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Crystallization of Amorphous Silicon Thin Films by Microwave Heating

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I. Motivation

Crystallization of amorphous silicon thin films is important for fabrication of the thin film transistors (TFTs) and the flat panel display. In this paper, we report crystallization of amorphous silicon thin films by the method with microwave heating assisted with carbon powders for effective microwave absorption, which we recently proposed in the previous meeting [1].

II. Experimental

50-nm-thick amorphous silicon films were formed on quartz substrates with a thickness of 500 μm and a diameter of 4 inch using the low pressure chemical vapor deposition (LPCVD). The samples were divided into 4 quarter pieces. The samples were placed in a quartz vessel with a diameter of 2.4 inches, and they were completely covered by carbon particles, as shown in Fig.1. They were heated with microwave irradiation using a 2.45 GHz commercial microwave oven at 1000 W for 2, 3 and 4 min. Visual observation of red color light emission from carbon powders indicated that they were heated to about 1000 ^{o}C for 4 min microwave irradiation. The samples were heated by heat conduction from the carbon powders. Raman scattering spectra were measured and analyzed using a numerical calculation program to estimate the crystalline volume ratio.

III. Results and discussion

Figure 2 shows Raman scattering spectra of the 50-nm-thick amorphous silicon films with different microwave heating durations. The initial sample had a broad peak at about 470 cm^{-1} with a full width at half maximum (FWHM) of 88.7 cm^{-1}. The crystalline volume ratio was almost 0. In the case of 2 min microwave irradiation, the 1 cm edge region of sample was crystallized and showed a sharp peak at 515.5 cm^{-1} with a FWHM of 11.4 cm^{-1} and crystalline volume ratio of 0.57. On the other hand, in the cases of 3 and 4 min microwave irradiation, the samples were entirely crystallized over the whole region with sharp Raman scattering peaks, as shown in Fig. 2. Raman scattering spectra measured at the middle point gave the peak wavenumber, FWHM and the crystalline volume ratio as 515.1 cm^{-1}, 11.9 cm^{-1}, and 0.55 for the 3 min heated sample, and 515.3 cm^{-1}, 11.5 cm^{-1}, and 0.61 for 4 min heated sample. These results demonstrate that microwave heating with carbon powders easily crystallizes a-Si films for short times. 4 min microwave irradiation increased the crystalline volume ratio. We believe the highest heating temperature was achieved in the case of 4 min. In the meeting, we will report optical and electrical properties of crystallized silicon films. Moreover, we will discuss application of the present heating method to fabricate thin film transistor.

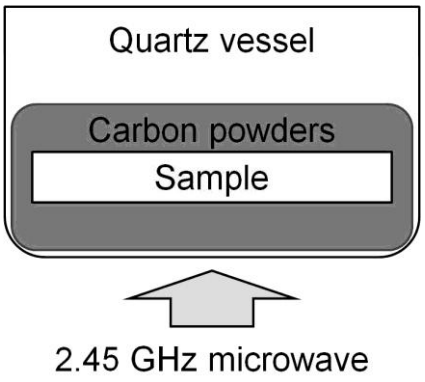

Fig.1　Schematic cross section of experimental equipment and microwave irradiation image for heating the samples.

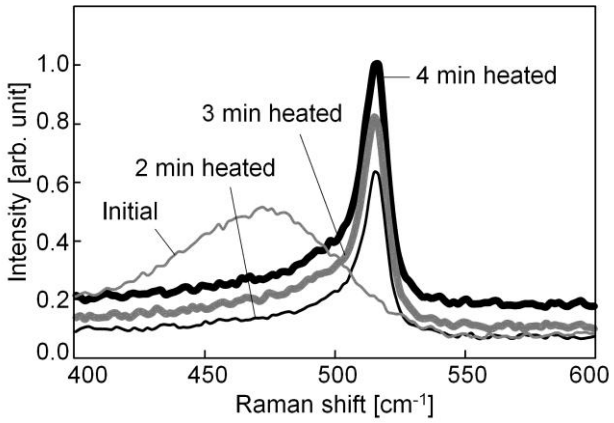

Fig.2　Raman scattering spectra of the 50-nm-thick amorphous silicon films with different microwave heating durations.

References

[1] T. Nakamura, S. Shigeno, S. Yoshidomi, M. Hasumi, T. Ishii, T. Sameshima, Y. Inouchi, M. Naito, and T. Mizuno : The 74th JSAP Autumn Meeting (2013) 19p-B4-20