Baliga’s FOM

\[ B^n_B = \frac{\varepsilon E_{crit}^2}{2V_{BV}} \quad (\text{max doping density to have } E_{max} \leq E_{crit}) \]

\[ R_{onsp} = \frac{2V_{BV}}{M_n^2} \sqrt{\frac{1}{\varepsilon E_{crit}^2}} = \sqrt{\frac{2V_{BV}}{M_n^2 E_{crit}^2}} \]

"Ideal" specific on-resistance

Baliga’s Figure of Merit

Note: Impact Ionization

\[ \alpha = \text{Impact Ionization coefficient} \left( \frac{1}{\text{cm}} \right) \]

Empirically modeled as

\[ \alpha = K_1 \varepsilon^2 \]

Definition of Breakdown:

\[ \int_0^E \alpha \text{d}x = 1 \]

From our analysis:

\[ E = \frac{k_B T}{e} X + \frac{8nV_B}{e} \]

\[ 1 = \int_0^E k_1 \left( \frac{k_B T}{e} X + \frac{8nV_B}{e} \right) \text{d}x \]

Plug in: \( E_{max} = \frac{8nV_B}{e} \)
Ideal Specific On-Resistance

Baliga, B. J., "Advanced Power MOSFET Concepts"

WBG Materials

Example: \( \text{R}_{\text{on,sp}} \cdot C_{\text{sp}} \) (nF x 10^16/cm^2)

from Si \( \rightarrow \) GaN

\( \text{R}_{\text{on,sp}} \cdot C_{\text{sp}} \rightarrow 5 \times 10^7 \) improved
Resistance Contributions Vs. Voltage

Figure 9. Relative Contributions to $R_{\text{ON,sem}}$ with Different Voltage Ratings.

V. Barkhordarian et al. “Power MOSFET Basics”

Resistance Contributions

A. Lidow er al. “The Semiconductor Roadmap for Power Management in the New Millennium”