A study of Ar/N_2-sputtering gas pressure on electrical characteristics of LaB_xN_y insulator formed by RF sputtering

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1. Introduction

The nitrogen-doped (N-doped) LaB_6 has low work function, chemical stability, and low resistivity [1].

Previously, our group has reported LaB_xN_y insulator formation by Ar/N_2-plasma sputtering for organic-based floating-gate memory applications [2].

In this study, Ar/N_2-plasma sputtering gas pressure dependence on LaB_xN_y insulator was investigated to improve the dielectric characteristics.

2. Experimental procedure

The p-Si(100) substrate was cleaned by SPM and DHF. Next, thick field oxide 150 nm was formed by thermal oxidation. Then, the N-doped LaB_6 (Metal: M)/LaB_xN_y (Insulator: I) with a thickness of 30/10 nm were in-situ formed by RF sputtering at room temperature (RT) using N-doped LaB_6 target (N: 0.4 %). In the case of the LaB_xN_y layer, the Ar/N_2-plasma sputtering gas pressure was carried out from 0.19 Pa to 0.65 Pa by changing the Ar/N_2 gas flow ratio from 4/2.8 sccm to 14/9.8 sccm. The N-doped LaB_6 layer was formed by Ar-plasma sputtering with Ar gas flow rate of 10 sccm. Next, the post metallization annealing (PMA) process was carried out at 400°C for 1 min in N_2 (1 SLM) ambient. The Al contact electrode was formed by thermal evaporation and Al/N-doped LaB_6/LaB_xN_y stacked layers were etched by H_3PO_4 and diluted HNO_3 solution. The pattern size was 30×30 μm^2. Finally, the back Al electrode was formed. The electrical characteristics of the MIS diodes were evaluated by C-V measurement.

3. Results and Discussion

The C-V and extracted equivalent oxide thickness (EOT) and density of interface states (D_{it}) for MIS diodes were shown in Fig. 1. The maximum capacitance of 0.59 $\mu F/cm^2$ and smallest EOT of 4.8 nm were shown at sputtering gas pressure of 0.19 Pa. The D_{it} was decreased from 6.5×10^{12} $cm^{-2}eV^{-1}$ to 3×10^{12} $cm^{-2}eV^{-1}$ by decreasing the sputtering gas pressure from 0.65 Pa to 0.19 Pa. Improved dielectric characteristic and interface property suggested that dense and smooth LaB_xN_y insulator was formed at low sputtering gas pressure [3].

4. Conclusions

We investigated the sputtering gas pressure dependence on LaB_xN_y insulator. The dielectric characteristic and interface property were improved at low sputtering pressure of 0.19 Pa. It would be promising for organic-based floating-gate memory with low operation voltage.

Acknowledgements

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References

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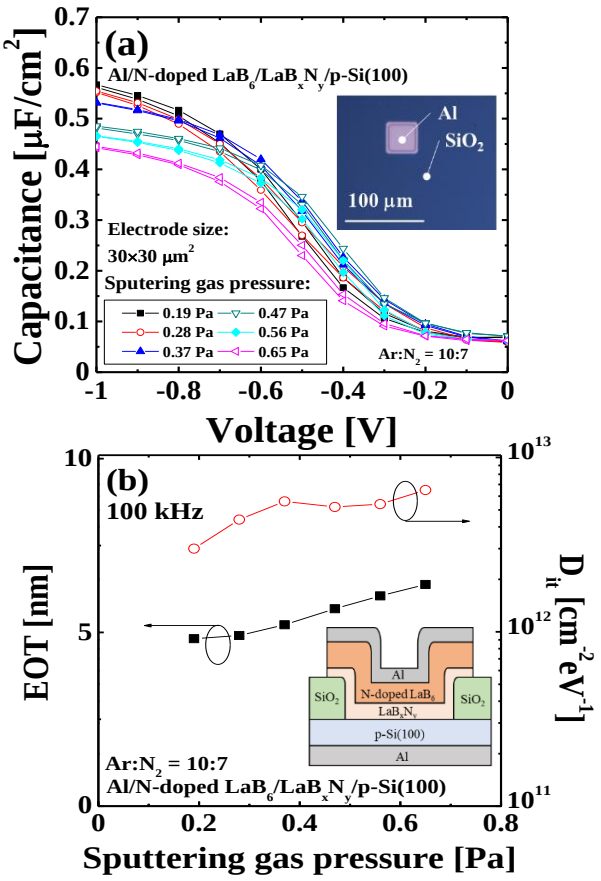

Figure 1. (a) C-V and (b) EOT and D_{it} of Al/N-doped LaB_6/LaB_xN_y/p-Si(100) diode.