용액 공정으로 제작된 InGaZnO TFT의 인듐 조성비에 따른 문턱전압 변화

Threshold voltage shift of solution processed InGaZnO thin film transistors with indium composition ratio

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Abstract : We investigated the influence of the indium content on the threshold voltage (V_{th}) shift of sol-gel-derived indium-gallium-zinc oxide (IGZO) thin film transistors (TFTs). Surplus indium composition ratio into IGZO decreases the value of V_{th} of IGZO TFTs showed huge V_{th} shift in the negative direction. V_{th} shift decreases from 10 to -28.2V as Indium composition ratio is increased. Because the free electron density is increased according to variation of the Indium composition ratio.

Key Words : threshold voltage (V_{th}), indium-gallium-zinc oxide (IGZO), thin film transistors (TFTs)

1. Introduction

ZnO-based transparent electronic devices have been extensively studied. High mobility Indium gallium zinc oxide (IGZO) for transparent active-channel thin film transistors (TFTs) have been demonstrated [1]. They are attractive owing to the high carrier mobility, low processing temperature, excellent environmental stability, and high transparency [2]. In the display industry, the alternative manufacturing processes to conventional and vacuum process are emerging to reduce manufacturing cost [3]. One of the most promising alternatives and vacuum processes is solution process. In this study, we focused on the effects of the indium content in IGZO TFTs fabricated a sol-gel method. And we observed the threshold voltage (V_{th}) shift according to induim content in IGZO TFTs.

2. Results and Discussion

The IGZO sol-gel precursor was prepared by combinding 0.5 M of zinc acetate dihydrate [$Zn(CH_3COO)_2 \cdot 2H_2O$], induim nitrate hydrate [$In(NO_3)_3 \cdot H_2O$], and gallium nitrate hydrate [$Ga(NO_3)_3 \cdot H_2O$] in 15mL of 2-methoxyethanol solvent. And the indium composition ratios were prepared (In:Ga:Zn = 1:1:2, 3:1:2, 5:1:2). The 50 nm thick active channel layer was deposited by the spin coating method and then annealed at 500°C for 1h. To improve the quality and performance of the TFT, it is important that the size, shape and crystal structure of nanocrystal oxide materials are well controlled. The grain size decreased according to increasing indium composition ratio by SEM images.

Excess indium composition ratio into IGZO decreases the value of V_{th} in IGZO TFTs. The V_{th} shift decreases from 10 to -28.2V as indium composition ratio is increased. It indicated the free electron density is increased according to variation of the indium composition ratio. Especially, the relatively high performance were observed characteristics such as field-effect mobility of 0.177 cm^2/V s, on/off ratio of 3.64×10^5, V_{th} of -2.2 V and subthreshold swing of 1.74 V/decade in the composition ratio (In:Ga:Zn=3:1:2).

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References

[1] K. Nomura, H. Ohta, A. Takagi, T. Kamiya, M. Hirano, H. Hosono, Nature Vol.488, p.432, 2004.

[2] G. H. Kim, B. D. Ahn, H. S. Shin, W. H. Jeong, H. J. Kim, and H. J. Kim, Appl. Phys. Lett. Vol.94, p.233501, 2009.

[3] T. Kawase, S. Moriya, C.J. Newsome, T. Shimoda, Jpn. J. Appl. Phys., Part Vol.44, p.3649, 2005.

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