FT-IR Study on Chemical Bonds of Low-Temperature Si Oxide Films Preserved in Various Conditions

Japan Adv. Inst. Sci & Tech. (JAIST)[1], ○Zhou Weiqi[1], Susumu Horita[1]

E-mail: s1810416@jaist.ac.jp

Introduction: To fabricate poly-Si TFT (Thin-Film Transistor) on non-heat resistant materials, our laboratory has been developing the low-temperature deposition method for Si oxide film using APCVD (Atmospheric Pressure Chemical Vapor Deposition) with silicon oil and ozone gas [1]. This method is low cost using safety materials, compared with the conventional CVD methods using plasma and TEOS gas. However, perfectly removing OH bonds in deposited films is still desired because they degrade insulator property. Recently, we found that some dehydration phenomenon occurred when as-deposited films were preserved in ethanol or low humidity air condition. In this meeting, the results are presented, and the mechanism is discussed to further reduce the Si-OH content.

Experimental procedure: Si oxide films were deposited with the aid of trichloroethylene (TCE) under 200°C substrate temperature. The details were mentioned in the previous report [1]. After deposition, the films are preserved in three kinds of conditions, ethanol (99.5%): P_E, low humidity air (<8%): P_{LA}, and high humidity air (~67%): P_{HA}. FT-IR (Fourier transform infrared spectroscopy) measurement was conducted after different preservation days of 0, 2, and 6, and the spectra were deconvoluted to distinguish OH-related component from other ones.

Results: Figure 1 shows the four sets of FT-IR spectra of the Si oxide films, which were measured just after deposition and after 2-days preservation in the three kinds of conditions. The peaks in the high wavenumber range around 3400 cm^{-1} and the low wavenumber around 950 cm^{-1} are related to water and/or -OH. It can be seen clearly that both peaks are reduced after 2-days preservation in P_E and P_{LA} conditions.

Figure 2 shows the change of the peak area ratio with the preservation period, where the ratio is between the high wavenumber range peak and the main SiO_2 TO3 peak. From this result, we can see that the P_E and P_{LA} conditions have dehydration effect on the films and that the Si-O-Si network and Si-OH structure seem to be changed. These results can be explained as follows: For the P_E case, OH of ethanol forms a hydrogen bond with OH-Si, which induces dehydration reaction to remove OH of OH-Si and leave H_2O in the preservation solution of ethanol. For the P_{LA} case, dehydration reaction occurs between OH neighbors of OH-Si in the film so that OH of OH-Si are removed and H_2O is released into the air. The H_2O may hardly remain in the film as H_2O concentration in the film is more than in the low humidity air. For the P_{HA} case, the film may additionally absorb water and/or OH from the air which has lots of H_2O to supply.

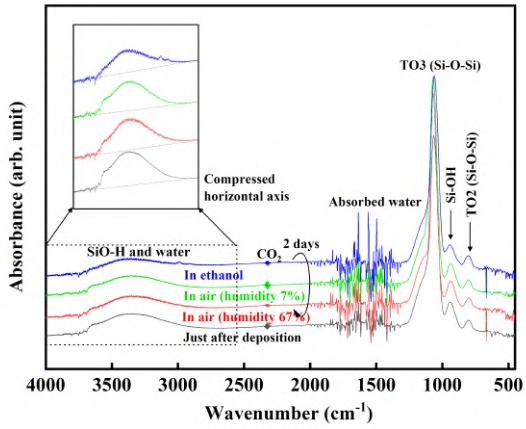

Figure 1. FT-IR spectra of the Si oxide films measured just after deposition and after 2-days preservation in three kinds of conditions.

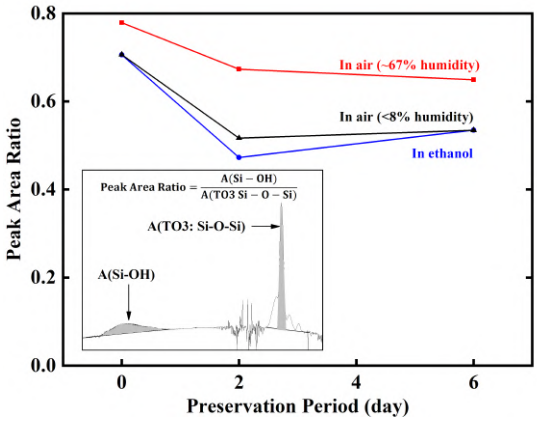

Figure 2. Preservation period dependence of the peak area ratio between the high wavenumber peak and the main SiO_2 TO3 peak.

Summary: Preservation conditions of ethanol and low humidity air have OH removing effect from the Si oxide films deposited at low temperature. In the meeting we will show other data and discuss them.

Reference: [1] Horita et al., 2018 Jpn. J. Appl. Phys. 57 03DA02.