Characteristics of low temperature polysilicon thin film deposited using SiF_4 and D_2 gas mixture in PECVD system

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There have been many studies on the growth of polycrystalline silicon thin films due to their higher field effect mobility compared with amorphous silicon. Although recent studies focused on the laser annealing of amorphous silicon, there were many problems to be solved, such as non-uniform performance of TFTs and problems at the interface of between gate insulator and polysilicon. Then, a direct deposition of high quality polysilicon thin film at low temperature using plasma enhanced chemical vapor deposition (PECVD) appears to be the best way to make uniform and low cost polysilicon TFTs.[1]

In hydrogenated amorphous silicon(a-Si:H), hydrogen atoms which are combined with silicon dangling bond passivates the defects in the film, but this Si-H weak bonds are also the cause of the performance instability.[2] Studies on deuterium passivation in MOSFET's and solar cell exibit superior stability to hydrogen passivation.[3,4] Recently, there was a report on deuterated amorphous silicon(a-Si:D) TFT which had a higher mobility than that of a-Si:H.[5] But deuteration of a-Si:H was a complex work, which included the dehrogenation and deuteration steps.

In this paper, we directly deposited deuterated silicon thin films using SiF_4/D_2 gas mixture in PECVD system. The process parameters of flow rate, temperature, and rf power density were varied and the crystallization and bond structures were examined.

Fig. 1 shows the FT-IR spectra of hydrogenated and deuterated silicon thin films at the flow rate of 20/20 sccm (SiF_4/H_2 or D_2) and 150°C, 280mW/cm^{-2}. In the hydrogenated silicon thin film, the peaks observe about 2100cm^{-1} and 630cm^{-1} show a stretching peak of Si-H_2 and a wagging peak of Si-H, respectively. Fig. 1(b) shows spectra of the deuterated silicon thin film. In this figure, the peaks at 1530cm^{-1} and 530cm^{-1} shows a stretching and wagging peak of Si-D, respectively. Other peaks at 1000-1200cm^{-1} shows Si-O(1000-1100cm^{-1}) and weak Si-Si(1100-1200cm^{-1}) bonds.

Fig. 2 shows the XRD results of silicon thin films deposited at low temperature of 150°C. The peaks of (111), (220), and (311) were observed both H_2 and D_2 cases. XRD results also show stronger peaks for the case of SiF_4/D_2 gas mixture.

By introducing the D_2 into the SiF_4 in PECVD, we could obtain a deuterated silicon thin film and its crystallinity was predominant over SiF_4/H_2 gas mixture at low temperature. Accordingly this results will be applicable to more stable and higher mobility polysilicon TFTs.

References

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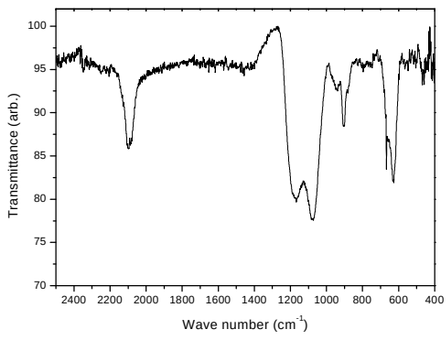
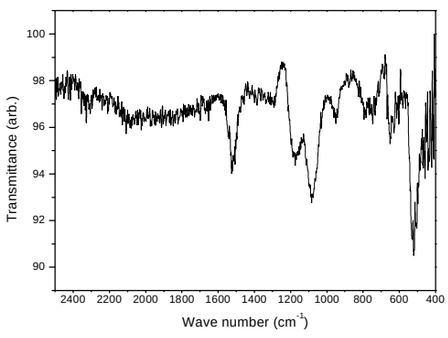
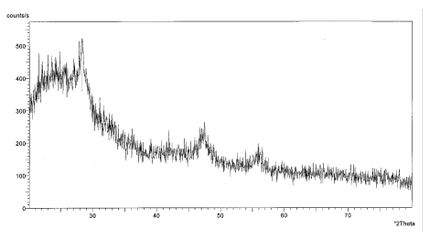


(a) hydrogenated (SiF_4/H_2 = 20/20sccm) silicon.

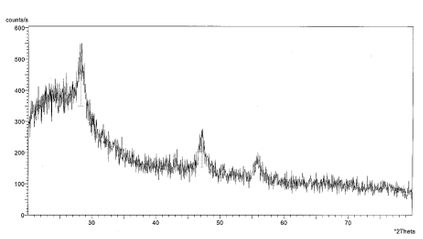


(b) deuterated (SiF_4/D_2 = 20/20sccm) silicon.

Fig. 1. FT-IR spectra of hydrogenated and deuterated silicon thin films.



(a) hydrogenated (SiF_4/H_2 = 20/20sccm)



(b) deuterated (SiF_4/D_2 = 20/20sccm)

Fig. 2. XRD results of hydrogenated and deuterated silicon thin films.