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

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- 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)

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

Example superjunction MOSFET cross section.
(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

![Gate Threshold Voltage](chart1)

![Drain Current at 0 Vgs](chart2)
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!