Table I. Functions of critical parameters for GaN

Parameter	Desired Characteristic	Advantage
Banddap (Eg) GaN, wurtzite -3.45 eV (hexagonal) GaN, zincblende -3.26 eV (cubic)	Wide GaN:~3x that of Si, ~7% greater than that of SiC	- Less susceptible to thermal runaway - High current-carrying capability - Projects operation at high temperatures - Emission at blue end of spectrum
Breakdown electric field (E_B) GaN, wurtzite – $5x10^6$ V/cm	High GaN: ~16x that of Si, ~2x that of SiC	- Important for high packing densities - Provides lower limit for gate length - Required for high-voltage applications (Rectifiers, thyristors, etc.)
Thermal conductility (σ_T) GaN, wurtzite – 1.3W/cm℃	High GaN: ~2.5x that of GaAs, ~10% less than for Si	- Duty cycles and packing densities (for high-frequency, high-power devices) are proportional to thermal conductility.
Electron saturated drift velocity (V_{sat}) GaN, wurtzite – $2.7x10^7$ cm/sec	High GaN:35% greater than GaAs and SiC (4H and 6H), 2.7x that of Si	- Higher electron saturated drift velocity translates into higher maximum operating frequency
Dielectric constant (K) GaN, wurtzite: 9.5	Low for high-frequency GaN: ~25% less than for GaAs; ~20% less than for Si; slightly lower than for SiC (3C)	- Reduced K requires less time for excited carriers to recombine, providing higher frequency operation

Table II. Comparison of 300 K semiconductor material properties

Property	Si	GaAs	4H-SiC	GaN
Bandgap E_g (eV)	1.12	1.42	3.25	3.40
Breakdown field E_b (MV/cm)	0.25	0.40	3.0	4.0
Electron mobility μ (cm^2/V s)	1350	6000	800	1300
Maximum velocity v_s (10^7 cm/s)	1.0	2.0	2.0	3.0
Thermal conductility χ (W/ cm K)	1.5	0.5	4.9	1.3
Dielectric constant ε	11.8	12.8	9.7	9.0
CFOM $=\chi\varepsilon\mu v_s E_b^2/(\chi\varepsilon\mu v_s E_b^2)_{Si}$	1	8	458	489

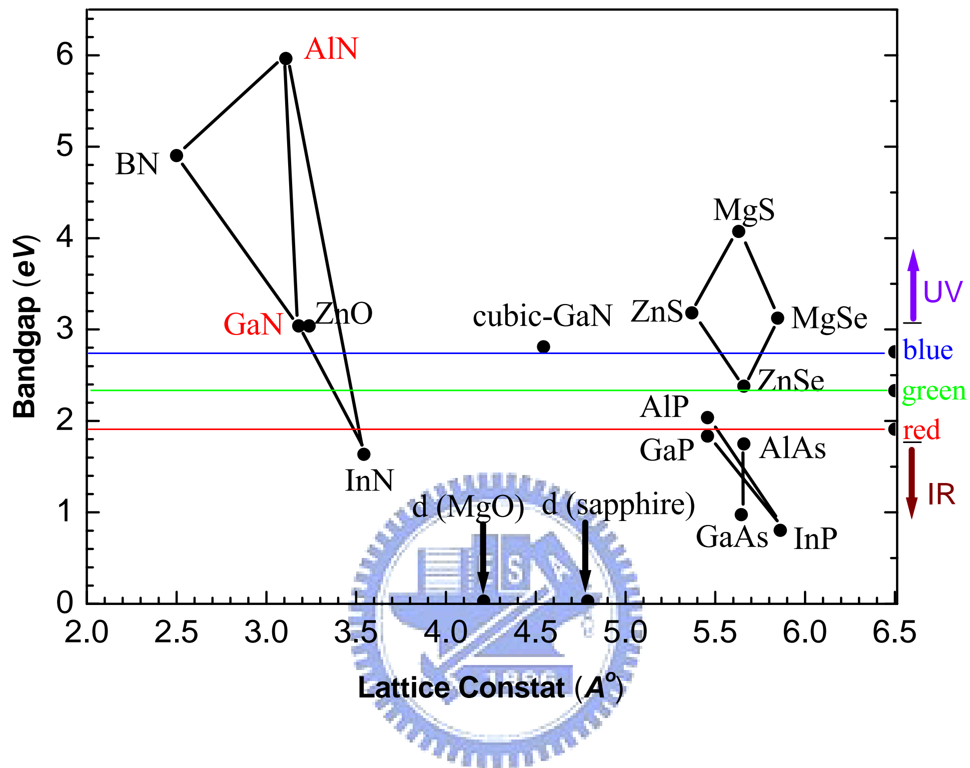

Figure 1-1. Bandgap diagram of III-V compound semiconductors

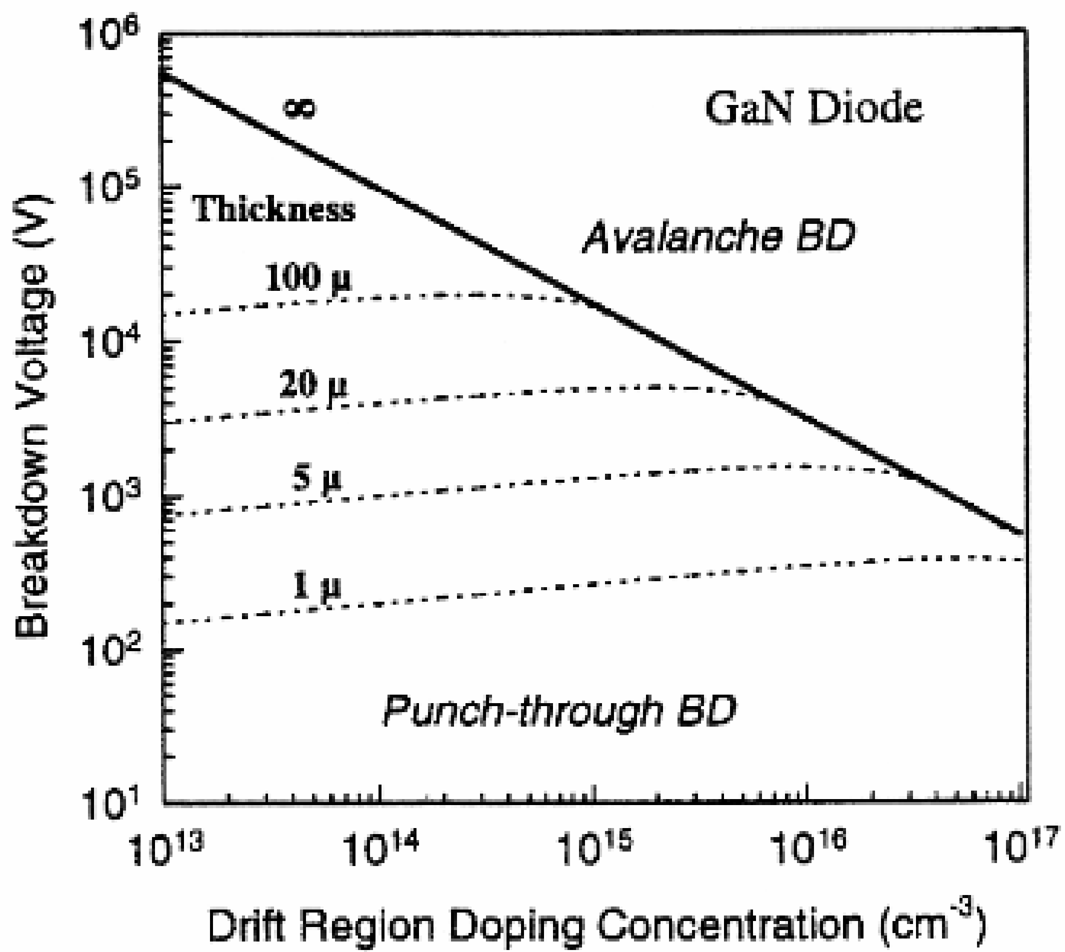

Figure 1-2. Calculated breakdown voltage as a function of doping concentration and thickness of the drift region in GaN $M\text{-}n^{-}\text{-}n^{+}$

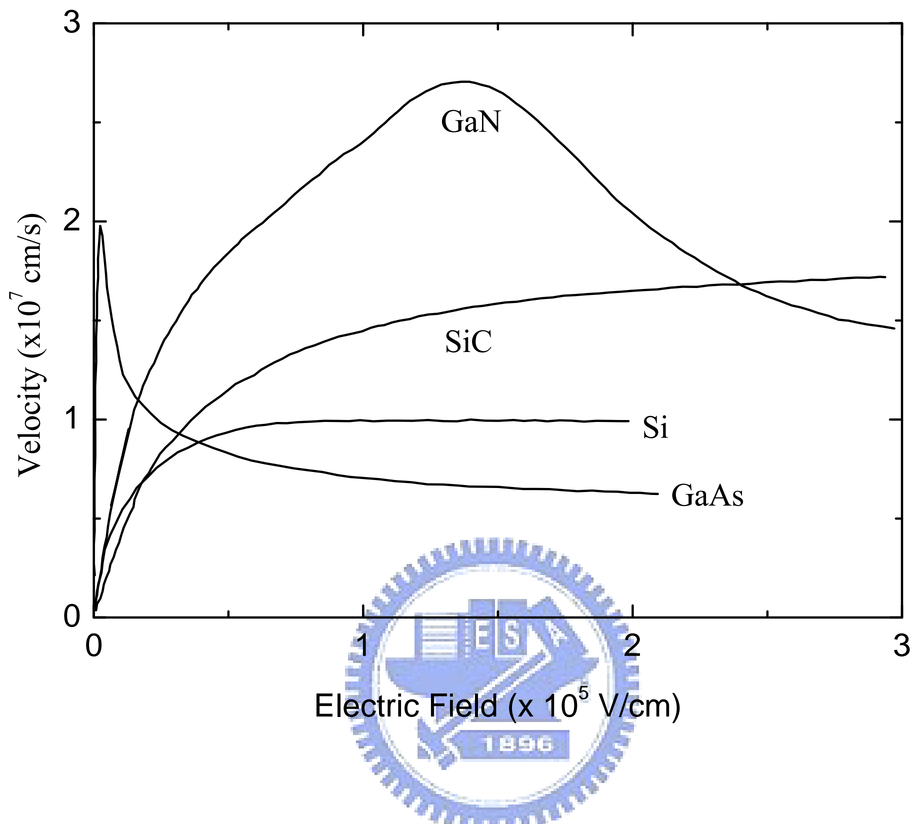

Figure 1-3. Electron drift velocity at 300 K in GaN, SiC, Si and GaAs computed using the Monte Carlo technique.

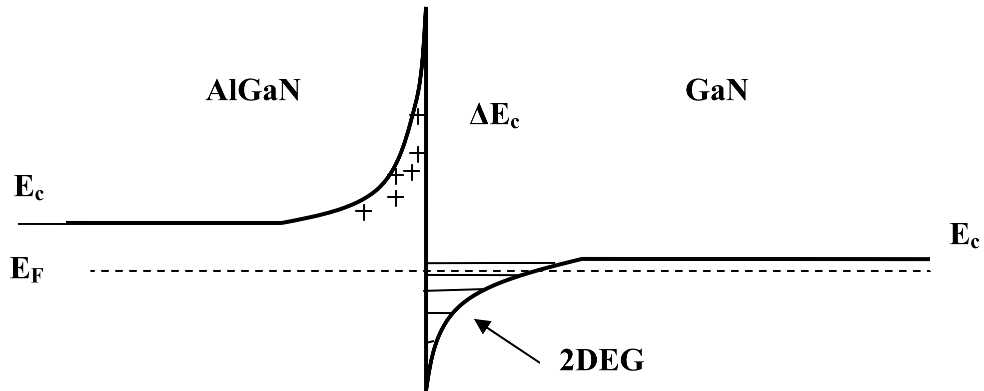

Figure 1-4. Schematic plot of conduction band structure of a AlGaN/GaN heterostructure.