Annealing Process Development for Amorphous InWO Thin Film Transistors

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Recently amorphous InWO (a-IWO) thin film transistors (TFTs) were proved to show high field-effect mobility (μ_{FE}) and stable properties, implying their potential applications in active matrix flat panel displays [1, 2]. However, the influence of processing conditions on the electrical performance of a-IWO TFTs is still unclear. In this study, the effect of annealing conditions including annealing temperature and annealing time in air on the performance of a-IWO TFTs was investigated in detail, where the related physical mechanisms were analyzed with studying the microstructures and properties of a-IWO films.

Figure.1 shows the dependence of V_{th} and μ_{FE} of a-IWO TFTs on the annealing temperatures at annealing time of 1 hour in fabrications. With the annealing temperature increasing from 160 ℃ to 220 ℃, the threshold voltage evidently increased when the annealing temperature was lower than 200℃ but then decreased. On the other hand, the field-effect mobility of a-IWO TFTs increased gradually with the annealing temperature increasing. From the small figure of XPS results, the ratio of oxygen vacancies increased evidently .One may assume here that the higher annealing temperatures might lead to more oxygen in a-IWO, and hence the greater μ_{FE} of the corresponding TFT devices. The μ_{FE} of 200℃ annealing temperature was close to that of 220℃ temperature, but the V_{th} was smaller evidently. So 200℃ was appropriate temperature.

As shown in Figure 2, the threshold voltage (V_{th}) of a-IWO TFT decreased first and then increased a little after the annealing time of 1.5h. The XPS results indicates that the ratio of oxygen vacancies increased with increasing annealing time. As for the field effect mobility, it evidently increased probably due to the increase in the oxygen vacancies as well as the carrier concentrations.. The variation tendency of μ_{FE} with annealing time was assumed to result from the combinational effect of the trap states and the carrier concentrations in a-IWO films.

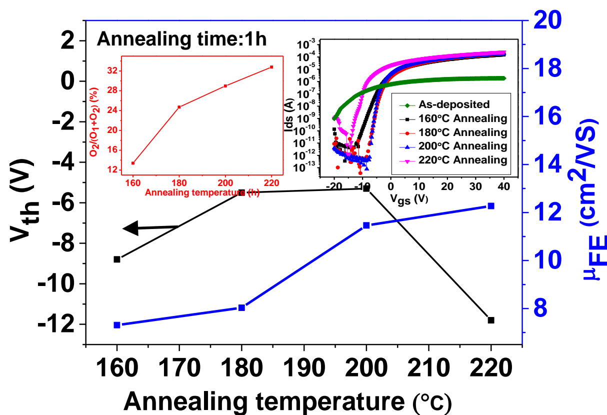

Figure 1. Variation of V_{th} and μ_{FE} with annealing temperature

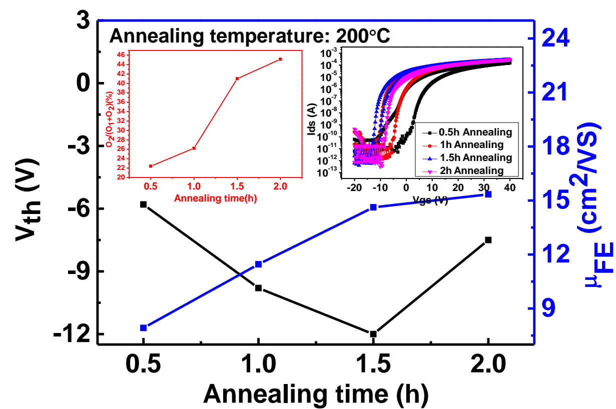

Figure 2. Variation of V_{th} and μ_{FE} with annealing time

In summary, the electrical performance of amorphous IWO TFTs could be evidently influenced by annealing temperature and annealing time in fabrications.

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References

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