광원 적용을 위한 신재생에너지 카본 박막의 전기적 특성

論 文
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Electrical Properties of Renewable Energy Carbon Film for Light Source Technology

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Abstract - The carbon film was deposited by the electrolysis of methanol solution. Carbon films have been grown on silicon substrates using the method of chemical process. From investigations of the Raman spectroscopy and the FTIR spectroscopy, the carbon film deposited by the electrolysis was identified the hydrogenated carbon film with the porous structure. The carbon film deposited by elctrolysis of methanol was identified as the hydrogenated carbon film with porous structure. Deposition parameters for the growth of the carbon films were current density, methanol liquid temperature. We electrical resistance and surface morphology of carbon films formed various conditions specified by deposition parameters. It was clarified that the high electrical resistance carbon films with smooth surface morphology are grown when a distance between the electrodes is relatively wider. We found that the electrical resistance in the films independent of both current density and methanol liquid temperature. The temperature dependence of the electrical resistance in the low resistance carbon films is different from one obtained in graphite..

Key Words : Si, Carbon, Methnol, Polytetrafluoroethylene, DC Power

1. 서 론

The carbon is known to be a typical high temperature semiconductor, very inert to chemical substances, and a number of attempts have been made to fabricate both passive and active electronic devices using diamond. It was recently recognized that the electronic properties of diamond are strongly influenced by surface modifications ; for instance, hydrogenation of carbon surface leads to a marked increase in conductivity, while subsequent treatment in oxygen ambient result in an increase in resistivity. Carbon film have recently attracted much interest for their potential use as hard, wear resistant films, and optical coatings. From the viewpoint of practical applications, the deposition techniques by the electrolysis of organic solution techniques by the electrolysis of organic solution have many advantages, such as simplicity of the apparatus, low deposition temperature and availability for large area deposition. There is experimental evidence that most materials which can be deposited from the vapor phase can also be deposited in liquid phase using electroplating techniques and vice versa[1]. Suzuki et al[2], recently made an attempted to deposit carbon films by electrolysis of a water-ethylene glycol solution.The carbon films contain sp^3 and sp^2 carbon bonds, which is well known.However, characteristics of carbon bonds in the films formed by electrolysis are not still investigated. Furthermore, there is no examination with respect to hydrogenation of these films. In this work, form results of Raman spectroscopy and FTIR, it is pointed out that the amorphous carbon film deposited by the electrolysis of methanol solution was identified as the hydrogenated carbon film that containing sp^3 and sp^2 carbon bonds with porous structure.

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2. 실험방법

The carbon film was deposited on silicon substrate by using the electrolysis of methanol solution. The experimental apparatus consisted of an electrolytic bath, two electrodes and DC power source. Si substrate was covered with polytetrafluoroethylene. Teflon which prevents current leak. A carbon plate and the Si substrate were mounted on the positive and the negative electrodes. Just before the deposition of carbon film, native oxide on Si substrate was etched in diluted fluorine solution. Distance between the two electrodes was set to 1mm. The constant dc potential of 2kV was applied during the deposition of the carbon film. The current density was held at 15mA/cm^2 for initial period of the electrolysis of methanol solution. The current density increased up to 50 mA/cm^2 with increase of the electrolysis time. Then, it decreased up to 10 mA/cm^2 in final period of the elctrolysis Tempearature of the methanol solution was at 25℃ when the deposition of carbon film deigns. The increase of current density during the deposition was caused by the increase of methanol solution

temperature. The decrease of current density during electrolysis suggest that the high resistivity carbon was deposited on the Si substrate.

3. 결과 및 고찰

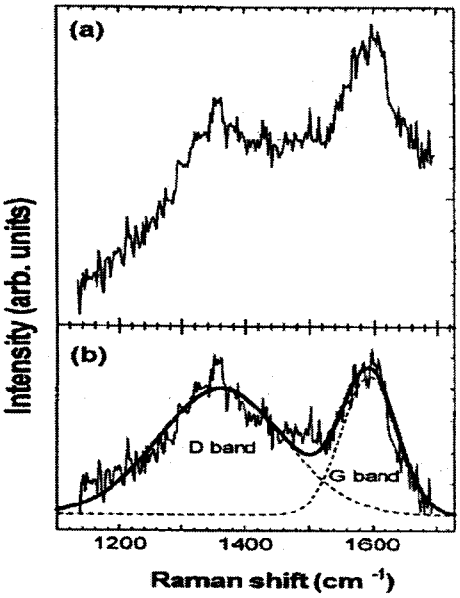

Fig. 1. Raman spectroscopy spectrum of the carbon film (a) Raman spectrum of carbon film no correction for background (b) Raman spectrum corrected with subtracting the background which is due to the luminescence. The solid curve in (b) is Gaussain fit to the data, the dot lines show decomposed to two bands, Dand G band.

Fig.1(a) shows the Raman spectrum of the carbon film. Broad background underlies in the range of 1100 to 1730 cm-1 in Raman spectrum. Such board background was identified a photoluminescence (PL) signal which cam be observed when a incident laser beam is partially absorbed in the film. Intensity of the luminescence becomes larger with increase of the hydrogen content. It is suggest that the hydrogen is involved in the carbon film.

Fig.1. (b) shows the Raman spectrum of after correction for the background on the base line. Such the spectrum can be decomposed into two the broad bands of which peaks locate at 1590 cm^{-1} and at 1360cm^{-1}. These two broad bands are related to the G band at 1580 cm^{-1} and D band at 1350cm^{-1} for graphite, respectively. The G band associates with the optically allowed E_{2g} zone center mode of crystalline graphite. The D band has been interpreted as the scattering by disorder activated optical zone edge phonons. Generally, these bands originate from carbon atoms with an sp^2 configuration. The D and G bands of Raman spectrum become broad as shown Fig.1 (b). This broadening of the Raman spectrum is related to an increase in disorder due to increase in the defect density of decrease in the graphite domain size. Integrated intensity ratio in the Raman spectrum for the carbon film that was deposited by the elctrolysis was calculated for the decomposed two broad bands as shown in Fig.1(b).

The FTIR spectraum was useful in identifying about nature of C-H bonding in the hydrogenate carbon films. Since, the C-H vibrations are very sensitive to the nature of C-C back bonds, analysis of the C-H vibrational modes with the infrared spectroscopy has considerable potential for structural investigations of the hydrogenate carbon. Assignments of the vibrational frequencies to distinct the C-H modes were carried out [3-9].

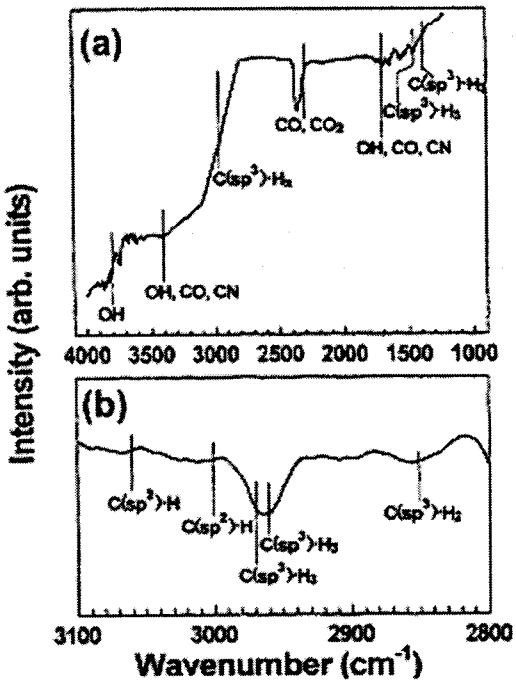

Fig. 2 FTIR spectrum of the carbon film. (a) FTIR spactrum of carbon film in the range 1200 to 4000 cm^{-1} (b) FTIR spectrum extended between 2800 and 3100 cm^{-1}.

Fig.2(a) shows the FTIR spectrum that is the range of 1200 to 400 cm^{-1} for the carbon film deposited by the electrolysis of methanol solution. The absorption peak related to C (sp^3)-H_3 bond was observed at 1450 cm^{-1} and 1370cm^{-1}, and the very board peak at 2960 cm^{-1} can be assigned to well known the stretch vibration mode of the C-H bond for the absorption spectrum. These absorption peaks observed in the FTIR provide an evidence for the incorporation of hydrogen in the film. The vibrations around 3400 cm^{-1} and 1700cm^{-1} in the FTIR are due to bulk contamination, which attributed to O-H and C-O C-N groups, respectively. Then, the peaks around 2300cm^{-1} and 3800 cm^{-1} relate to C-O, C-O_2, and O-H, respectively. The existence of theses absorption peak means that the material have porous structure. Therefore, it is suggested that the carbon film deposited by the electrolysis of methanol solution has porous structure. However, the structure does not detect by a conventinal. scanning electron microscopy(SEM). This implies that the carbon film has the very fine porous structure. The region near 3000cm^{-1}

in the FTIR spectrum was useful in identifying about the nature of C-H bonding for the hydrogenated carbon film.. The C-H vibrations are vibrations are sensitive to the nature of C-C back bonds. This means that the FTIR spectroscopy can be investigated about sp3 carbon bond for the carbon film which was deposited by the electrolysis of methanol solution. Fig.2(b) show the FTIR spectrum between 2800 $cm^{-1}$and 3100 cm^{-1} .after correction for the base line.

The borad absorption peak was observed around 2960 cm^{-1}. Generally, the broad absorption peak around 2900cm^{-1} is observed in hydrogenated carbon film. This broad peak is a superposition of the absorption peaks of $C(sp^3)$-H_3, $C(sp^3)$-H_2 and $C(sp^2)$-*H stretching vibrations.*

As shown in Fig2(b), such the broad absorption peak around 2950 cm^{-1} is appeared in carbon film. Consequently, it was clarity that the carbon film deposited by the electrolysis consists of mixture of sp^3 and sp^2. bonding structure.

4. 결 론

The carbon film was deposited by the electrolysis of methanol solution. In this work, form results of Raman spectroscopy and FTIR, it is pointed out that the *amorphous carbon film deposited by the electrolysis of* methanol solution was identified as the hydrogenated carbon film that containing sp^3 and sp^2 carbon bonds with porous structure.

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