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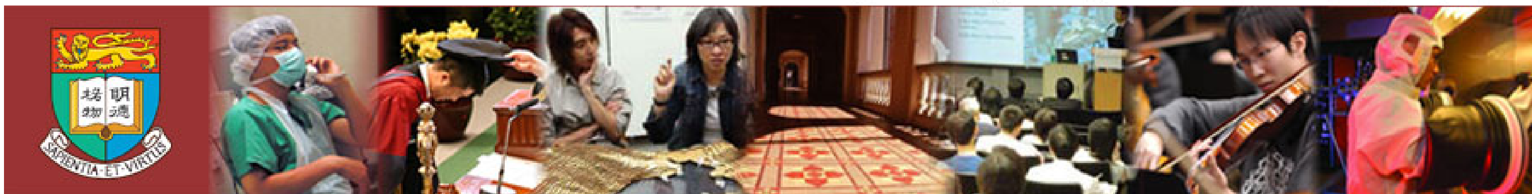

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Influence of Ar/O_2 Ratio during IGZO Deposition on the Electrical Characteristics of a-IGZO TFT with HfLaO Gate Dielectric

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***Abstract*—In this work, the influence of Ar/O_2 ratio during InGaZnO (IGZO) deposition on the electrical characteristics of a-IGZO thin-film transistor (TFT) with HfLaO gate dielectric has been investigated. It is found that lowering the oxygen concentration in the a-IGZO sputtering ambient can effectively improve the device performance, including carrier mobility (μ_{sat}), threshold voltage (V_{th}), sub-threshold slope (SS) and on-off current ratio (I_{on}/I_{off}). Moreover, the hysteresis (ΔV_H) of the transfer characteristics of the device under forward and reverse sweepings of gate bias voltage can be suppressed, and improvement on its low-frequency noise properties has been found for lower oxygen concentration in the sputtering ambient. As a result, a high saturation mobility of 12.5 cm^2/Vs, a low sub-threshold slope of 0.260 V/dec and a small Hooge's parameter (α_H) of 0.4 have been achieved for the sample with an Ar/O_2 ratio of 24 sccm / 1 sccm. All these improvements can be ascribed to the fact that more oxygen vacancies exist in the a-IGZO film deposited in an ambient with less oxygen. These positively-charged oxygen vacancies can induce a higher electron concentration in the a-IGZO film and thus fill up more electron traps at the interface between a-IGZO and HfLaO.**

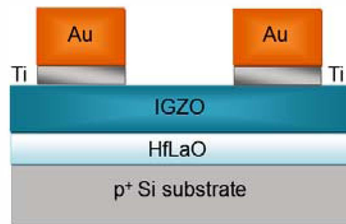

Fig. 1. Schematic diagram of the a-IGZO TFT with HfLaO gate dielectric

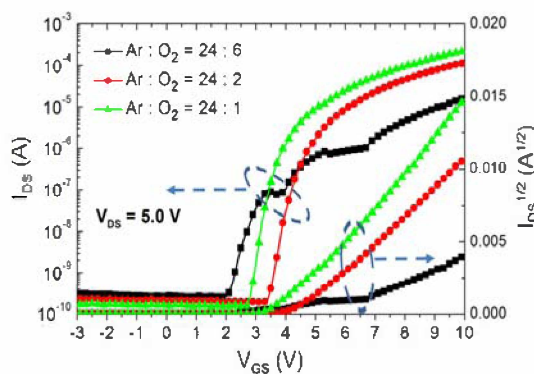

Fig. 2. Transfer characteristics of the a-IGZO TFTs with different Ar/O_2 ratios during IGZO deposition.

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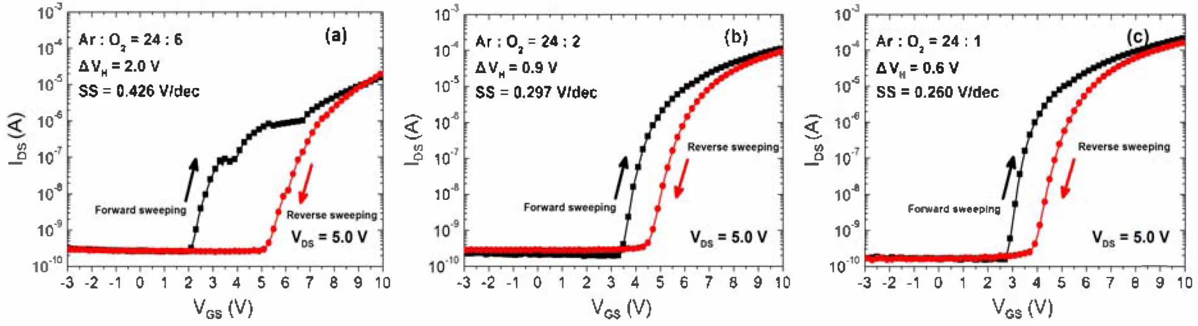

Fig. 3. Transfer characteristics of the a-IGZO TFTs measured under forward (V_{GS} = -3 V to 10 V) and reverse (V_{GS} = 10 V to -3 V) sweepings: (a) Ar:O_2 = 24:6; (b) Ar:O_2 = 24:2; (c) Ar:O_2 = 24:1.

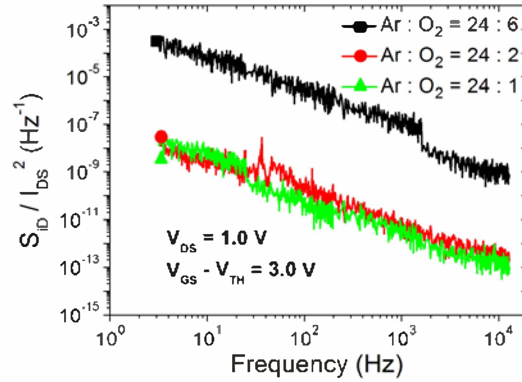

Fig. 4. S_{iD}/I_{DS}^2 versus frequency of the a-IGZO TFTs with different Ar/O_2 ratios during IGZO deposition.

Table I Electrical parameters of the a-IGZO TFTs extracted from Fig. 2, Fig. 3 and Fig. 4

Ar : O_2	μ_{sat} (cm^2/Vs)	V_{TH} (V)	SS (V/dec)	ΔV_H (V)	I_{on}/I_{off}	α_H
24 : 6	1.2	5.5	0.426	2.0	6.6×10^4	16189
24 : 2	7.0	4.8	0.297	0.9	6.3×10^5	1.0
24 : 1	12.5	4.5	0.260	0.6	1.5×10^6	0.4

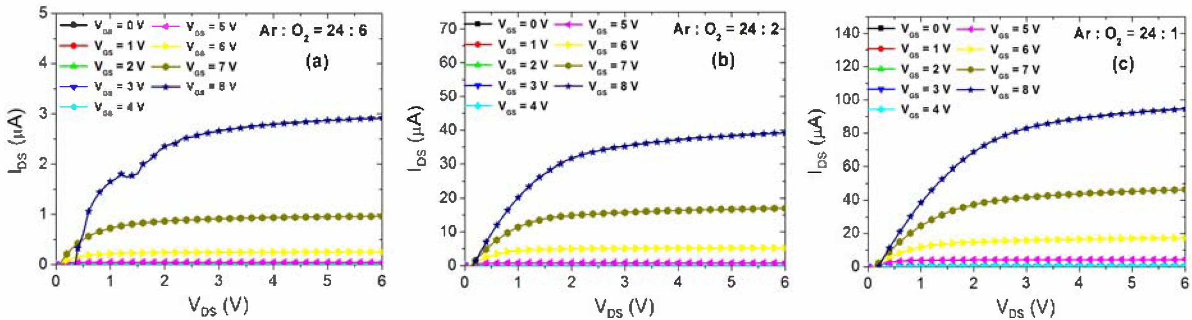

Fig. 5. Output characteristics of the a-IGZO TFTs with different Ar/O_2 ratios during IGZO deposition: (a) Ar:O_2 = 24:6; (b) Ar:O_2 = 24:2; (c) Ar:O_2 = 24:1.