

2-D Electric Field

insulator

$Q = \beta q N w$

$E_y = \alpha E_c$

$E_x = \frac{V}{l_x}$

$E_g^2 = E_x^2 + E_y^2$

@ Breakdown $E_c^2 = E_x^2 + (\alpha E_c)^2$

$E_{x,max} = \frac{1}{\alpha} E_c$

$V_{BV} = \frac{\alpha E_c W}{2} + E_x l_x$

Design so that $\frac{\alpha E_c W}{2} \ll E_x l_x$

$V_{BV} \approx E_x l_x$

$R_{onSP} = \rho l_x = \frac{1}{\mu_n n_0 \beta} l_x = \frac{1}{\mu_n n_0 \beta} \frac{V_{BV}}{\alpha E_c} = \frac{V_{BV} W}{\mu_n \alpha E_c^2 l_x} = \frac{2V_{BV} W}{\mu_n \alpha E_c^2}$

$\max(\alpha, 1-\alpha^2) \rightarrow \alpha \approx \frac{1}{\sqrt{2}} \rightarrow 0.5$

T. Fujihira, "Theory of Semiconductor Superjunction Devices"

SJ MOSFET Experimental Potential

(a) $V_{DS} = 40\text{ V}$

(b) $V_{DS} = 60\text{ V}$

(c) $V_{DS} = 100\text{ V}$

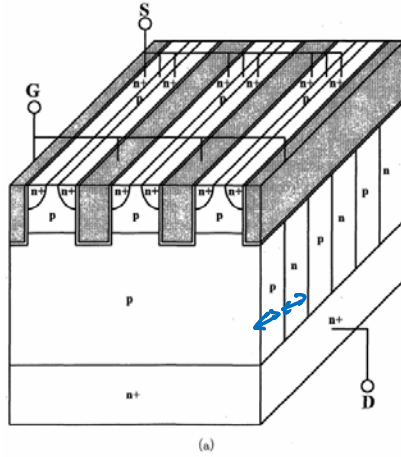
(d) $V_{DS} = 200\text{ V}$ for $V_{GS} = 0\text{ V}$

Fig. 3. Potential contours in the CoolMOS structure for (a) $V_{DS} = 40\text{ V}$, (b) $V_{DS} = 60\text{ V}$, (c) $V_{DS} = 100\text{ V}$, and (d) $V_{DS} = 200\text{ V}$ for $V_{GS} = 0\text{ V}$.

P. Kondekar et al., "Study of the Degradation of the Breakdown Voltage of a Super-Junction Power MOSFET due to Charge Imbalance"



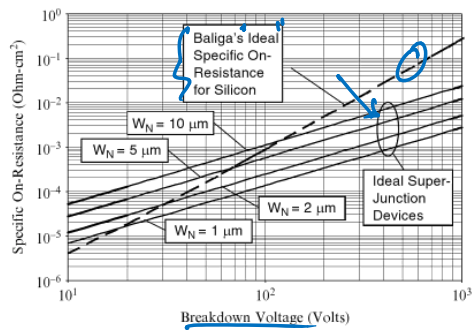
Surpassing "Ideal" $R_{on,sp}$



T. Fujihira, "Theory of Semiconductor Superjunction Devices"



Charge Coupled FOM



Baliga, B J, "Advanced Power MOSFET Concepts"