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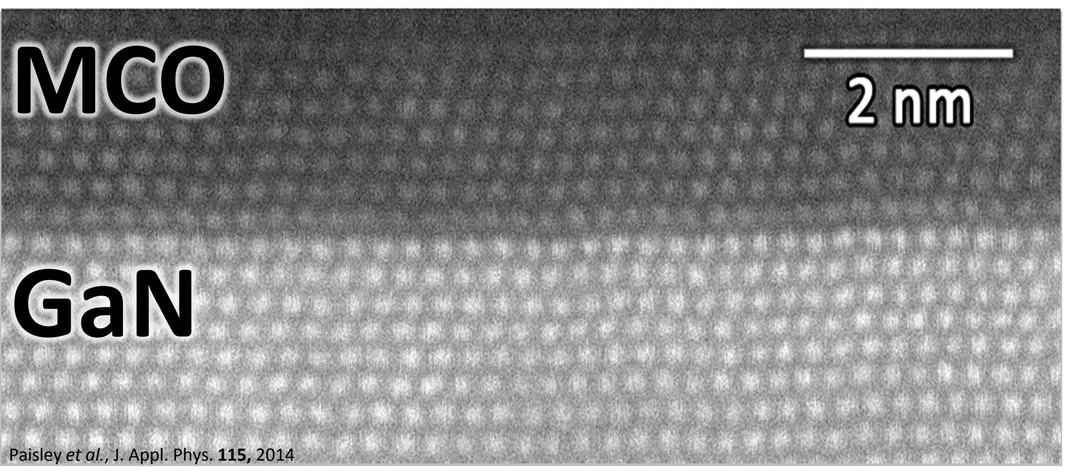
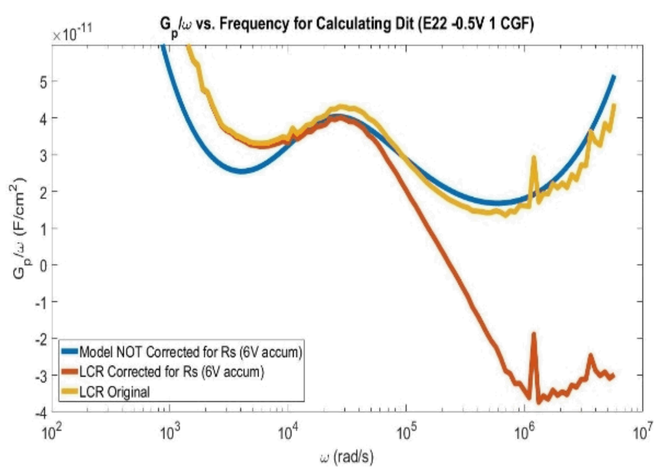
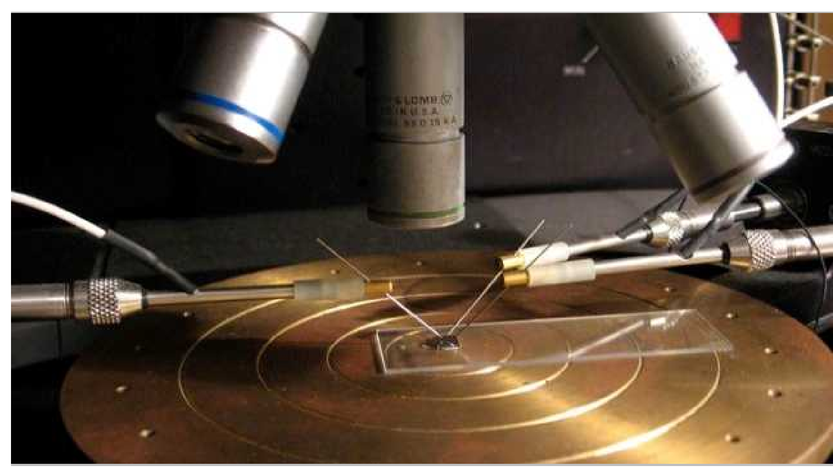


Paisley *et al.*, J. Appl. Phys. **115,** 2014





Gate Oxide Capacitance Characterization for Wide-bandgap Devices

Motivation:

- WBG devices offer system level benefits to power conversion systems (PCS) for grid-tied energy storage systems (ESS)

Objective:

- Reliability is achieved through stability on the atomic level, therefore need cohesive materials, capable of operating under high-stress environments, for WBG devices (SiC, GaN)
- Weak-link for WBG MOSFETs is the gate oxide. Desire high quality oxide material(s) → low interface state density (D_{it})

Accomplishments:

- Reproduced measured D_{it} using quantum-level device physics
- Confirms most effective gate oxide on GaN to date

Potential Impact:

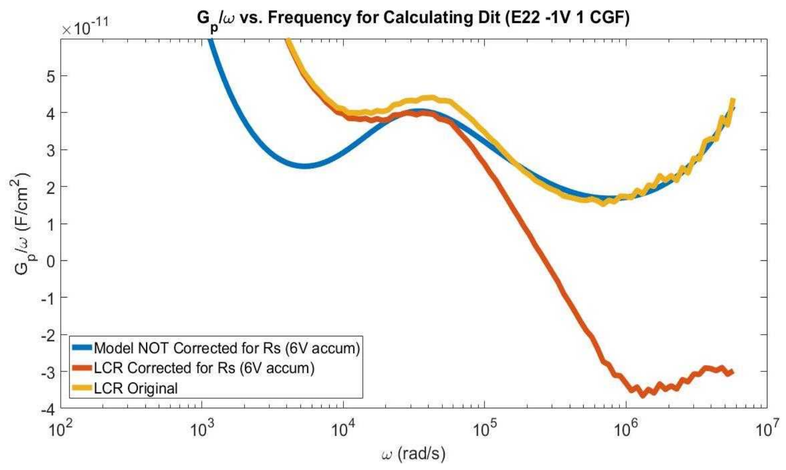
- Offers reliable, intimate control for more robust PCS for ESS

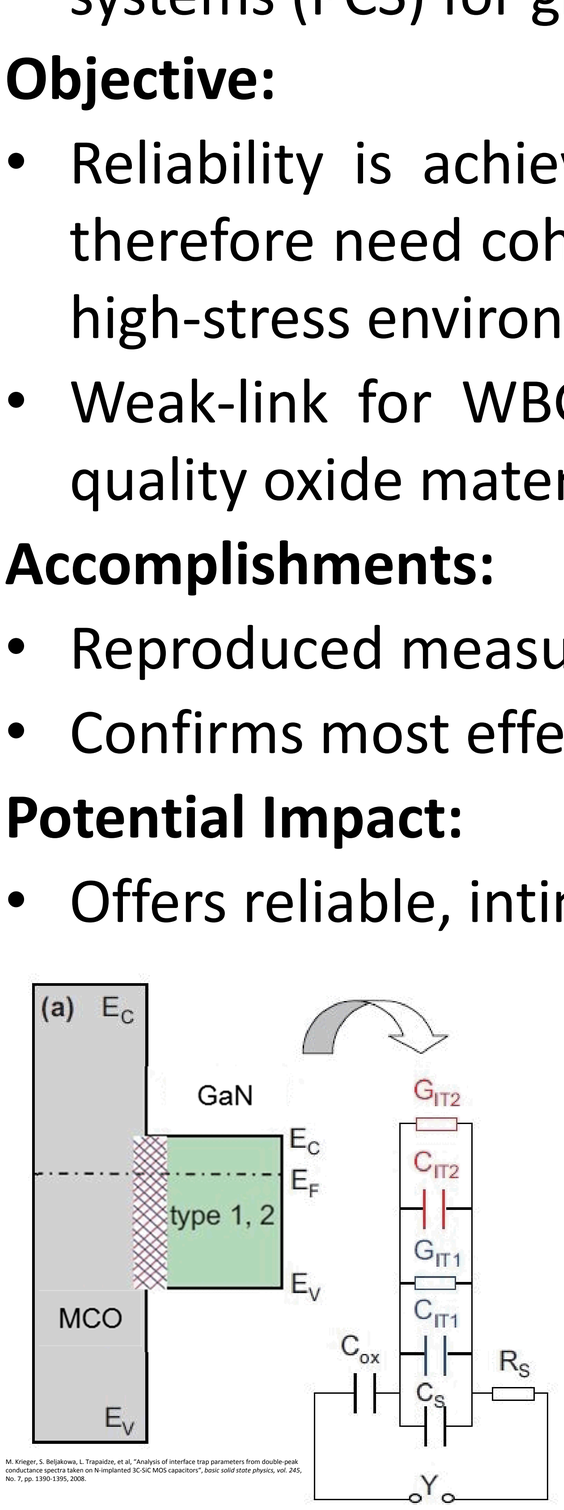
Si-based inverter

SiC hybrid module-based inverter
(40% smaller and lighter)

10 kW - Cost Comparison	Silicon	WBG
Semiconductors	5% of BOM	18% of BOM
Total System	$161.40	$137.19 (15% less)

http://www.powerguru.org/are-sic-solutions-really-still-more-expensive-than-si-solutions-today/





M. Krieger, S. Beljakowa, L. Trapaidze, et al, "Analysis of interface trap parameters from double-peak conductance spectra taken on N-implanted 3C-SiC MOS capacitors", *basic solid state physics, vol. 245,* No. 7, pp. 1390-1395, 2008.

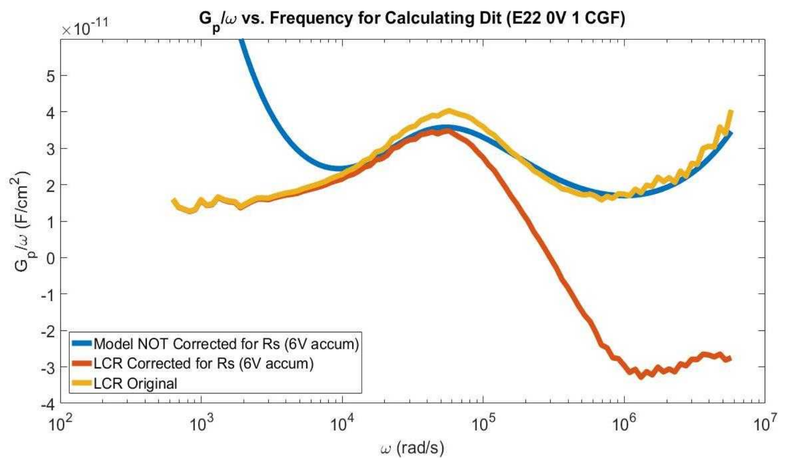
Material Interface	D_{it}(cm^{-2}eV^{-1})
Si / SiO_2	1.4 x 10^{10} [1]
4H-SiC / SiO_2	9.0 x 10^{10} [2]
GaN / MgO	2.7 x 10^{11} [SNL]

[1] Z. Zhuo, Y. Sannomiya, K. Goto, et. al, "Formation of SiO2/Si structure with low interface state density by atmospheric-pressure VHF plasma oxidation," in *Current Applied Physics*, vol. 12, pp. S57-S62, 2012. doi: 10.1016/j.cap.2012.04.015

[2] X. Yang, B. Lee and V. Misra, "Electrical Characteristics of SiO_2 Deposited by Atomic Layer Deposition on 4H-SiC After Nitrous Oxide Anneal," in *IEEE Transactions on Electron Devices*, vol. 63, no. 7, pp. 2826-2830, July 2016. doi: 10.1109/TED.2016.2565665

DC Voltage Bias:	0.0 V
LCR D_{it} (cm^{-2} eV^{-1})	2.74e11
Model D_{it} (cm^{-2} eV^{-1})	3.21e11
% Error	14.64

$$D_{it} = \frac{2.5}{qA} * \left[\frac{G}{\omega}\right]_{max}$$



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