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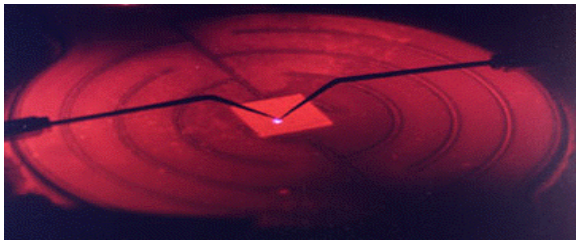
Testing and Modeling Electrical Characteristics of Novel Silicon Carbide (SiC) Static Induction Transistors (SITs)

Why is SiC hot?

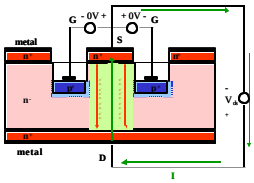


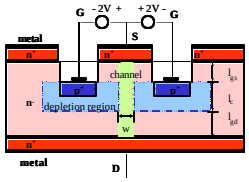
Device operating at 600 ^{0}C! High Temperature and High Power devices (Courtesy NASA Glenn)

Comparison of SiC with other Semiconductor Materials

Property	6H SiC	4H SiC	3C SiC	GaAs	Si
Wide Energy Bandgap (eV)	2.9	3.26	2.2	1.43	1.12
Electric Field Breakdown (◈10^5 V/cm @ 1000V operation)	2.5	2.2	2.0	0.30	0.25
Thermal Conductivity (W/cm ◦C @ Room T)	4.9	4.8	4.9	0.5	1.5
Saturated Electron Drift (◈10^7 cm/s @ E >2◈10^5 V/cm)	2.0	2.0	2.5	1.0	1.0

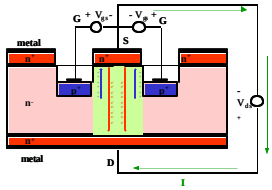
SIT operating in the Unipolar mode

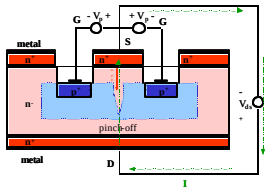




- The electrons are the majority carriers and is the only mechanism of current flow.
- Notice the reduction of the channel width.

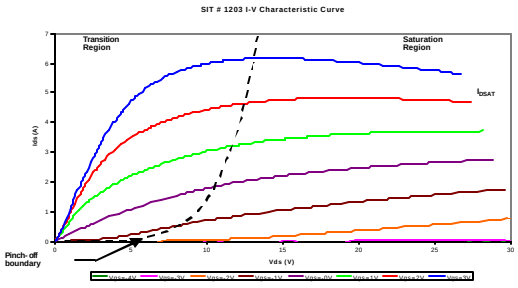
SIT operating in the Bipolar mode



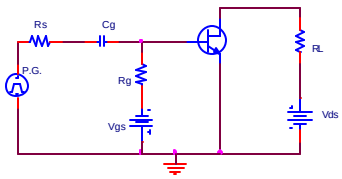


- The gate-source region is forward biased, which in effect is turning on the pn-junction into conduction mode between the p^+ and n^- region.
- In the bipolar mode both electrons and holes conduct.
- The SIT partially conducting with a large drain to source voltage.
- When V_{DS} is very high, the depletion region does not grow parallel, it grows more at the source side than drain.

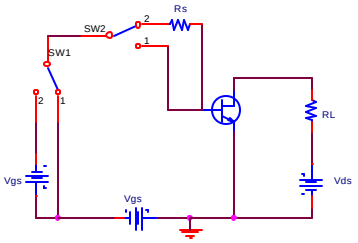
ON-State Characteristic Curve of SiC SIT



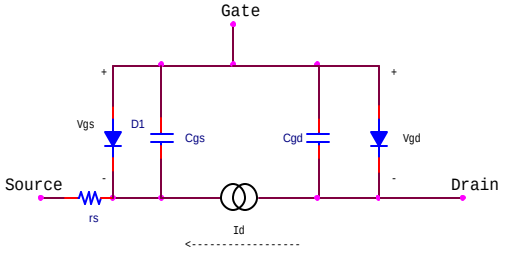
Switching circuit to find the ON resistance



Switching circuit to find the mutual conductance



Equivalent Circuit for the SIT model



SiC SIT Half Bridge (500W) designed by the Uof A SiC Group