Effects of Negatively Charged Energy-Beam-Irradiation on a-IGZO Film

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Amorphous oxide semiconductors are preferred for active layers due to low processing temperature and good uniformity in the large glass substrates compared to conventional silicon-based ones [1]. Recently, however, the long-term stability of oxide semiconductor during the operation of TFTs has been a critical issue. It is known that the instability of oxide thin-film transistors (OTFTs) is mainly originated from the internal defects of oxide materials, such as crystallographic imperfection and stoichiometric incompleteness [2]. Many attempts including high temperature annealing under various ambient have been explored to overcome the instability of an amorphous In-Ga-Zn-O (a-IGZO) films but the problems are still remained.

In this work, an irradiation process of negatively charged energy beam during the growth of a-IGZO thin-film using a conventional RF sputtering system was developed to improve the stability of OTFTs. Electron gun module with 60 mm diameter was attached in the sputtering system and the circular electron beam could be irradiated to the substrate varying the energy from 0.1 kV to 5 kV. Negatively charged energy beam was mainly composed of electron and O^- ion and those were generated by Ar plasma including O_2 gas.

Figure 1 showed the typical bottom gate TFT structure including 50 nm IGZO channel, and 100 nm SiO_2 gate and 200 nm ITO electrode. Low resistance Si wafer was used as a gate electrode. After the irradiation of negatively charged electron and oxygen beam, the microstructure and the composition of IGZO films were controlled depending on the beam energy and the quantity of oxygen. The effects of electron and negative oxygen ion irradiation were investigated in detail by evaluating the characteristics of a-IGZO-based TFTs.

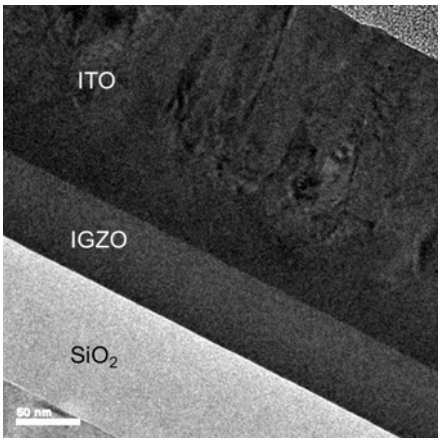

Fig. 1 Cross-sectional view of a-IGZO TFT including SiO_2 gate oxide and ITO electrode

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References

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2. J. S. Park *et al.*, *Thin Solid Films*, 520, 1679 (2012)