Malaysian Journal of Fundamental & Applied Sciences Vol.8, No.5 (2012) 259-261

Malaysian Journal of Fundamental & Applied Sciences

available online at http://mjfas.ibnusina.utm.my

FTIR Spectroscopy Characterization of Si-C bonding in SiC Thin Film prepared at Room Temperature by Conventional 13.56MHz RF PECVD

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Received 29 December 2011, Revised 21 July 2012, Accepted 29 July 2012, Available online 25 Agust 2012

ABSTRACT

SiC thin film has been synthesized by using conventional 13.56MHz radio frequency plasma enhanced chemical vapour deposition (PECVD). The mixture of silane (SiH_4) and methane (CH_4) were used as precursor gases while hydrogen as carrier gas. The SiH_4/CH_4 ratio and the substrate temperature have been varied in order to examine the reaction of the active species which can produce the Si-C bonding in the deposited film. FTIR spectroscopy was used to analyse the type of bonding and particularly to confirm the existence of Si-C bonding by comparing the spectrums obtained from deposited thin film samples and standard reference sample of bulk SiC single crystal wafer. The existence of Si-C bonding was confirmed and it was slightly shifted from the bulk SiC wafer at around 722cm^{-1} and 817cm^{-1}.

|PECVD | FTIR Spectroscopy | Silicon Carbide |

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1. INTRODUCTION

Silicon carbide (SiC) is an emerging semiconductor material, which has received a great deal of attention due to their application in high frequency and high power systems. Its outstanding mechanical properties, chemical inertness and thermal stability has gained important for several applications in the optoelectronic devices [1,2] such as light emitting diode [3], electroluminescent devices [4], nanoelectromechanical system (NEMS) sensors fabrication and also thermoelectric cooling (TEC) devices for deployment in extreme environments [5]. However, conventional PECVD thin film deposition technique generally produced amorphous and poly-crystalline SiC type of film [5-7]. Amorphous and poly-crystalline SiC film is less competitive material for TEC application due to its high thermal conductivity and low electrical conductivity properties compared to a nanocrystalline SiC (nc-SiC).

This paper is reporting the existence of Si-C bonding on the thin film which growth at different Methane (CH_4), Silane (SiH_4) and Argon (Ar) ratio using conventional 13.56 MHz RF PECVD. FTIR Spectroscopy was utilised in order to examine the existence of Si-C bonding in the deposited film.

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2. EXPERIMENTAL

2.1 Sample Preparation

Corning Glass (CG) 1737 was used as a substrate and was cut into 10mm x 10mm. For cleaning process, substrates were washed with DI water, immersed in acetone while undergone ultrasonic bath, rinsed using DI water consecutively and finally dried by nitrogen gas. The substrates were then placed into a descum chamber for Argon plasma cleaning for at least 5 minutes.

2.2 Growth Parameters

The deposition times for all samples are 900s and the hydrogen (H_2) carrier gas flow is set at 500 sccm. All samples are growth at room temperature. RF power was set at 90W to 100W. The other parameters are shown in the Table 1.

Table 1 Growth Parameters

Sample No.	CH_4 sccm	SiH_4 sccm	Ar sccm	H_2 sccm	P_{growth} mTorr
1	10	0	100	500	702
2	10	2	100	500	710
3	10	10	100	500	713
4	10	10	500	500	1289

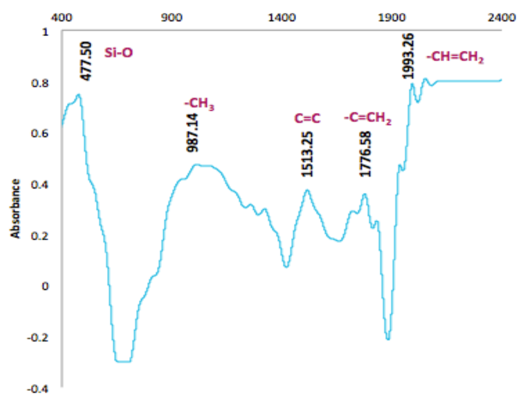

Fig. 1 FTIR for Sample 1

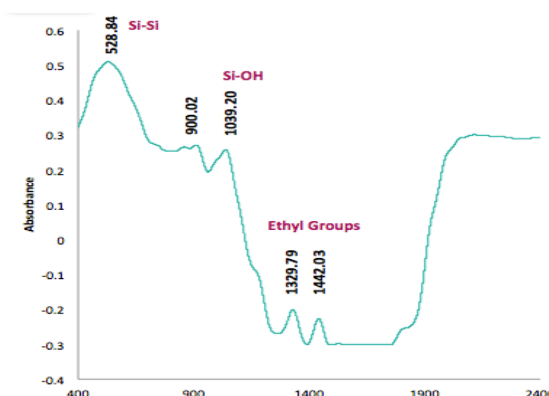

Fig. 3 FTIR for Sample 3

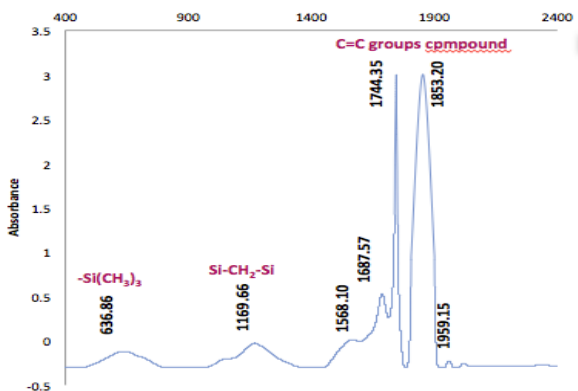

Fig. 2 FTIR for Sample 2

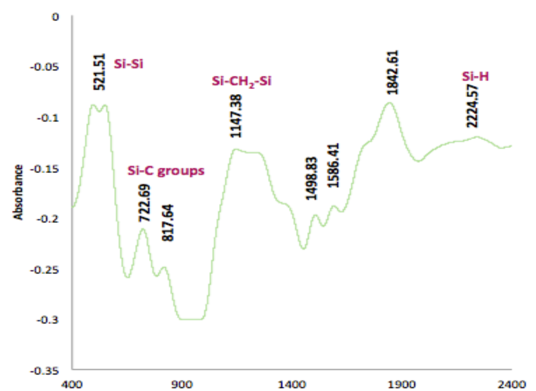

Fig. 4 FTIR for Sample 4

3. RESULTS & DISCUSSION

A standard FTIR spectrum found in many literatures for Si-C bonding at 90W to 100W laser power was used as reference in this characterization process.

Figure 1 shows FTIR spectrum for sample 1. C=C bonding appears weak at 1513.25cm^{-1}. In contrast for sample 2 shown in Figure 2, C=C group compound obviously appears at 1744.35cm^{-1}. However, the methyl-silicon compound in this sample exhibits a low peak with a weak band.

Figure 3 and Figure 4 are FTIR spectrums for sample 3 and 4 respectively. It can be observed that, Si-Si bonding starts to stretch in sample 3 and sample 4. However, a stronger Si-C bonding appears in sample 4 at 722cm-1 and 817cm-1, which in this case is slightly shifted from the bulk SiC compound. Further investigation is needed to confirm this result.

Argon flow rate also seemed to play an important role in the SiC thin film deposition process. Argon breakdown voltage might be the cause which influencing the formation of Argon plasma.

4. CONCLUSION

FTIR analyses on SiC thin films prepared by PECVD at room temperature have been performed and the existence of Si-C bonding was confirmed in all samples. The peak intensity was influenced by the laser power setting and should be manipulated in order to give observable peaks. The existence of Si-C bonding was slightly shifted from the bulk SiC wafer at around 722cm^{-1} and 817cm^{-1} but within tolerable range.

ACKNOWLEDGEMENT

The author thanks the Ibnu Sina Institute, Universiti Teknologi Malaysia, Johor for PECVD and FTIR-Raman facilities as well as to Ministry of Higher Education Malaysia (MOHE) for funding the project (FRGS vot 78471).

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