Recent Power Metal-Oxide-Semiconductor Field-Effect Transistor (MOSFET) Test Results

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Acknowledgments

Government:

- Defense Threat Reduction Agency
- NASA/GSFC Radiation Effects and Analysis Group
  - Ken LaBel, Ray Ladbury, Hak Kim, Anthony Phan, Megan Casey, Alyson Topper, Stephen Cox, and Tim Irwin
- NASA/JPL

Industry:

- Aeroflex
- Fuji
- International Rectifier
- Infineon Technologies
- Microsemi
- SEMICOA
- STMicro
- Texas Instruments
- Tower JAZZ
- Vishay Siliconix
Introduction

• NEPP focus: Evaluate alternative power devices for space applications
  – New technologies
  – New suppliers

• This talk:
  – Silicon power MOSFETs – part 1 (GSFC)

• Other talks during this NEPP ETW:
  – Silicon – part 2 (JPL)
  – Gallium Nitride
  – Silicon Carbide
Vishay Commercial n-Type TrenchFET®

• Previous tests of Vishay commercial p-channel 12 V and 200 V TrenchFETs® showed good total ionizing dose (TID) and single-event effect (SEE) performance
  – Data presented at 2011 NEPP ETW

• SUM45N25:
  – commercial 250 V, 45 A, 0.058 Ω TrenchFET®
  – 175 °C junction temperature capability
  – ± 30 V gate rating

Example TrenchFET® cross section.
(From: Vishay Siliconix AN605)
Vishay SUM45N25 Commercial n-Type TrenchFET® TID Results

• **Bias conditions:**
  - On-state: gate-source voltage (Vgs) = 18V; drain-source voltage (Vds) = 0V
  - Off-state: Vds = 190V; Vgs = 0V
  - Unbiased: Vds = Vgs = 0V

• **Dose rate:** 517 rad(Si)/min, with 2.62 rad(Si)/min overnight dose from 7.5 krad(Si) to 10 krad(Si) total dose steps
Infineon Radiation-Hardened n-Type Superjunction (SJ) MOSFET

- Infineon Technologies is first to develop a radiation-hardened version of a superjunction power MOSFET
  - Superjunction process should prove SEE-hardened:
    - Fields develop fairly evenly both laterally and vertically, reducing the peak field strength, thus impact ionization important for single-event burnout (SEB)
    - Reduced field strength + lateral fields reduce peak transient $E_{ox}$ following an ion strike, important for single-event gate rupture (SEGR)

Example superjunction MOSFET cross section.

Device tested: BUY25CS54A
- 250 V, 54 A, 0.030 $\Omega$
- 100 krad(Si) rating

(Infineon Technologies Application Note AN-CoolMOS-CP-01)
Infineon BUY25CS54A n-Type SJ MOSFET TID Results

- **Bias conditions:**
  - On-state: $V_{gs} = 12V; V_{ds} = 0V$
  - Off-state: $V_{ds} = 200V; V_{gs} = 0V$
  - Unbiased: $V_{ds} = V_{gs} = 0V$

- **Dose rate:** 940 rad(Si)/min with lower overnight rates

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**Gate Threshold Voltage**

**Drain Current at 0 Vgs**
SEE Tests

• Planned this summer:
  – Infineon 250 V SJ MOSFET (BUY25CS54A)
  – Aeroflex 250 V vertical MOSFET (VDMOS) (RAD7264)
  – Fuji 500 V VDMOS (JAXA-R-2SK4188)
  – SEMICOA -100 V p-type VDMOS (2N7425)
  – Vishay 250 V trenchFET® (SUM45N25)
  – Tower JAZZ 40 V lateral MOSFET (LDMOS) (test chip)

Stay tuned for these and more test results!