유기물 박막에서 일어나는 친핵성 반응에 대한 연구

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Study on the nucleophilic reaction on Orgniac Thin Films

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요약 : The chemical shift of SiOC film was observed according to the flow rate ratio. SiOC film has the broad main band of 880~1190 cm^{-1}a nd the sharp Si-CH_3 bond at 1252 cm^{-1}, and the infrared spectra in the Si-O-C bond moved to low frequency according to the increasing of an oxygen flow rate. The chemical shift affected the carbon content in the SiOC film, and the decreasing of carbon atoms elongated the C-H bonding length, relatively. The main bond without the sharp Si-CH_3 bond at 1252 cm^{-1} consisted of Si-C, C-O and Si-O bonds, and became the bonding structure of the Si-O-C bond.

Key Words : PMMA, C=O bond, C=C bond, Si-O bond.

I. INTRODUCTION

In order to reduce signal propagation delay time and cross-talk noise in ultralarge-scale integrated (ULSI) circuits, the development of low dielectric (low-k) constant materials are required instead of silicon dioxide fim. There are alternative low-k materials such as hydrogenated amorphous carbon fim (a-C:H), florinated amorphous carbon fim (a-C:F), florine-doped silicon dioxide fis (SiOF) and parylene polymer fim. In these materials, SiOC fim using bistrimethylsilylmethane (BTMSM) and an oxygen-mixed precursor possess a lower dielectric constant due to the presence of lighter C and H atoms, as opposed to Si and O. SiOC fim display a blueshit and redshift in IR absorption spectra, depending on the nature of the bonding structure such as C-H bond elongation or condensation. The distinction between the Si-O-C bond of the redshift and the C-O bond of the blueshift has already been discussed ref. 4. The main IR signal involving the Si-CH3 absorption at 1270 cm^{-1} accounted for the redshift, while the main signal . without the Si-CH3 absorption at 1270 cm^{-1} accounted for the blueshift. SiOC film with a blueshift has the organic properties, and that with a redshift has the hybrid or inorganic properties. SiOC film with a blueshift decreases the dielectric constant because a silicate network generates pores through the action of steric and electrostatic forces, but that with a redshift decreases the dielectric constant due to the electron deficient effect of C-H bond elongation.

In this paper, the SiOC fim deposited using various BTMSM ([(CH3)3 Si]2 CH2) and O2 flw rate ratios were examined by deconvolution of sample spectra using Fourier transform infrared (FTIR) spectroscopy. We researched the correlation between the generation of Si-O-C bond and C-H bond elongation in SiOC film with the Si-CH_3 bond, which does not possess in the main mode.

II. EXPERIMENT

The SiOC films were obtained using the mixed gases of oxygen and bistrimethylsilylmethane by chemical vapor deposition of Applied Materials Corporation (Precision 5000). The precursor of bistrimethylsilylmethane was purchased from the Applied Materials Corporation. The deposition condition was the substrate temperature at 100℃ for 10 sec. The BTMSM was vaporized and carried by argon gas at 35 ℃ from a thermostatic bubbler. SiOC films were prepared by various flow rate ratio, but the total flow was 120 sccm. The base pressure was 3 Torr and the rf power was 300 W in each experiment. The chemical properties were analyzed from Fourier Transform Infrared Spectrometer (FTIR, Galaxy 7020A). The FTIR spectra of sampleswere deconvoluted.

III. RESULTS AND dISCUSSION

Figure 1(a) shows the FTIR spectra in the full range from 600 cm^{-1} to 4000 cm^{-1} of SiOC film with increasing the BTMSM flow rate ratio. There are the CH peak near 2950 cm^{-1}, the conjugated C=O bond of 1500~1750 cm^{-1}, the C=C bond of 1400~1500 cm^{-1}, Si-CH_3 peak near 1252 cm^{-1} and Si-O-C bonds below 1190 cm^{-1}. SiOC film is generally divided into the blue and red shifts by FTIR spectra,and classified into three types by chemical properties: organic, hybrid and inorganic [ ]. Common SiOC film with a redshift has the broad bond possessed the Si-CH_3 peak near 1275 cm^{-1}. In this SiOC film, there is the Si-CH_3 peak near 1252 cm^{-1} but the main band does not possess the Si-CH_3peak. The C-H bond near 2950 cm^{-1} displays generally in SiOC film with organic properties.

Figure 1(b) shows the FTIR spectra of the low range of 750~1450 cm^{-1}. The samples were named BT20, BT30, BT40 and BT50 with increase the BTMSM flow rate ratios, respectively. Thepeak intensity of bonds increased according to the increasing of the flow rate ratio of BTMSM precursor. The tendency of increasing the peak intensity such as these samples is similar to the organic properties in SiOC film. The sample with the flow rate ratio of BTMSM:O_2=20:100 is distinguished from other samples because of the different bond formation.

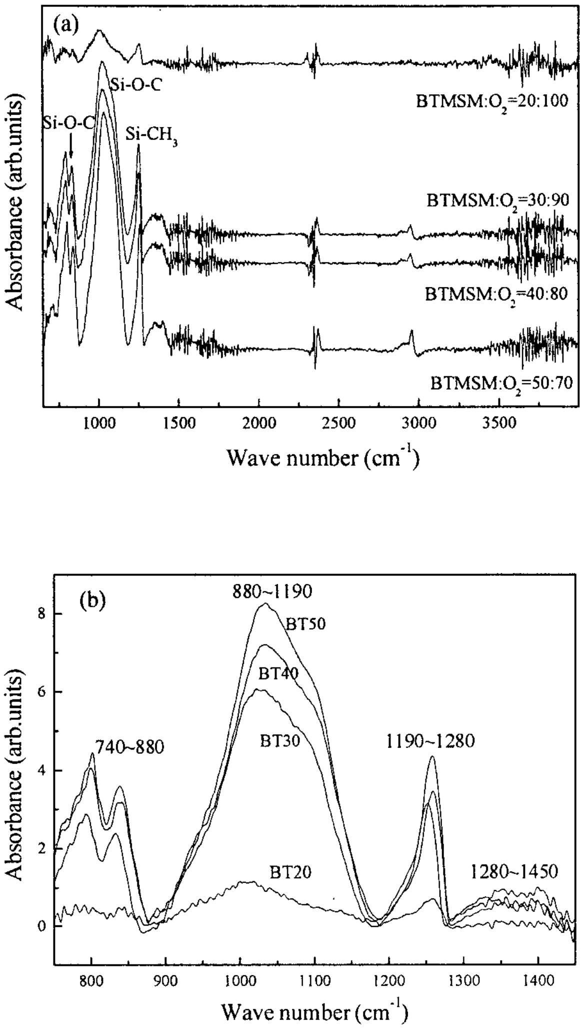

Fig. 1. FTIR spectra of SiOC film in (a) the full range from 600 to 4000 cm^{-1}, (b) the low range of 750~15450 cm^{-1}.

Figure 2 show the tendency of the chemical shift of the bond peaks. Figure 2(a) displays the main bond in the range of 880~1190 cm^{-1}. The peak position of the main bond changed to high frequency according to the increasing of the flow rate ratio of BTMSM precursor. The shift tendency of the peak intensity indicates the redshift in SiOC film with inorganic properties. Figure 2(b) shows the Si-O-C bond in the range of 740~880 cm^{-1}. The peak position of the Si-O-C bond also moved to high frequency according to the increasing of the flow rate ratio of BTMSM precursor, but the sample with the flow rate ratio of BTMSM:O_2=20:100 disappeared the Si-O-C bond in the range of 740~880 cm^{-1}.

IV. CONCLUSION

The SiOC films were obtained using the mixed gases of oxygen and bistrimethylsilylmethane by chemical vapor deposition. The main band without the Si-CH_3 bond in the redshift of SiOC film with the flow rate ratios of O_2/BTMSM>1.0 moved low frequency in the range of 880~1190 cm^{-1}. The most C-O bond in a main band increased according to the BTMSM flow rate ratios.

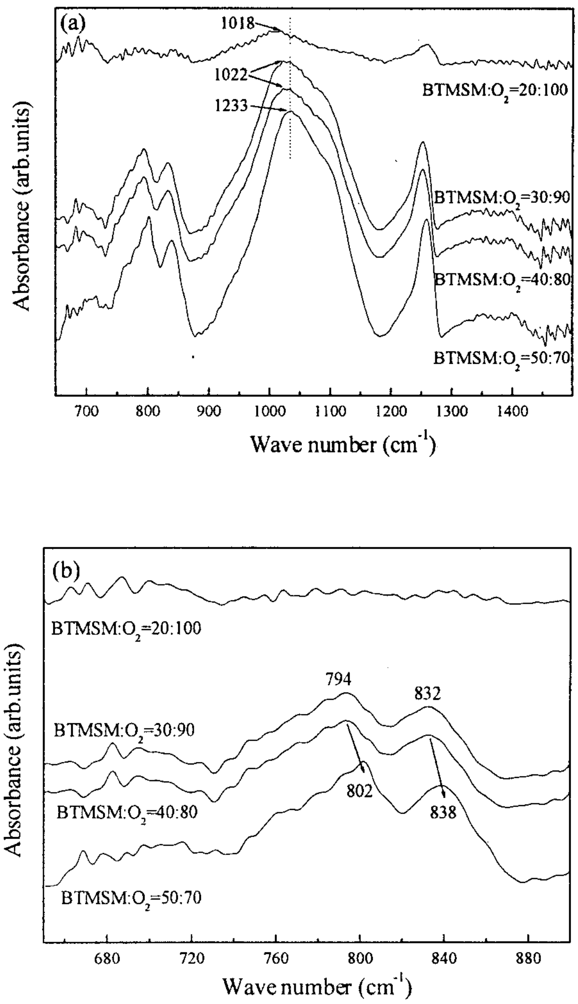

Fig. 2. FTIR spectra of the low range of 750~1450 cm^{-1}, (a) chemical shift in the range of 880~1190 cm^{-1}, (b) chemical shift in the range of 740~880 cm^{-1}.

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