Hydrogenated diamond NOT and NOR logic gates composed of enhancement-mode and depletion-mode MOSFETs

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It is well-known that wide bandgap semiconductors such as GaN, SiC, and diamond are suitable to replace silicon partly for fabrication of high-power and high-frequency electronic devices because of their large band-gap energies, high carrier mobility, and high breakdown field. According to figure of merit, diamond-based electronic devices have the largest power-frequency product, the highest thermal limitation, and the lowest power-loss at high-frequency. Thus, diamond semiconductor devices are expected to be of very importance for the future practice applications. Recently, fabrication of diamond metal-oxide-semiconductor field-effect transistor (MOSFET) has been developed greatly. Most of them have been fabricated on hydrogenated-diamond (H-diamond) epitaxial layers [1, 2], which accumulate holes on surface with sheet hole density of 10^{12}~10^{14} cm^{-2}.

In our previous studies, electrical properties of high-*k*/H-diamond MOSFETs with a bilayer gate structure deposited by radio-frequency sputtering deposition (SD) and atomic layer deposition (ALD) techniques were investigated [3, 4]. It was demonstrated that the SD-oxide/ALD-oxide/H-diamond MOSFETs showed good operations and enhancement-mode (E-mode) characteristics [3]. Recently, the controlling conditions for H-diamond depletion-mode (D-mode) and E-mode MOSFETs have been clarified [4]. There are two necessary conditions for the fabrication of E-mode MOSFETs, which are annealing at 180~300 °C and SD-oxide/ALD-oxide or ALD-oxide/ALD-oxide bilayer gate structure. Otherwise, if there is only single gate insulator on the H-diamond channel layer, the MOSFETs show D-mode characteristics. The successfully controlling for the H-diamond D/E-mode MOSFETs makes it possible for the fabrication of logic gates with D/E-mode MOSFETs.

In this study, we have fabricated H-diamond NOT and NOR logic gates composed of D-mode and E-mode MOSFETs. The top views of the H-diamond D/E-mode MOSFET NOT and NOR logic gates are shown in Figs. 1(a) and (c), respectively. Schematic structures of them are shown in Figs. 1(b) and (d), respectively. Both of them show good operations. The electrical properties of them will be demonstrated in the conference.

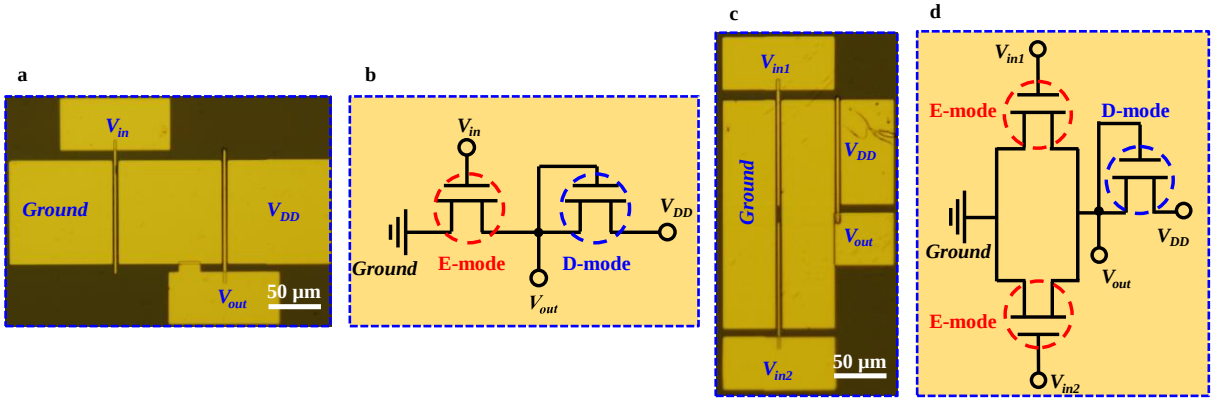

Fig.1 (a) and (c) Top views of the H-diamond D/E-mode MOSFET NOT and NOR logic gates, respectively. (b) and (d) Schematic structures of them, respectively.

Reference

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