

ABSTRACT

The aim of this study is to prepare thin films of diamond-like carbon (a-C:H) and to determine the conduction mechanisms in the diamond-like carbon thin films. Diamond-like carbon (a-C:H) thin films were deposited on corning glass substrates using PECVD method. The samples were fabricated in Al/a-C:H/Al structures in order to study the conduction mechanisms through the thin films. Current-voltage (I-V) measurements were carried out using an electrometer. The I-V curves of the diamond-like carbon thin films at 84 nm and 110 nm show the features of ohmic characteristics in the lower field region ($E < 2 \times 10^7$ V/m). In the higher field region ($E > 2 \times 10^7$ V/m), the I-V characteristics of the diamond-like carbon thin film at 110 nm show the conduction in the diamond-like carbon thin film follows space-charge-limited current (SCLC) mechanism. The conduction mechanisms in the diamond-like carbon thin films were influenced by the thickness of the films.

ABSTRAK

Penyelidikan ini bertujuan untuk menyediakan sputer tipis karbon serupa-intan dan menentukan mekanisme konduksi di dalam sputer tipis karbon serupa-intan. Sputer tipis karbon serupa-intan telah dimendapkan pada permukaan substrat kaca corning dengan menggunakan teknik PECVD. Sampel-sampel ini disediakan dalam struktur terapan Al/a-C:H/Al bagi mengkaji mekanisme konduksi dalam sputer tipis tersebut. Pengukuran arus-voltan (I-V) telah dijalankan dengan menggunakan sebuah elektrometer. Lengkuk I-V bagi sampel-sampel sputer tipis karbon serupa-intan yang mempunyai ketebalan 84 nm dan 110 nm menunjukkan ciri-ciri ohmik pada julat medan elektrik yang lebih rendah ($E < 2 \times 10^7$ V/m). Pada julat medan elektrik yang lebih tinggi ($E > 2 \times 10^7$ V/m), ciri-ciri I-V bagi sampel sputer tipis karbon serupa-intan yang mempunyai ketebalan 110 nm menunjukkan bahawa konduksi di dalam sputer tipis karbon serupa-intan adalah mengikut mekanisme arus cas-ruang-terhad (SCLC). Mekanisme konduksi di dalam sampel-sampel sputer tipis karbon serupa-intan didapati dipengaruhi oleh ketebalan sampel-sampel sputer tipis tersebut.

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CHAPTER 1

INTRODUCTION

1.1 Research Background

Diamond-like carbon (DLC) or amorphous diamond, as it is often called, has properties similar to those of diamond. DLC is currently of much interest as a promising material for electronics and optoelectronics devices operating at elevated temperatures because of inherently superior properties such as wide band gap, high carrier mobility and high thermal conductivity (Sugino *et al.*, 1993). The properties of the DLC films can be tuned by the deposition parameters. The type of a DLC film is either hydrogen-free amorphous carbon (a-C) or hydrogenated amorphous carbon (a-C:H), depends on the deposition technique. DLC films have attracted considerable attention due to their wide range of application, such as low-wearing and hard low-friction coatings in engineering and medical applications (Lazar and Lazar, 2006).

Knowledge of the electrical conduction mechanism in diamond-like carbon thin films is important, in order to identify the possible usage of diamond-like carbon as an electronics or optoelectronics material. There are several techniques developed for the deposition method of a-C:H such as Plasma-Enhanced Chemical Vapor Deposition (PECVD), coupled Radio Frequency (RF)-PECVD and RF-magnetron sputtering. There was a previous study shows that space-charge-limited current (SCLC) conduction mechanism dominant in both of metal-insulator-metal (MIM) and metal-insulator-semiconductor (MIS) structures of a-C:H that were prepared by RF-magnetron sputtering (Lazar and Lazar, 2006). There were many studies done on field emission conduction mechanisms of diamond and diamond-like carbon (a-C:H) films prepared by chemical vapour deposition have been concluded that the I-V measurements data was fit to variety of conduction mechanism models. The most

usual of these models are Fowler-Nordheim, Schottky, space-charge-limited current (SCLC), Pool-Frenkel hopping model modified by SCLC (SCLC+PF), Pool-Frenkel and Hill's Law (May *et al.*, 1999).

There was a study in 1974 described that the electrical conduction mechanism in DLC films prepared by glow-discharge decomposition of methane/hydrogen mixtures follows the mechanism of electron hopping (Thompson, 1989).

According to Robertson (2008), even though there were many studies have been done on electrical properties of DLC thin films, DLC is still uncompetitive with other materials for electronic or optoelectronic applications. Therefore, more studies in electrical properties of DLC thin films are needed for the expansion of their application in the future.

1.2 Statement of Problem

The purpose of this study is to answer these questions:

What is the mechanism of electrical conduction in DLC thin films those prepared by PECVD method?

Does the conduction mechanism in the DLC thin films influenced by the thickness of the films?

1.3 Research Objective

The main objectives of this work are to deposit diamond-like carbon (DLC) thin films with different thicknesses by using PECVD technique and to determine the conduction mechanisms in those DLC thin films. The thickness and refractive index of the DLC thin films are also to be determined.

1.4 Scope of Studies

In general, this study consists of the preparation of the DLC thin films by using PECVD technique and the study of the I-V characteristics of the DLC thin films in order to determine the conduction mechanisms in the DLC thin films. Thickness and refractive index are very important for the accuracy and reliability of this study, therefore the thickness and refractive index of the DLC thin films are also to be determined.