Comparison of SiC to other Semiconductors

- Here are some particular noteworthy **SiC** properties in comparsion to those of **GaAs** and **Si**.
  - The data are mostly form Cree Inc.

	6H-SiC 4H-SiC	GaAs	Si	Comments
Bandgap [eV]	3.03 direct	1.4 direct	1.12 indirect	**SiC** devices can operate at rather high temperatures without suffering from intrinsic conduction effects because of the wide energy bandgap. **SiC** can also emit and detect short wavelength light which makes the fabrication of blue light emitting diodes and nearly solar blind **UV** photodetectors possible.
Breakdown Electric Field [MV/cm] (for **1000 V** operation)	2.4×10^6	0.3×10^6	0.2×10^6	**SiC** can withstand a voltage gradient (or electric field) over eight times greater than than **Si** or **GaAs** without undergoing avalanche breakdown. This high breakdown electric field enables the fabrication of very high-voltage, high-power devices such as diodes, power transitors, power thyristors and surge suppressors, as well as high power microwave devices. Additionally, it allows the devices to be placed very close together, providing high device packing density for integrated circuits.
Thermal Conductivity @ RT [W/cm · K]	3.0-3.8 4.9	0.5	1.5	**SiC** is an excellent thermal conductor; at room temperature, **SiC** has a higher thermal conductivity than any metal. This property enables **SiC** devices to operate at extremely high power levels and still dissipate the large amounts of excess heat generated.
Saturated Electron Drift Velocity @ $E \geq 2 \times 10^5$ V/cm) [cm/sec]	2.0×10^7	1.0×10^7	1.0×10^7	**SiC** devices can operate at high frequencies (**RF** and microwave) because of the high saturated electron drift velocity of **SiC**.

- The "**Saturated Electron Drift Velocity**" is a property that we have not dealt with so far. It is easy to understand **-** the name tells it all:
  - The relation between mobility **μ**, drift velocity $\mathbf{v_D}$, and electrical field $\boldsymbol{E}$ was $\mathbf{v_D = \mu \cdot} \boldsymbol{E}$. However, for ever increasing fields, the direct proportionality fails, and $\mathbf{v_D}$ becomes saturated, i.e. does no longer increase with increasing electrical fields.
  - The mobility **μ** then is no longer a useful quantity; we use the saturation electron/hole drift velocity instead. Of course, the maximum speed of devices operated at high field strengths is directly related to this quantity. That is where **SiC** has the advantage; simply comparing mobilities puts **SiC** at an disadvantage.
- Cree concludes: "*The physical and electronic properties of **SiC** make it the foremost semiconductor material for short wavelength optoelectronic, high temperature, radiation resistant, and high-power/high-frequency electronic devices.radiation resistant*".
  - Note that a new property not contained in the table above sort of creeps in: **SiC**, or more to the point, **SiC** *devices* are **radiation resistant**. Moreover (as mentioned elsewhere), they are "rugged", i.e. they can take a lot of mechanical abuse.
  - To put it less euphemistic : **SiC** devices may still work if something (inluding atomic bombs) explodes nearby; in satellites of all kinds, possibly exposed to lots of radiation etc. By now you get the point: **SiC** is of tremendous interest to the military!