Characteristics of Millisecond Solid Phase Crystallization of Phosphorus Doped Silicon Film Annealed by Thermal-Plasma-Jet Irradiation

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Introduction

Research on polycrystalline silicon thin film transistors has been restored recently because of its wide technology application [1]. Solid phase crystallization (SPC) of amorphous silicon (a-S) is the simplest way to make polysilicon. However, there is limited publications about millisecond SPC formed at high temperature. In our research, we will find out the electrical characteristics of millisecond SPC of phosphorous (P) doped a-Si induced by micro-thermal-plasma jet (μ-TPJ).

Experimental

Two kinds of film structure were prepared as 30-nm-thick P doped a-Si deposited on quartz substrate (denoted as SL sample) and 30-nm-thick intrinsic a-Si deposited on 30-nm-thick P-doped a-Si deposited on quartz substrate (denoted as DL sample) by using plasma enhanced chemical vapor deposition (PECVD). The samples were annealed by μ-TPJ at difference scanning speed (v) from 400 to 900 mm/s. Figure 1 shows the experimental set-up. Crystallization area, 5x10 mm^2, was formed by overlapped scanning with the pitch as 100 μm. Resistivity, carrier mobility and carrier concentration were measured by Hall effect.

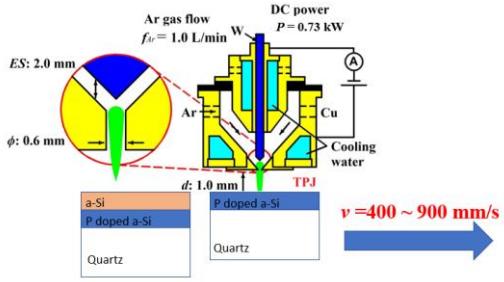

Fig.1. Experimental set-up

Results and discussion

Figure 2 shows the resistivity of samples. As can be seen, the resistivity does not depend on the sample structure and millisecond SPC samples show low resistivity as melting and recrystallization samples. It decreases with the decreasing of v. When v = 500 mm/s, the millisecond SPC condition is the closet with melted condition, the resistivity is around 10^{-3} Ωcm. Figure 3 shows the carrier concentration (a) and carrier mobility (b). When v = 500 mm/s, carrier concentration of 5x10^{20} cm^{-3} and a mobility of 12 cm^2/Vs are obtained in DL sample. It should be noted that we can obtain very high carrier concentration and good mobility by millisecond SPC. According to H.T.K.N et al. [2], at millisecond SPC condition, when v decreases, the grain size is larger, the crystallinity of film is better. Based on these characteristics, millisecond SPC of DL sample under relatively slow scanning speed is expected to become a good candidate for TFTs fabrication.

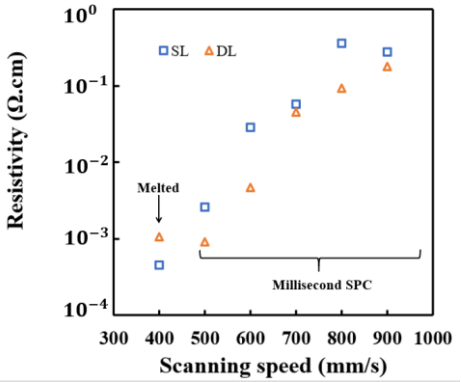

Fig.2. Resistivity of samples

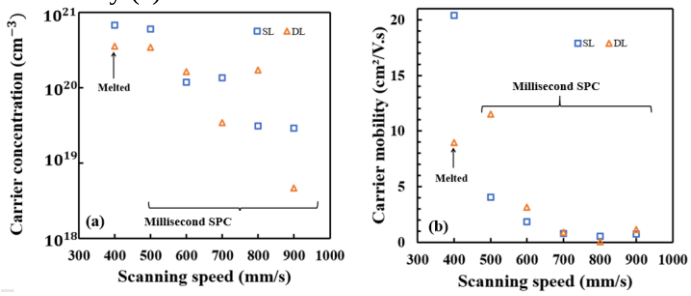

Fig.3. Carrier concentration (a) and carrier mobility (b) of samples

References

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