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Low-Frequency Noise in MOSFETs with La_2O_3 Gate Dielectrics

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Abstract

Post Deposition Annealing (PDA) conditions of lanthanum oxide (La_2O_3) MOS Transistors were studied in order to optimize the noise level of Low-Frequency Noise. By using O_2 gas PDA, it was found that the Noise level is suppressed, compare with N_2 ambient.

Introduction

According to the guideline of manufacturing process on the future CMOS technology, the thickness of the gate oxide is expected to be scaled down to sub 1nm. However the scaling of gate thickness causes high leakage current through the gate oxide. To overcome this problem, replacement of SiO_2 with a high-k material is necessary. Recently several groups have reported on excellent results of La_2O_3 deposited by electron beam evaporation [1-2]. La_2O_3 with high permittivity ($\varepsilon_r \sim 27$) is one of the candidates for the gate materials of the next generation. Low frequency noise is one of the most important characteristics of MOSFETs. Few groups hae reported on High-k gate dielectrics.

In this paper, we report on the annealing condition of Low-Frequency noise characteristics for La_2O_3 thin films deposited by MBE.

Experiments

Fabrication process of MOSFETs is shown in Fig.1. La_2O_3 thin films were deposited on dipped n-Si (100) substrate (HF-last) with implanted source and drain fields by electron beam evaporation in ultra high vacuum (UHV) chamber at 250ºC using MBE equipment. The pressure in the chamber before and during depositions was about 10^{-9} Torr. After deposition, La_2O_3 films were annealed by rapid thermal annealing (RTA) chamber with 1.2 liter/min flow rate of N_2 or O_2 gas. After annealing, aluminum was formed on La_2O_3 by metal evaporation using bell-jar type evaporator at 10^{-5} Torr. Then, patterning aluminum gate electrodes by photolithography, and etching La_2O_3 to make source and drain electrode contact fields. After this, aluminum were formed by metal evaporation on photo resist and contact fields. Then, create gate/source/drain electrodes by Lift off. And then, aluminum were formed by metal evaporation on the back side of transistor. Id-Vd and Id-Vg measurements were performed using a HP4156C Semiconductor Parameter Analyzer and Low-Frequency Noise measurements were done a HP89410A Vector Signal Analyzer.

Channel length L and width W of the devices were 5.0 and 24 µm, respectively.

Results and Discussions

Fig.2 shows the comparison of the noise level characteristics between N_2 ambient and O_2 ambience of the devices gate length were 2.5 and 10 µm, respectively. In the case of N_2 ambient, the low frequency noise level parameter (Svg) were higher than the case of O_2 ambient.

Conclusions

We have investigated the low frequency noise characteristics of High-k gate dielectrics MOSFETs. Using a O_2 gas for annealing ambient, there were effects of suppression of Low frequency noise level. Although these results are those of very primitive stages of the investigation.

Acknowledgements

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References

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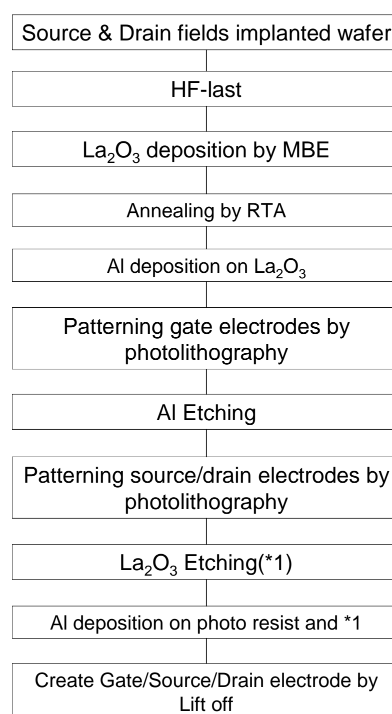

Fig.1. Fabrication process of MOSFETs

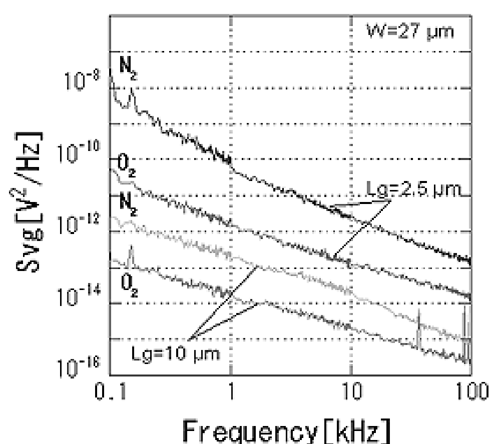

Fig.2. Noise level of MOSFETs,N2 and O2 ambient.