Ultra-Wide Bandgap HFETs for High Power, High Temperature & High Frequency Applications

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MOTIVATION
The present status of advanced communications is confined to low frequencies as a result of incompatible transistor materials at high power, high temperature, and high frequency applications. Ultra-wide bandgap (UWBG) materials have proven to become the new industry standard for such applications, however current research has not made clear specific performance advantages, nor offer an organized resource to device designers and researchers.

RECENT Ga2O3 RESEARCH HIGHLIGHTS
- D-mode planar MOSFETS results in breakdown electric fields of 3.8MV/cm.[1]
- Source-field-plated β-Ga2O3 MOSFETS had BFO in 50.4 MW/cm², J_{ds, sat} of 267/222 mA/mm, and V_{th} of 480/608 V (2321 V in other cases of increased gate-drain length)[1]
- β-Ga2O3 FinFETS reported high current densities of 1kA/cm².[2] Double-sided cooling β-Ga2O3 CAVET results in improved thermal resistance, counteracting effects of poor thermal conductivity.[2]

RESULTS
Schematic cross-section of Si-doped n− β-Ga2O3 CAVET used for 2D Device simulation [3-4]

Joule heat power distribution of CAVET. Displaying heat dissipation due to on-state resistance, as well as concentrated self-heating of the current blocking layers [3-4]

APPLICATIONS
This research will guide the 5G/6G industry into the future, eliminating obstacles that prevented optimization. Moreover, the UWBG materials will contribute to the defense/military, allowing unprecedented advancements.

CONTRIBUTIONS
- Provided a clear and organized master table, comparing UWBG materials properties.
- Proposed recommendation for device designers.
- Conducted unparalleled TCAD simulations based on complementary materials and device specifications.
- Suggested areas of significant and future research.

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METHODOLOGY
- Literature review
- Synopsys Sentaurus Device simulations on 2D HFET structures using accurate material properties
- Verification and extrapolation of published TCAD simulation reports

RELEVANT LITERATURE
[8] https://doi.org/10.1149/2.013097jss