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Low-temperature fabrication of high-mobility InGaZnO thin-film transistors using plasma-assisted reactive processes

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Introduction

Amorphous oxide materials including a-In-Ga-Zn-Ox (a-IGZO) are expected as key materials for next generation electronics. In particular, flexible devises with a-IGZO films have attracted much attention for next-generation FPDs. For low-temperature formation of a-IGZO films, an advanced plasma-assisted reactive processes using inductivity-coupled plasma (ICP) has been developed. In our study, to enhance reactivity of sputtering deposition, a plasma-assisted reactive sputter deposition system has been developed by installing low-inductance antenna (LIA) modules [1] to sustain ICP for enhancement of the sputter discharge and control of the reactivity during film deposition [2-6]. In this presentation, formation of IGZO thin film transistor (IGZO TFT) using these advanced plasma-assisted reactive processes is reported.

Experimental

The a-IGZO films were formed with plasma-enhanced reactive magnetron sputtering deposition system shown in Fig. 1, in which four inner-type LIA modules were mounted beside the magnetron target on the top flange of the chamber and were coupled to an RF power generator at 13.56 MHz via a matching network [3-8]. The magnetron sputter target was biased with a DC high-voltage source to sustain sputter discharge.

Results and Discussion

The plasma properties of a plasma-assisted reactive independent control of the sputtering flux and reactivity via the control of target voltage and plasma density [3-6]. As a typical result, the performance of IGZO TFT with a-IGZO channel layer deposited by plasma-assisted reactive sputtering demonstrated. Figure 2 shows typical transfer characteristics of IGZO TFT with a-IGZO channel layer demonstrating that the IGZO TFT fabricated with a-IGZO channel layer exhibited the excellent performance with the field effect mobility (μ_{FE}) as high as 42.2 cm^2/Vs.

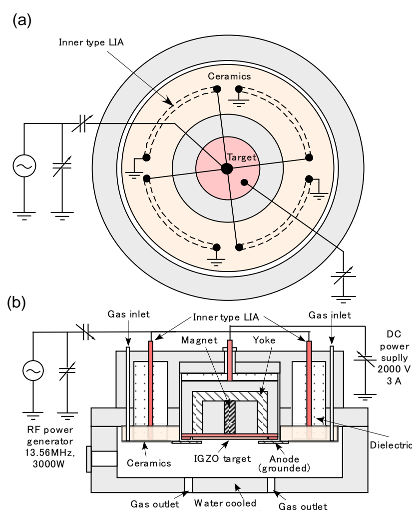

Fig. 1. Plasma-assisted reactive sputtering system
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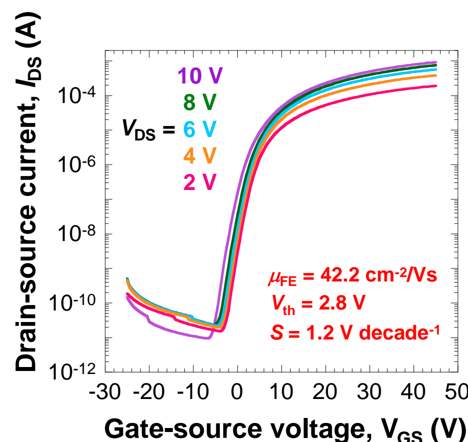

Fig. 2. I_{DS}-V_{GS} characteristics of TFT fabricated using as-deposited a-IGZO films with plasma-enhanced magnetron sputter deposition.

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