

Hydrogenated-diamond logic inverter fabrication with enhancement-mode metal-insulator-semiconductor field effect transistor

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Since diamond has some excellent intrinsic properties such as a wide band gap, a high thermal conductivity, a high hole mobility, and a large breakdown field, it is considered to be a promising material for the fabrication of high-power and high-frequency electronic devices. Most of diamond-based field effect transistors (FETs) have been fabricated on the H-diamond epitaxial layers, which accumulate two-dimensional hole gases on the surface with sheet hole density and hole mobility of $\sim 10^{14} \text{ cm}^{-2}$ and $\sim 100 \text{ cm}^2 \cdot \text{V}^{-1} \cdot \text{s}^{-1}$, respectively.

Recently, an increasing interest has been focused on the fabrication of H-diamond-based metal-insulator-semiconductor FETs (MISFETs). Due to the existence of gate insulators, the leakage current and the breakdown voltage of the MISFETs are improved compared with those of the metal-semiconductor FETs (MESFETs). In our previous studies,^{1,2} electrical properties of high-k/H-diamond MISFETs have been investigated. The high-k insulators have bilayer structures, which are formed by radio-frequency sputtering deposition (RF-SD) and atomic layer deposition (ALD) techniques. The ALD-insulators in the SD/ALD bilayer structures impact as buffer layers to prevent the H-diamond surface from plasma discharge damage during the deposition of SD-insulators. Both SD-HfO₂/ALD-HfO₂/H-diamond and SD-LaAlO₃/ALD-Al₂O₃/H-diamond MISFETs showed good operations and normally-off (enhancement-mode) characteristics. In particular, there was a quite low leakage current density ($10^{-8} \text{ A} \cdot \text{cm}^{-2}$) for the SD-LaAlO₃/ALD-Al₂O₃/H-diamond. Thus, it is promising to fabricate high-performance H-diamond-based logic inverters using the enhancement-mode SD-LaAlO₃/ALD-Al₂O₃/H-diamond MISFETs.

In this study, the H-diamond-based logic inverters with the enhancement-mode SD-LaAlO₃/ALD-Al₂O₃/H-diamond MISFET will be fabricated and characterized. The voltage transfer characteristics of them with the different load resistors will be discussed.

References

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