SAND2017-9413PE

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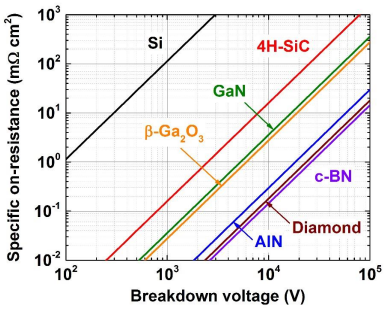

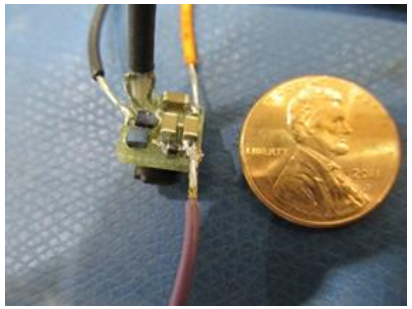

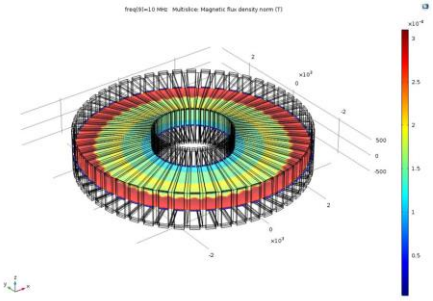

New Ideas for SSL: Integration of III-N LEDs and Power Electronics

Bob Kaplar and Greg Pickrell, Sandia National Labs

DOE SSL Roundtable

August 31, 2017

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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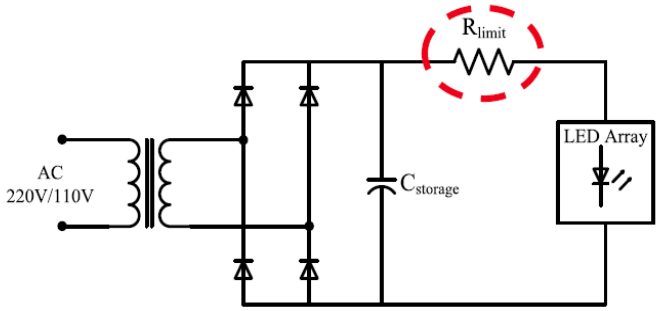
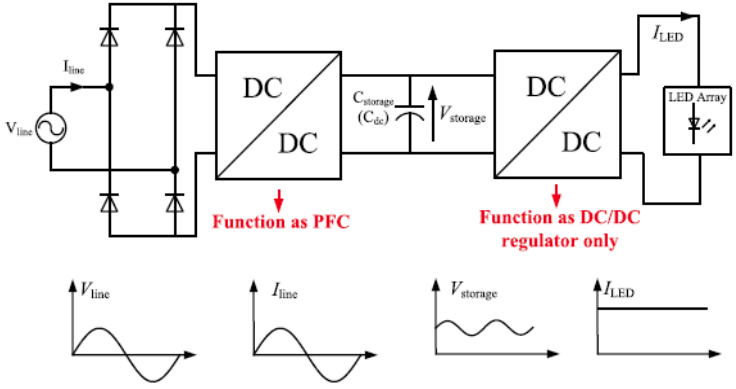
SSL Drivers and Potential Advantages of Integration

Sandia National Laboratories

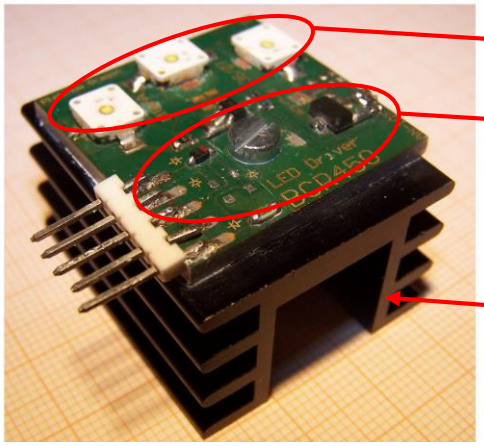
Passive converter



Two-stage switching converter



S. Li et al., Trans. Power Elec. 31(2), 1503 (2016)



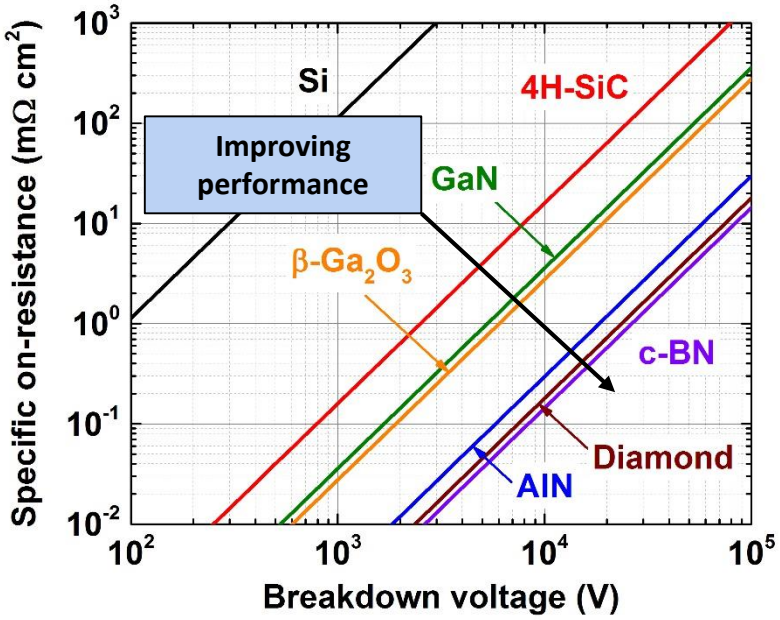
Infineon application note 105

Integration may be advantageous if:

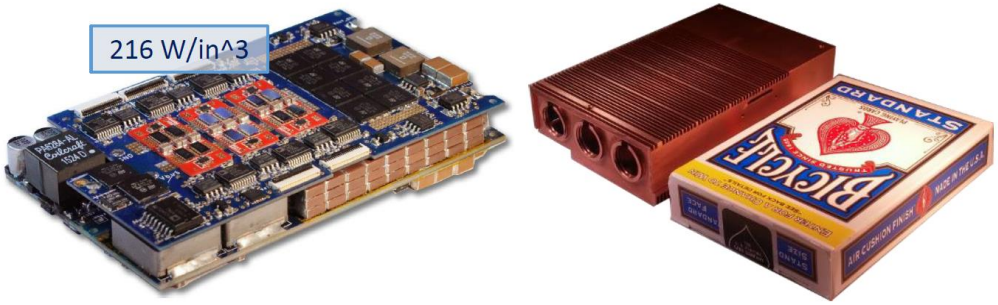
- Small volume and/or high efficiency (low loss = reduced thermal management) are paramount
- Enhanced functionality requiring complex circuitry is required
- Some tolerance for higher cost exists (at least initially – cost may ultimately be lower in the long term)

GaN Power Electronics

Unipolar FOM = $V_B^2/R_{on,sp} = \varepsilon\mu_n E_C^3/4$

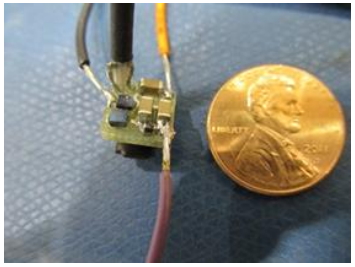


J. Y. Tsao et al., Adv. Elec. Mat. (in press)



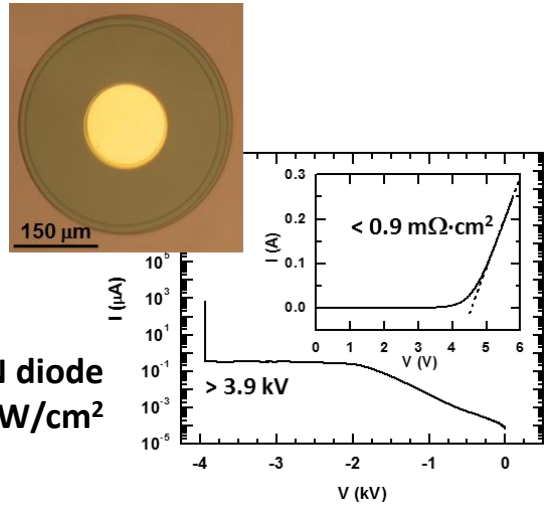
UIUC multi-level flying-capacitor converter using GaN HEMTs:
2 kW, 216 W/in³, > 97% peak efficiency

Y. Lei et al., APEC 2016



SNL "Coin Converter" using GaN HEMTs:
90 V, 90 mA → 215 W/in³

J. Neely



SNL vertical GaN PiN diode
UFOM = 18 GW/cm²

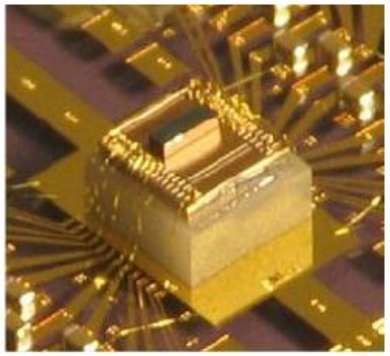
A. Armstrong et al., Elec. Lett. 52(13), 1170 (2016)

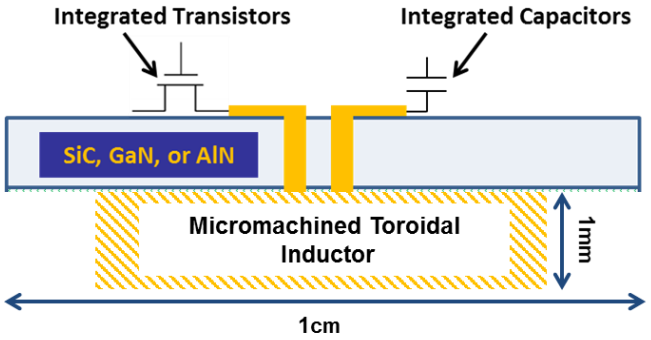
Different Approaches to Integration: Package (Module) and Chip Levels

Sandia National Laboratories

Heterogeneous integration of III-V optoelectronics and Si CMOS

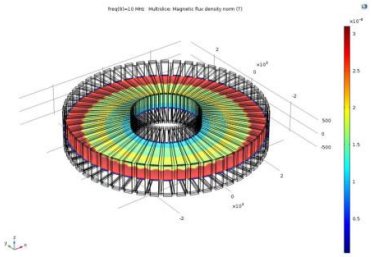
A. Tauke-Pedretti, SNL





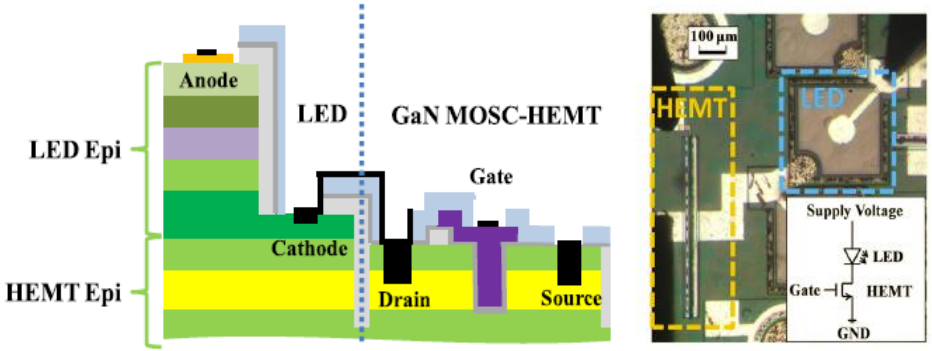
Integration of micromachined nanocomposite magnetics

T. Monson, SNL



Chip-scale integration of GaN LED and HEMT (RPI)

Z. Li et al., Appl. Phys. Lett. 102, 192107 (2013)



Chip-scale integration of GaN power and gate drive HEMTs (Navitas)

M. Giandalia, APEC 2016