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Switching Reliability of Vertical GaN PiN Diodes

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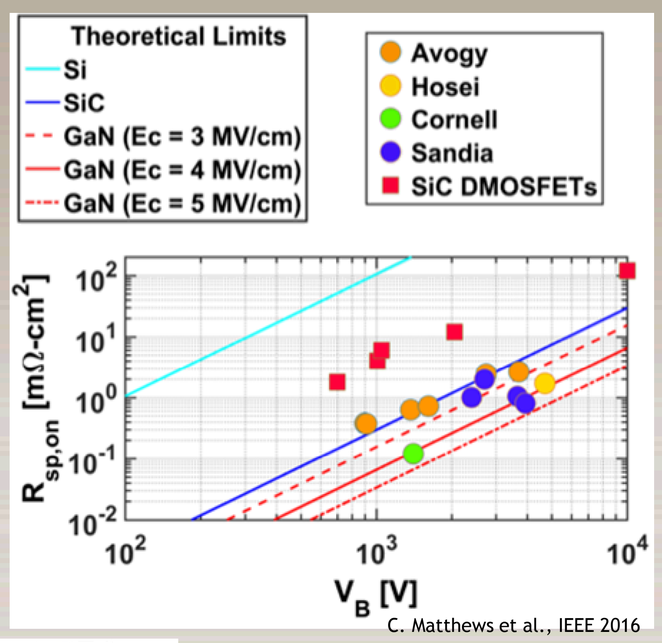
Why Gallium Nitride?



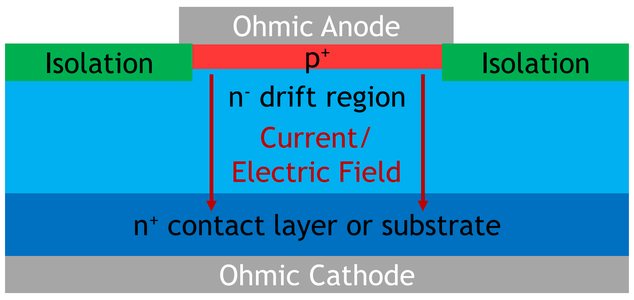
C. Matthews et al., IEEE 2016

Better material → *Improved device performance & efficiency → Reduced passive component & cooling demands →* **Lower overall system cost**

SOA commercial microinverter
250 W in 59 in^3 → 4.2 W/in^3

SNL GaN HEMT microinverter
400 W in 2.4 in^3 → 167 W/in^3

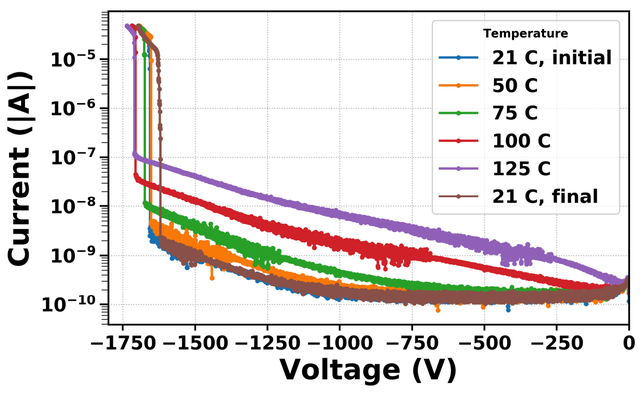
Vertical PiN Diode

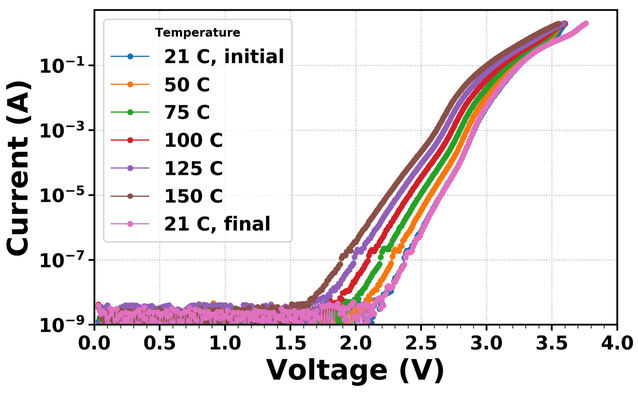


- Vertical structure offers superior electric field control
  - ➤higher voltage and current limits

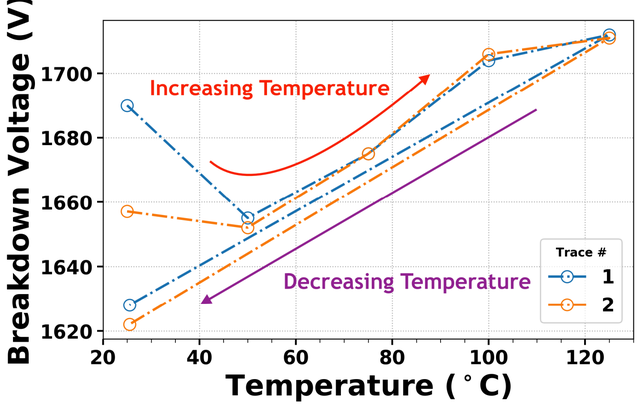
Superior material must translate to both good device behavior and reliability

Current-Voltage Characterization





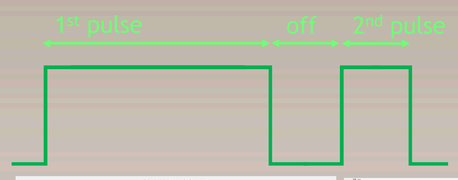
Expected I-V wafer device performance

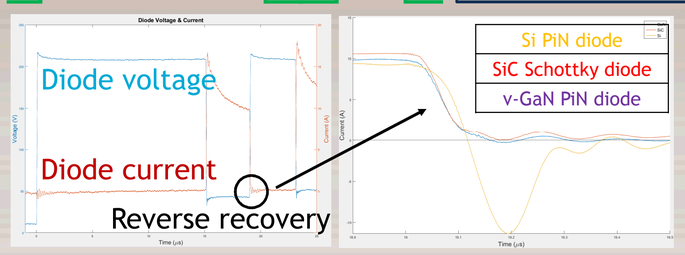


- Positive breakdown coefficient
  - ➤ *avalanche process*
- Breakdown hysterisis
  - ➤ evidence of burn-in effect

Double-Pulse Test Circuit

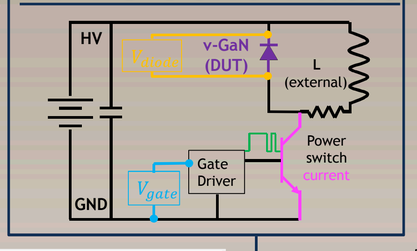
Double-pulse Switching Characterization:



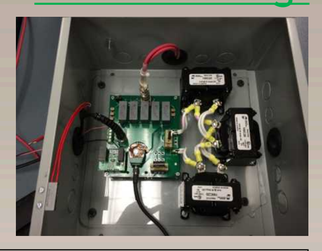


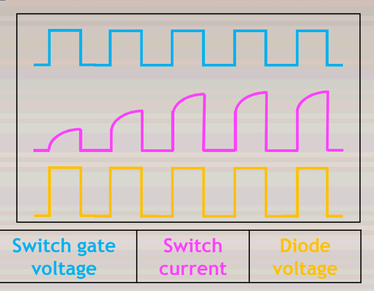
C. Matthews et al., IEEE 2016

DPTC Schematic



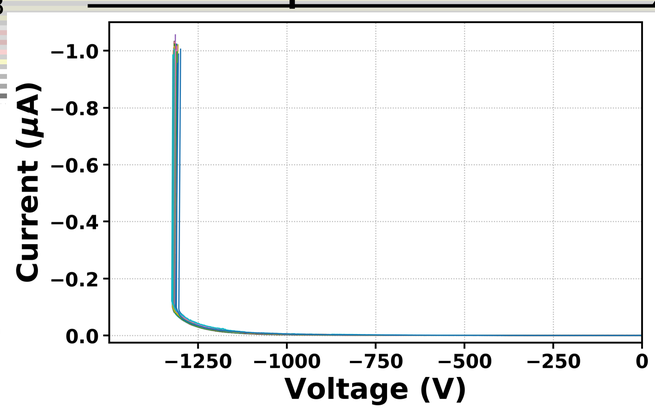
Stress Testing:

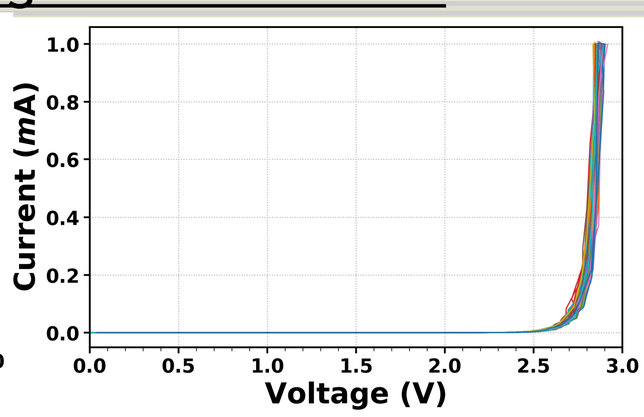




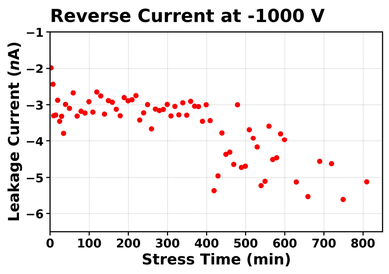
Stress Testing Results

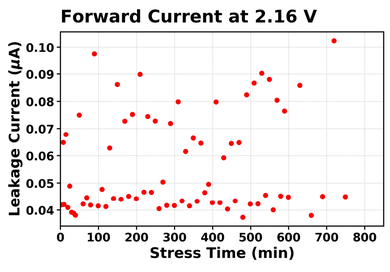
Double-pulse switching stress at -500 V

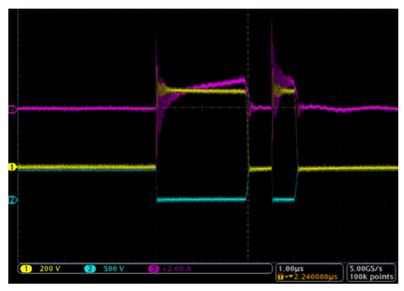




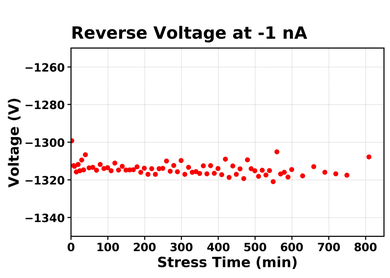
Packaged devices stable for 800 minutes of switching stress:

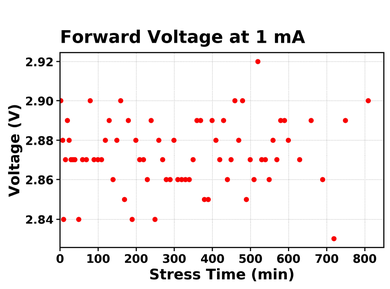


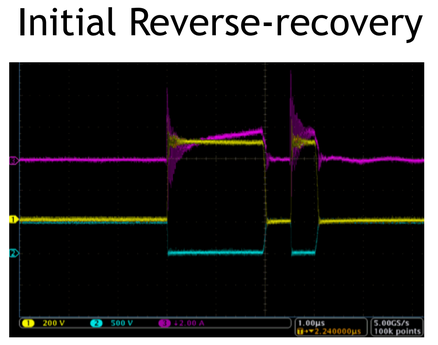




Initial Reverse-recovery







Final Reverse-recovery

Acknowledgments

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