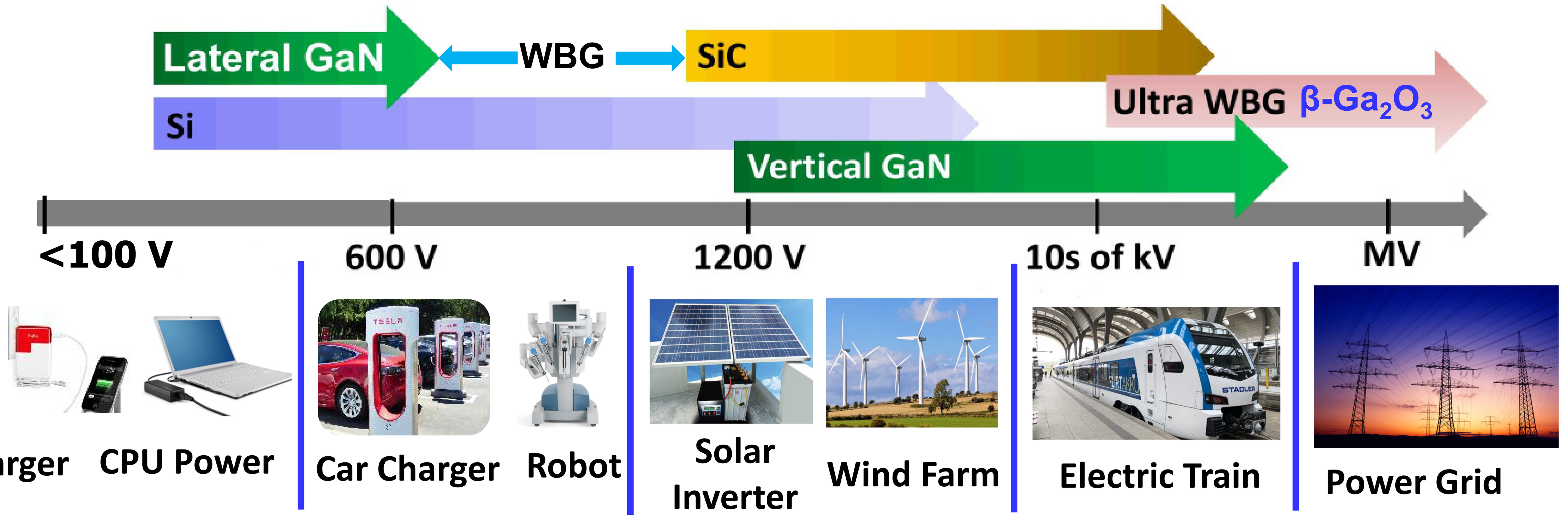
Wide Bandgap (WBG) in High-Power Electronics

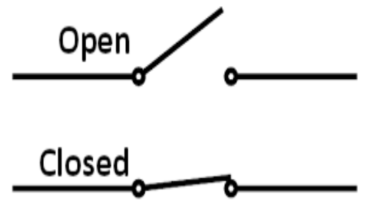


R. Kaplar, Sandia National Labs, UNM ECE Graduate Seminar, 2019

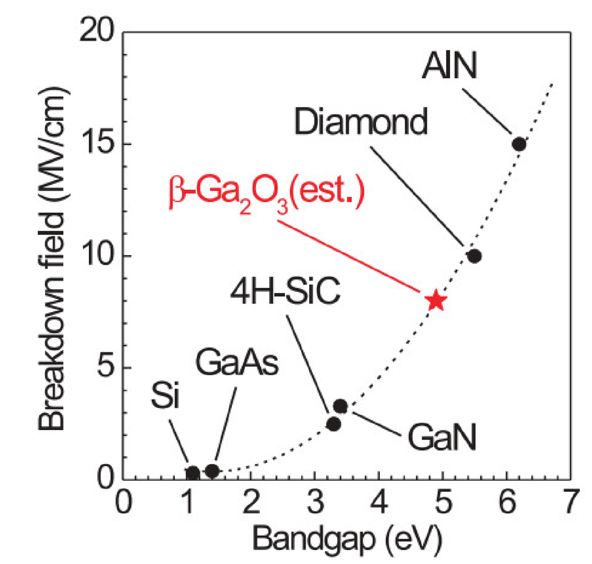
S. Pearton *et al.*, *J. Appl. Phys.* 124, 220901 (2018)

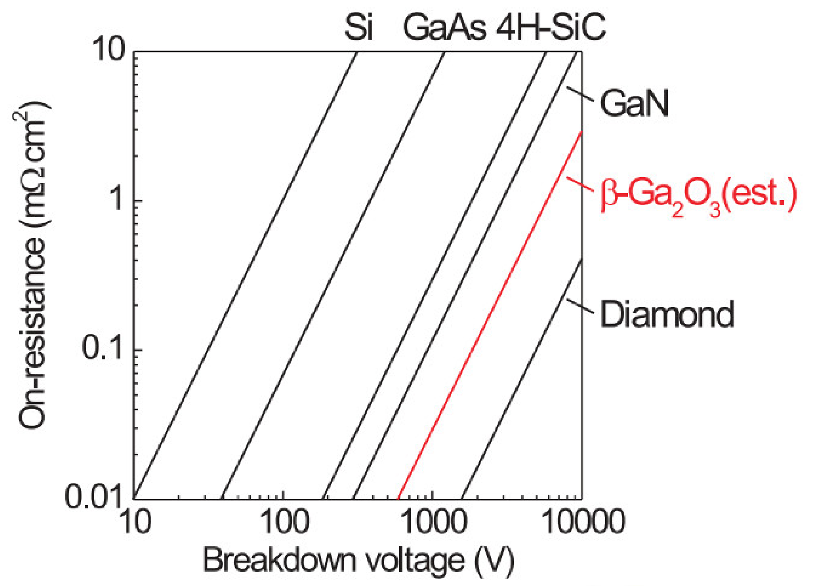
WBG in Energy-Efficient Switching

High breakdown voltage (V_B) (off-state)



Low on-resistance R_{on} (on-state)

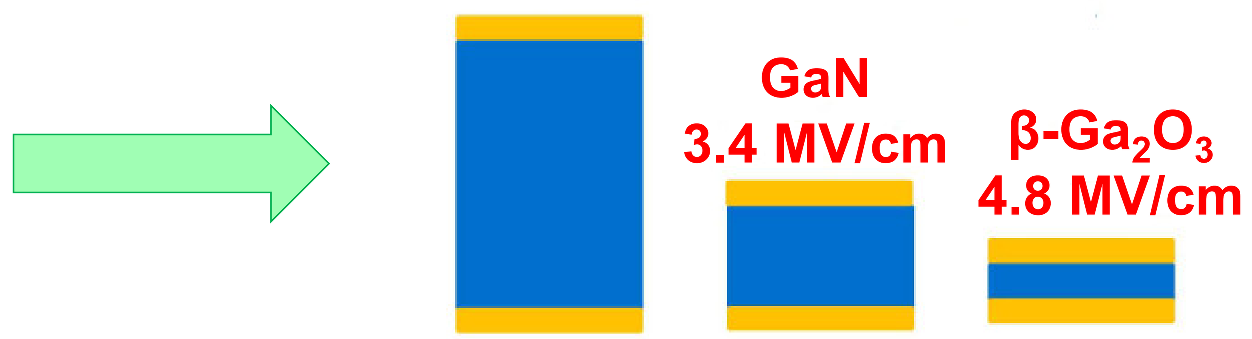




Towards Green Electronics ➤ Low loss ➤ High-Power ➤ Smaller

Breakdown Voltage $V_B = 0.5 \times E_{max} \times W$

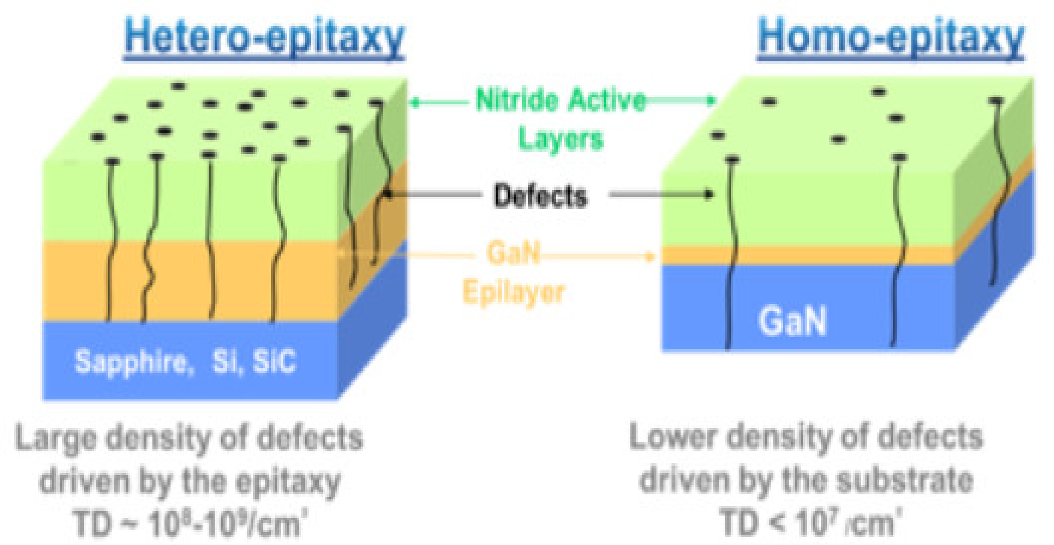
Max field ↑ Width ↓



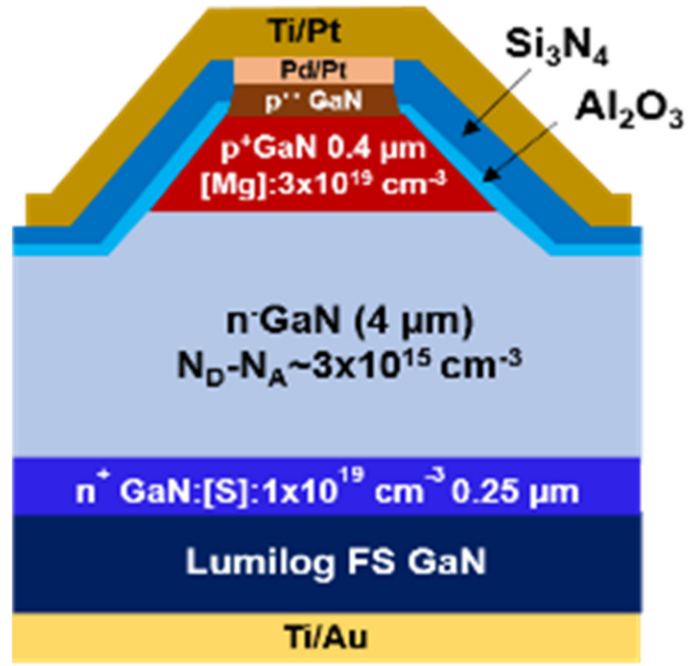
M. Higashiwaki *et al.*, *Appl. Phys. Lett.* 100, 013504 (2012)

High-power GaN-on-GaN Device from Molecular Beam Epitaxy (MBE)

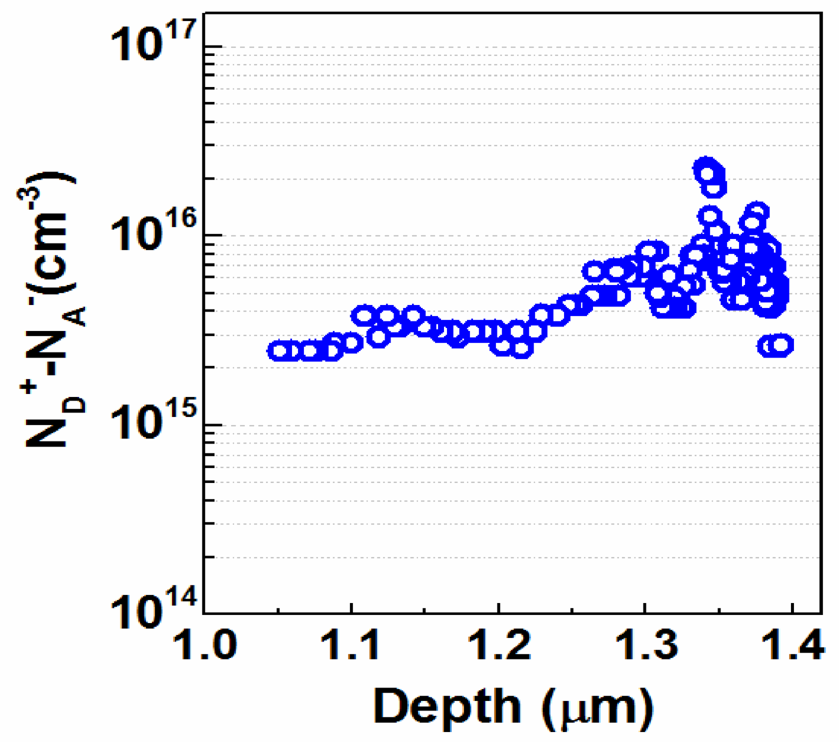
Low dislocation density from GaN-on-GaN growth



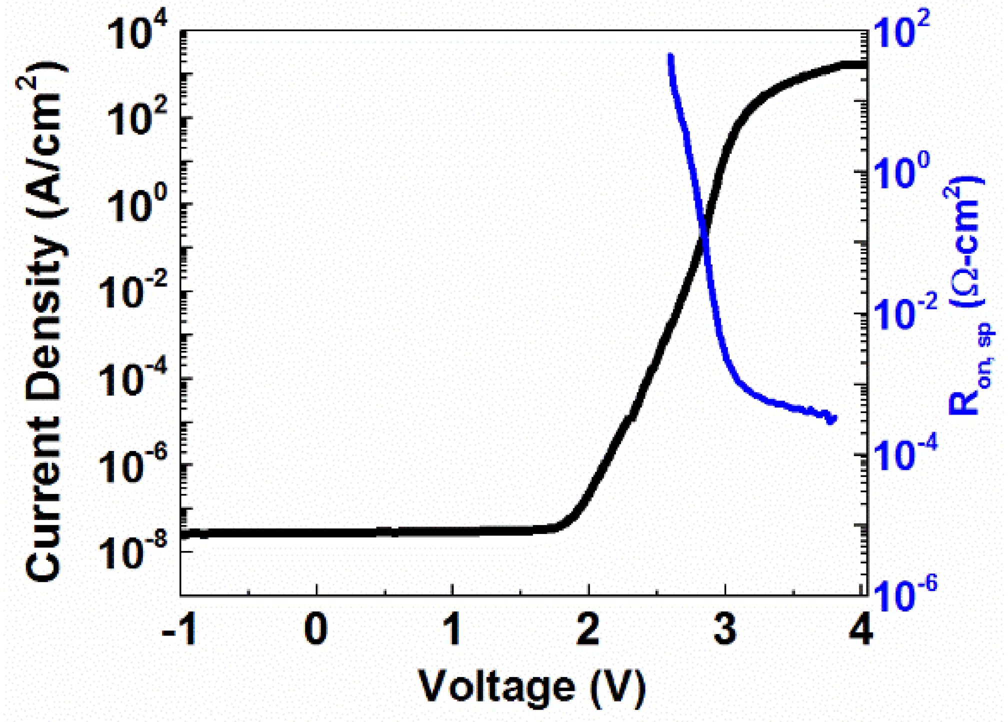
GaN-on-GaN p-n Diode



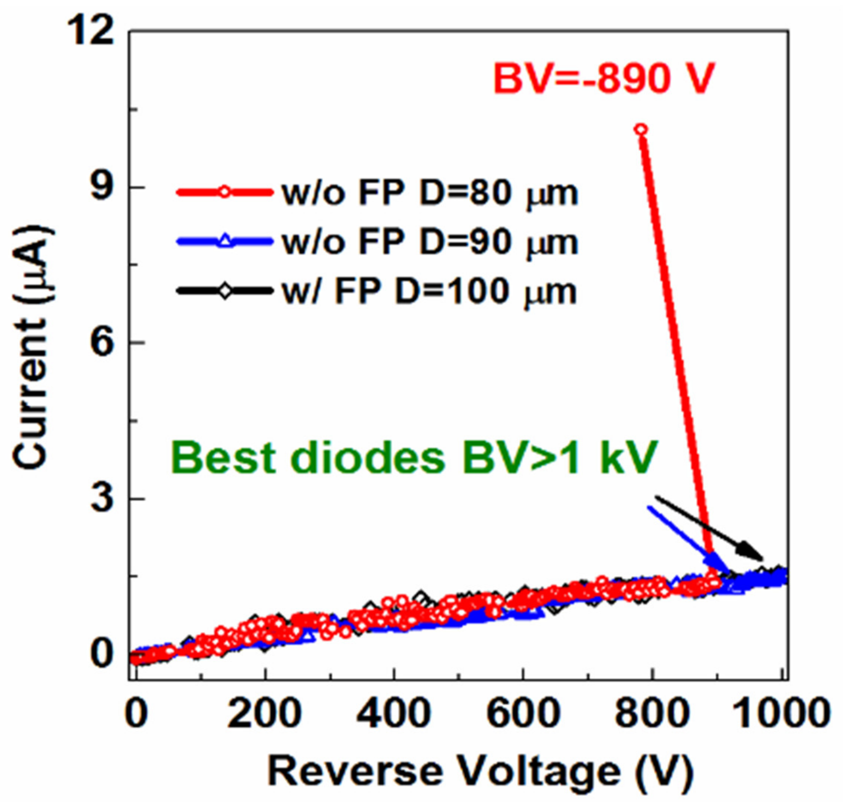
Low unintentional doping from NH_3-MBE



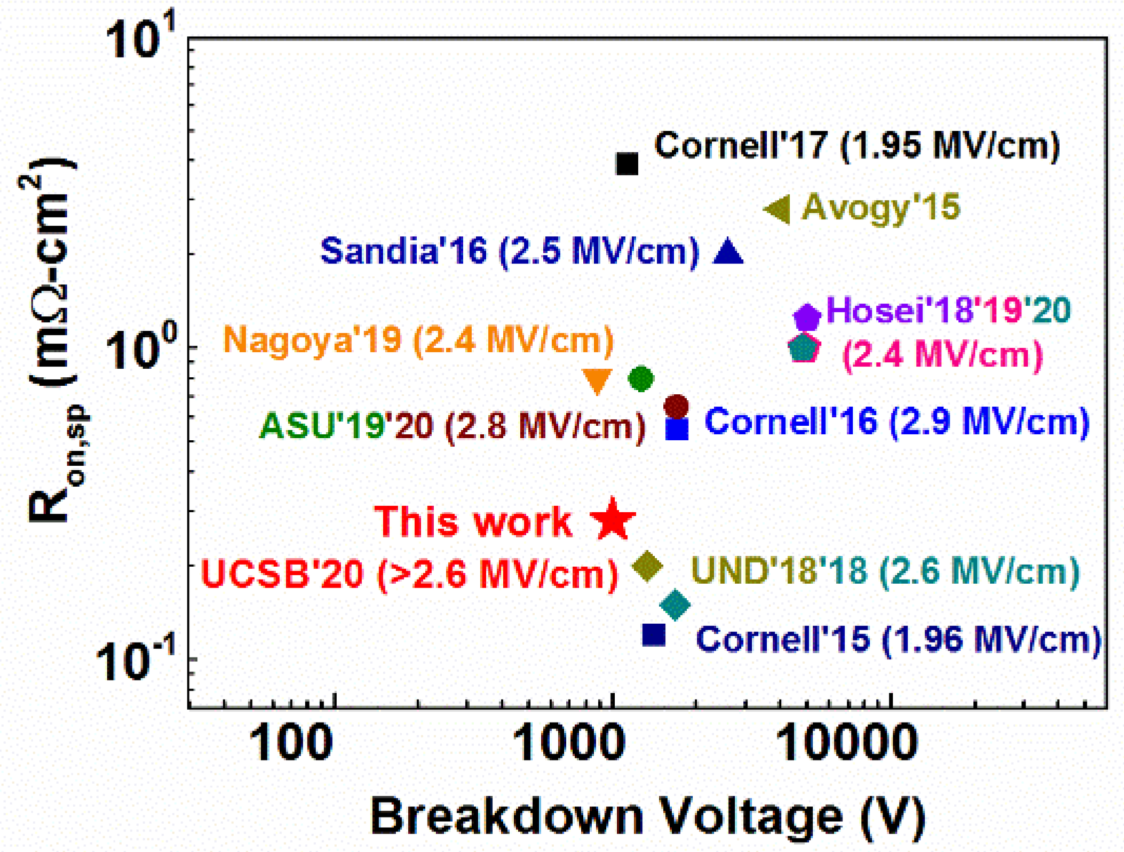
High on//off ratio & low R_{on}~0.28 mΩ-cm²



Breakdown Voltage >1000 V

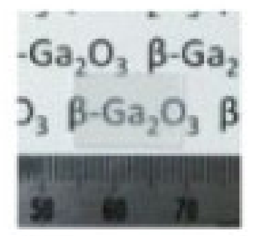


Comparable with the best GaN-on-GaN p-n diodes with only half of their thickness ~4 um



E. Farzana *et al.*, *IEEE Elec. Dev. Lett.*, pp-1-4 (2020)

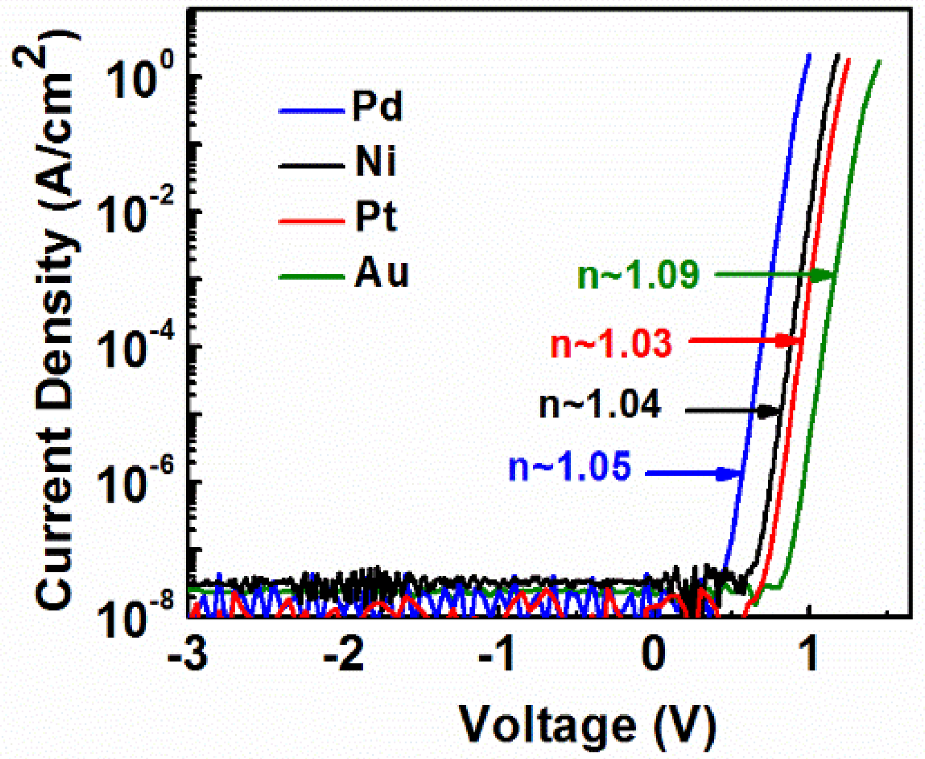
High-power Homoepitaxy β-Ga_2O_3 Devices



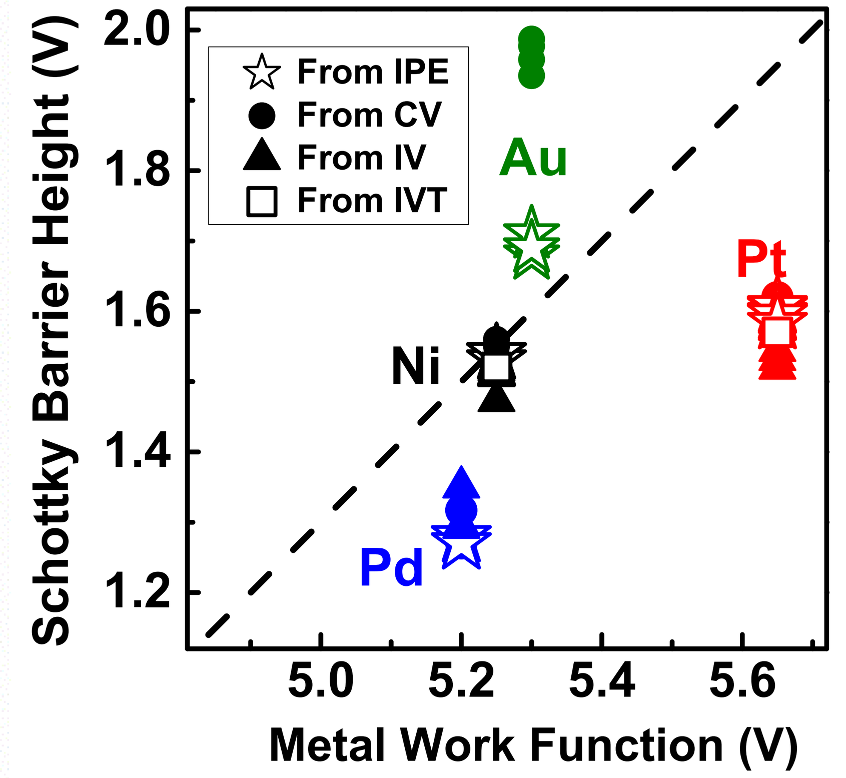
10 mm x 15 mm

(2̄01), (010), (001)

Melt-grown native substrate

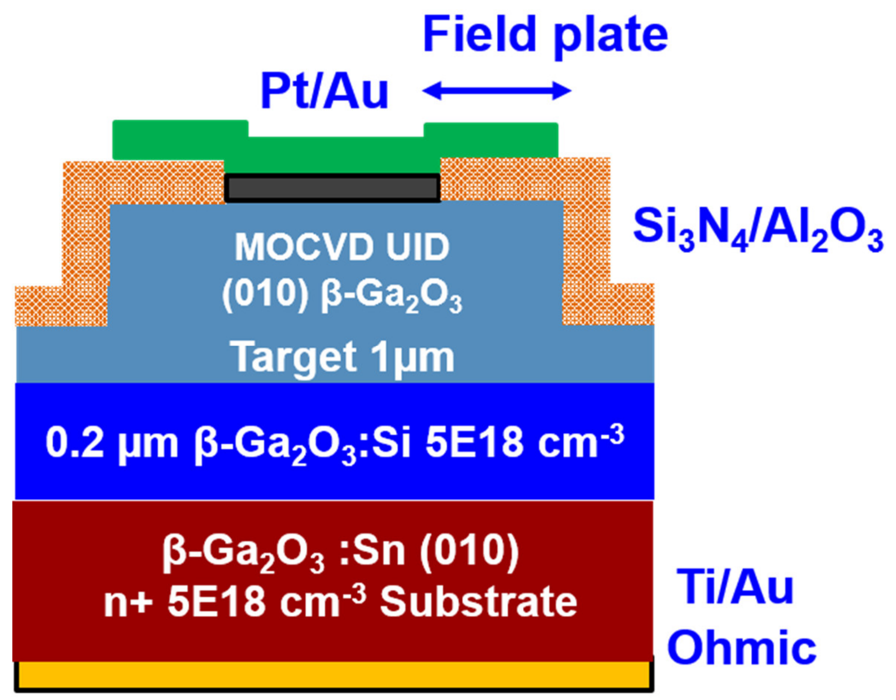


High-quality Schottky diode with unity ideality factor



Schottky barrier height can be modulated with metal choice: Not pinned interface

E. Farzana *et al.*, *Appl. Phys. Lett.*, 110, 202102 (2017). *Editor's Pick*



On-going and Future Works

- High-Power β-Ga_2O_3 devices with field management using field plate and guard rings.
- Develop improved device isolation with acceptors to avoid mesa-etch damages.
- Explore high-κ dielectrics to control breakdown.