jenis 'corning' dengan nisbah Hidrogen, H_2 (97%) dan Metana, CH_4 (3%). Perbezaan suhu di antara 200°C hingga 600°C sambil mengekalkan pembolehubah tetap penting lain seperti voltan (1.5kV) dan tekanan (1 x 10^{-1} torr). Berdasarkan analisis menggunakan spektroskopi UV-Vis didapati bahawa jenis peralihan optik dibenarkan ialah peralihan tidak langsung dalam julat 3.8eV untuk 4.3eV. Alat ellipsometer pula digunakan untuk menentukan ketebalan, d. Ketebalan menurun dengan kenaikan suhu pemendapan substrat. Sifat luminasi dipelajari dengan menggunakan spektrometer fotoluminesen. Analisis luminasi bertujuan untuk mendapatkan puncak pengujaan dan pancaran dari sampel. Berdasarkan analisis, didapati bahawa sampel memancarkan tenaga dalam lingkungan (3.06-3.22)eV.

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CHAPTER I

INTRODUCTION

1.1 Introduction

Nowadays, world has stepped into the nanotechnology and nano-science era. Nanotechnology is the creation of functional materials, devices and system through control of matter on the nano meter length scale (10-1000 nanometers), and exploitation of novel phenomena and properties (physical, chemical, biological, mechanical, electrical) at that length scale. Nanotechnology is based on a profound knowledge of the preparation, structure and properties of nanosystem. This field of research is often known as nanoscience. Although nanotechnology dates from 1950s, the biggest changes have occurred in just in the past few years when world star focused on making things smaller, in atoms and molecules size. By controlling the atomic and molecular structure, we are able to invent new materials, component and system with new attractive features and functions.

Thin-film is a branch of optics which deals with very thin structured layers of different materials. In order to exhibit thin-film, the thickness of the layers of material must be on the order of the wavelengths of visible light (about 500 nm). Layers at this scale can have remarkable reflective properties due to light wave interference and the difference in refractive index between the layers, the air, and the substrate. These effects alter the way the optic reflects and transmits light.

Diamond has some of the most extreme physical properties of any material, yet its practical use in science or engineering has been limited due its scarcity and expense. With the recent development of techniques for depositing thin films of diamond on a variety of substrate materials, we now have the ability to exploit these superlative properties in many new and exciting applications.

Diamond like carbon (DLC) or also known as amorphous hydrogenated carbon (a:C-H) is an interesting material that contains a lot of characteristic similarly to pure diamond. Pure diamond need million years with high degree of hotness to be formed. With the current technologies, the characteristics of pure diamond can be achieved through the deposition one or more thin layers of material onto a substrate by a physical or chemical vapor deposition.

1.2 Problem Statement

Nowadays, DLC studies of optical properties were carried out with different controlling variable such as gas phase carbon as precursor, quantity of gas flow, deposition method, different voltage, deposition time and also different temperature. Different temperature that was reported to form DLC was in the range between 973K to 1273K. Thus, DLC optical properties study with temperature below 973K were carried out.

1.3 Research Objectives

i) To grow diamond like carbon (DLC) thin films using DC-PECVD technique with a CH_4 gas precursor on corning glass substrate with different temperatures up to 873K

ii) To analyze the optical properties of DLC thin films samples using UV-Vis spectrophotometer, ellipsometer and photoluminiscene.

1.4 Scope of Studies

Diamond like carbon (DLC) thin films will be grown on corning glass substrates using DC-PECVD technique using with a CH4 plus Ar gas precursor with different deposition temperature, 473K to 873K respectively.

Then, to determine the thickness (d), refractive index (n) and extinction coefficient (k) of a-C:H thin film using ellipsometer. The values are related to complete the analysis yet using photoluminescence and UV-Vis spectrophotometer.

Photoluminescence is used to determine near band-gap transition energy, which is due to the excitation or electron-hole pair recombination. While the UV-Vis spectrometer is to find the transmission, absorption and energy gap of the sample.

The optical characteristics of a-C:H thin films thickness (*d*), refractive index (*n*) and extinction coefficient (*k*) of the films deposited are measured using Gaertner L117 Ellipsometry. Ellipsometry is based on the polarization of a light beam being altered on reflection from a bare or film coated surface. An elliptically polarized light beam is defined by the angular position of the ellipse (azimuth), its shape (ellipticity), and the sense of rotation of the light vector. Two parameters determine the state of polarization; these are the amplitude ratio, PSI and the phase difference DELTA. The ellipsometer is used to measure PSI and DELTA, and thus with the known values of PSI, and DELTA the *d, n* and *k* can be calculated respectively. Since the equation contains complex quantities, its solution is done by computer.

The optical transmission, reflectance and absorption were measured using UV-Vis spectrometer (UV-3101PC) at wavelengths 320 and 1000 nm with 0.3% accuracy. From the transmission data, optical band gap energy (E_g) can be calculated and analyzed and characterize it as DLC sample or instead.