# Vertical Trench Field-Plated $Ga_2O_3$ Schottky Barrier Diodes

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Development to enhance breakdown voltage ($V_{br}$) of β-$Ga_2O_3$ transistors and diodes have been actively pursued in the last decade. Vertical $Ga_2O_3$ Schottky barrier diodes (SBDs) with a field plate and a guard ring demonstrated superior device characteristics such as an on-resistance ($R_{on}$) of 4.7 mΩcm$^2$ and a $V_{br}$ of 1430 V [1]. In this work, $Ga_2O_3$ SBDs with novel edge termination structures were designed, fabricated, and characterized to understand electric field management for further enhancing the $V_{br}$ with keeping a low $R_{on}$.

We fabricated three types of $Ga_2O_3$ SBD structures in this work. Cross-sectional schematics of a conventional field-plated SBD (CFP-SBD), a staircase field-plated SBD (SFP-SBD), and a trench staircase field-plated SBD (TSFP-SBD) are shown in Figs. 1(a)–1(c), respectively. Note that the structures and dimensions were designed using technology computer aided design simulation, and that all the SBDs were simultaneously fabricated on an $n$-$Ga_2O_3$ drift layer ($N_d - N_a \sim 2\times10^{16}$ cm$^{-3}$) grown on an $n^+$-$Ga_2O_3$ (001) substrate by halide vapor phase epitaxy.

Forward and reverse DC current density–voltage ($J$–$V$) characteristics of the fabricated SBDs are shown in Figs. 2(a) and 2(b), respectively. The $R_{on}$ and $V_{br}$ of the $Ga_2O_3$ CFP-SBD, SFP-SBD, and TSFP-SBD were 4.7 mΩcm$^2$ and 977 V, 7.0 mΩcm$^2$ and 1527 V, and 7.6 mΩcm$^2$ and 1662 V, respectively. These results indicate large potential of the novel edge termination structure having a staircase field plate formed on a deep trench filled with $SiO_2$.

This work was supported in part by Ministry of Internal Affairs and Communications (MIC) research and development (JPMI00316).

[1] C.-H. Lin *et al.*, IEEE Electron Device Lett. 40, 1487 (2019).

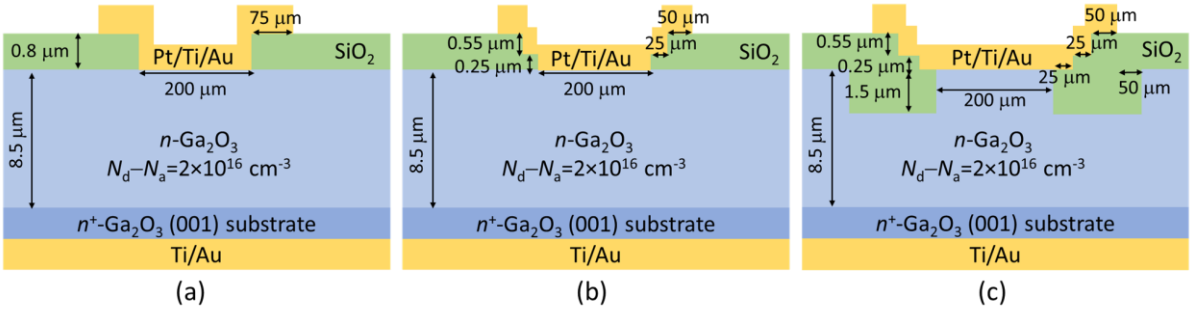


Fig 1. Cross-sectional schematics of (a) CFP-SBD, (b) SFP-SBD, and (c) TSFP-SBD structures.

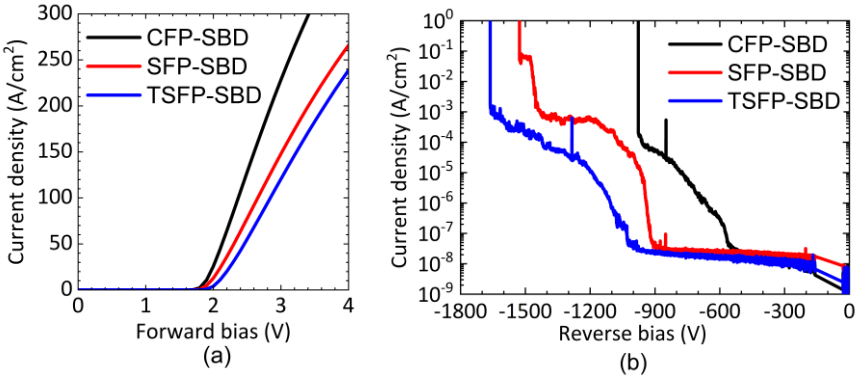


Fig. 2. (a) Forward and (b) reverse $J$–$V$ characteristics.