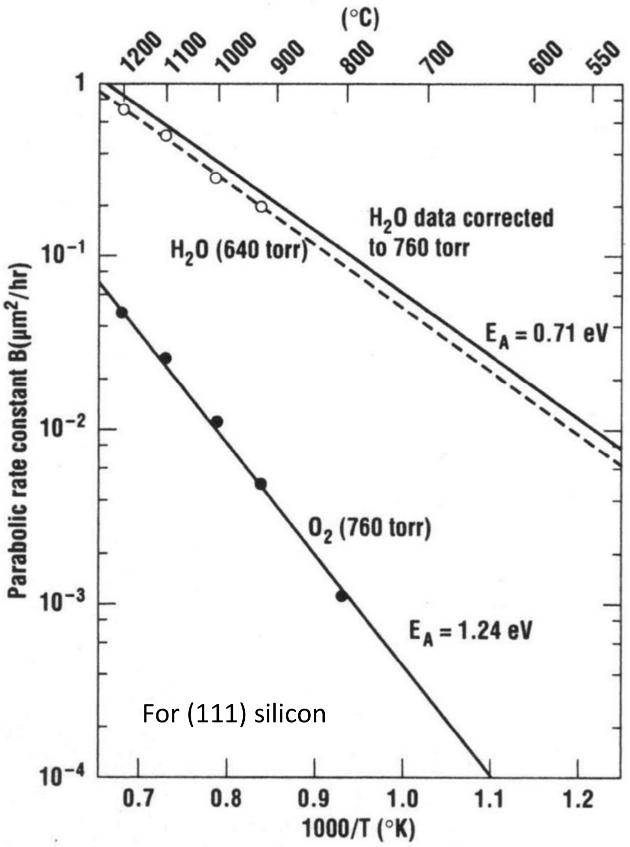

Figure 4.2 Arrhenius plot of the *B* oxidation coefficient. The wet parameters depend on the H_2O concentration and therefore on the gas flows and pyrolysis conditions *(after Deal and Grove)*.

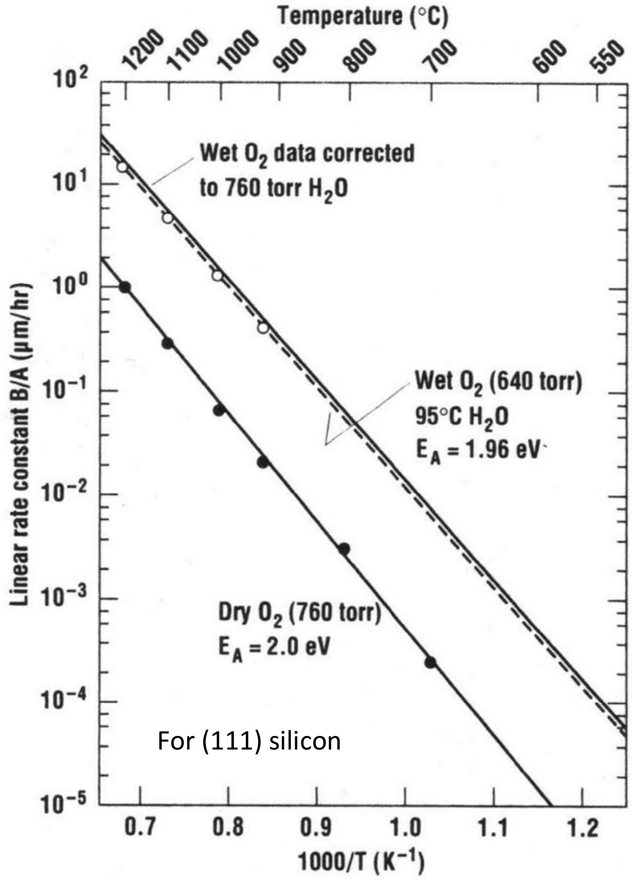

Figure 4.3 Arrhenius plot of the ratio *(B/A)* of the oxidation parameters *(after Deal and Grove)*.

Deal-Grove Model: $t_{ox}^2 + At_{ox} = B(t+\tau), \quad \tau = \frac{t_o^2 + At_o}{B}$

Table and Graphs from S. Campbell, *Fabrication Engineering at the Micro- and Nanoscale*, 3rd edition.

Table 4.1 Oxidation coefficients for silicon - For (111) silicon

	Dry			Wet (640 torr)	
Temperature (°C)	*A* (μm)	*B* (μm²/hr)	*τ* (hr)	*A* (μm)	*B* (μm²/hr)
800	0.370	0.0011	9	—	—
920	0.235	0.0049	1.4	0.50	0.203
1000	0.165	0.0117	0.37	0.226	0.287
1100	0.090	0.027	0.076	0.11	0.510
1200	0.040	0.045	0.027	0.05	0.720

The *τ* parameter is used to compensate for the rapid growth regime for thin oxides. *(After Deal and Grove.)*

Table from S. Campbell, *Fabrication Engineering at the Micro- and Nanoscale*, 4th edition.

$$D = D^o + \frac{n}{n_i} D^- + \left[\frac{n}{n_i}\right]^2 D^{2-} + \left[\frac{n}{n_i}\right]^3 D^{3-} + \left[\frac{n}{n_i}\right]^4 D^{4-}$$

$$+ \frac{p}{n_i} D^+ + \left[\frac{p}{n_i}\right]^2 D^{2+} + \left[\frac{p}{n_i}\right]^3 D^{3+} + \left[\frac{p}{n_i}\right]^4 D^{4+}$$

TABLE 3.2 / DIFFUSION COEFFICIENTS OF COMMON IMPURITIES IN SILICON AND GALLIUM ARSENIDE

		Donors						Acceptors	
		$D_o^=$	$E_a^=$	D_o^-	E_a^-	D_o	E_a	D_o^+	E_a^+
As in Si	D			12.0	4.05	0.066	3.44		
P in Si	D	44.0	4.37	4.4	4.0	3.9	3.66		
Sb in Si	D			15.0	4.08	0.21	3.65		
B in Si	A					0.037	3.46	0.41	3.46
Al in Si	A					1.39	3.41	2480	4.2
Ga in Si	A					0.37	3.39	28.5	3.92
S in GaAs	D					0.019	2.6		
Se in GaAs	D					3000	4.16		
Be in GaAs	A					7e − 6	1.2		
Ga in GaAs	I					0.1	3.2		
As in GaAs	I					0.7	5.6		
Si in GaN	D					6.5e-11	0.89		
Mg in GaN	A					2.8e-7	1.9		

Si and GaAs data taken from Runyan and Bean [3] and references quoted therein. GaN data is taken from Jakiela [4] and Benzarti [5]. Donors are labeled with a "D," acceptors with an "A," and self-interstitials with an "I." All preexponentials are in centimeters squared per second, and the activation energies are in electron-volts.

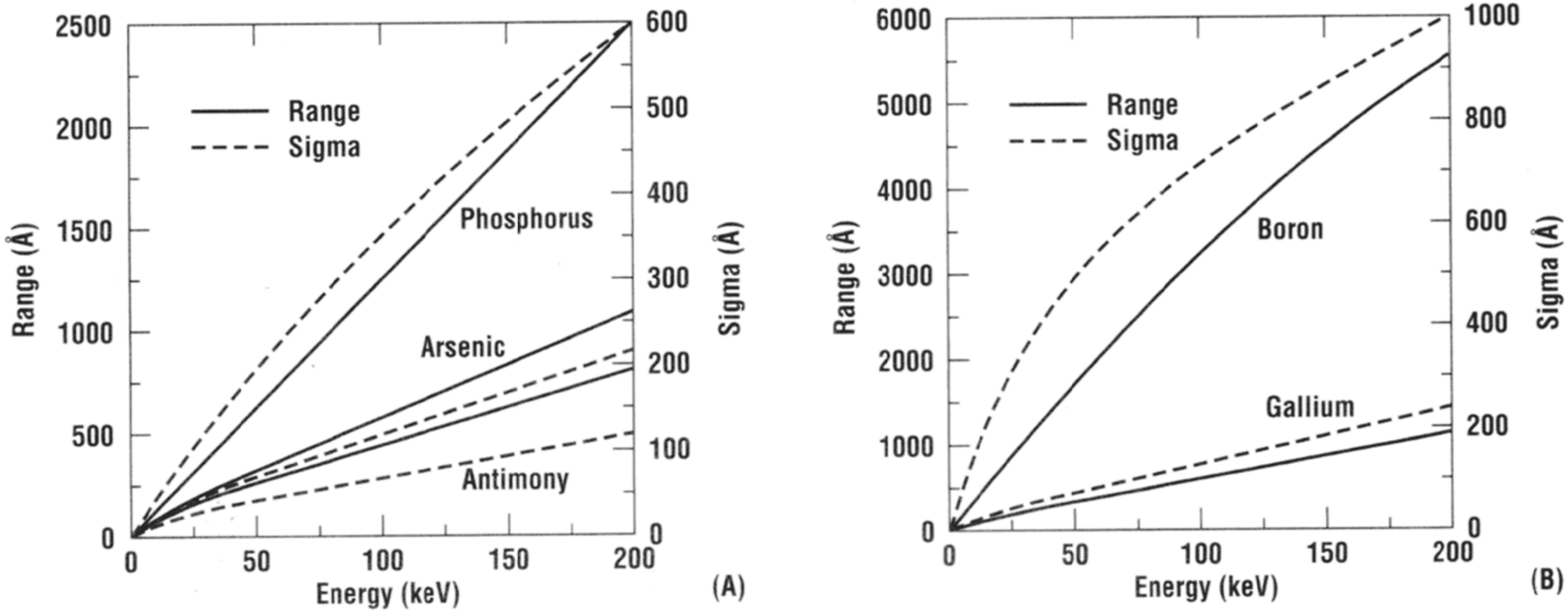

Figure 5.9 Projected range (solid lines and left axis) and standard deviation (dashed lines and right axis) for (A) n-type, (B) p-type, and (C) other species into a silicon substrate; (D) n-type and (E) p-type dopants into a GaAs substrate; and several implants into (F) SiO_2 and (G) AZ111 photoresist *(data from Gibbons* et al.).

Useful Constants

Avogadro Constant (N_A)	6.02204 X 10^{23} $mole^{-1}$
Boltzmann Constant (k)	1.38066 X 10^{-23} J/K 8.617 X 10^{-5} eV/K 1.3626 X 10^{-22} atm-cm^3/K
Gas Constant (R)	1.987 cal/mole/K
Electric Charge (q)	1.60218 X 10^{-19} C
Permittivity in vacuum (ε_o)	8.854 X 10^{-14} F/cm
Thermal voltage at 300 K (kT/q)	0.0259 V

Constants for silicon at 300 K:

Bandgap (E_g)	1.107 eV
Effective Density of States	N_c = 2.8 X 10^{19} cm^{-3}, N_v = 1.0 X 10^{19} cm^{-3}
Carrier Mobility	μ_n = 1500 cm^2/Vs, μ_p = 450 cm^2/Vs
Relative Dielectric Constant (permittivity)	11.7
Density (ρ)	2.328 g/cm^3
Atomic Density	5 X 10^{22} cm^{-3}
Atomic Weight	28.09 g/mole
Intrinsic carrier concentration (n_i)	1.5 X 10^{10} cm^{-3}

Unit Conversions

Pressure: 1 atm = 1.01325 ×10^5 Pa = 1.01325 bar = 760 torr = 14.696 psi
(1 Pa = 1 kg/(m·s^2) = 1 N/m^2)

Energy: 1 J = 1 kg m^2/s^2 = 9.4782 ×10^{-4} Btu = 6.2415 ×10^{16} eV = 0.23901 cal = 1 A V s = 1 W s

Capacitance: 1 F = 1 A s/V = 1 C/V = 1 s/Ω