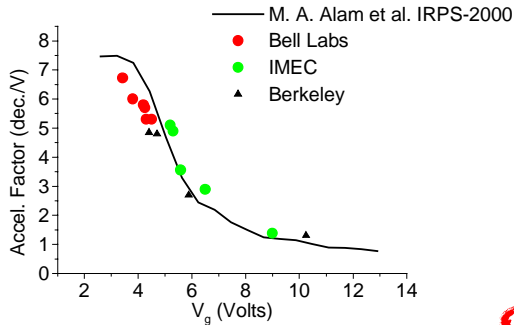


Voltage Acceleration



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Anode-Hole Injection Model Provides Simplest Explanation for the Following:

- 1. Voltage Acceleration Increases with Lower Voltage**
- 2. Field Acceleration Appears to go from $1/E$ to E**
- 3. Voltage Polarity Asymmetry (Due to Minority Ionization)**
 Q_{BD} depends more on E_F difference (V_G) than on interface elec. energy
- 4. N-Poly, $V_G > 0$: Reduced Poly Doping Effect**
 Lower interface, same total elec. energy & lower E_{OX} , but Q_{BD} decreases.
- 5. Damage Acceleration due to N-well Bias**
 Same interface elec. energy, same E_{ox} , but $T_{BD} \downarrow$ with N-well bias
- 6. Shift to Hard Breakdown due to N-well Bias**
 Same interface elec. energy & E_{ox} , but hard bd. frac. \uparrow with N-well bias

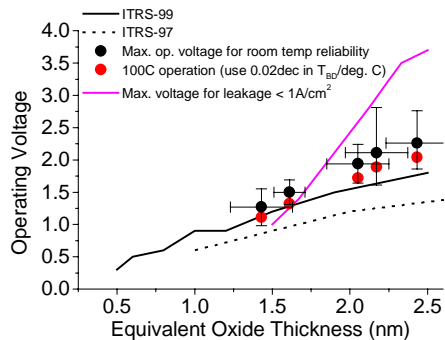
From J. D. Bude et al. SISC 1999
and M. A. Alam et al. IRPS 2000

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Leakage & Reliability--Similar Limits



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Possible Reasons Why We May Scale Beyond 1.6nm:

- Design changes which allow higher leakage
- Refinement of oxide growth techniques, e. g. N-incorporation
- Soft Breakdown -- allowing for new reliability specifications

Possible Reasons Why Not:

- Leakage-current limits
- Plasma damage
- Boron-penetration
- Voltage overshoot
- Possible remote gate scattering?
- Drive current increase may not be attainable through t_{ox} reduction
 $[Mobility \propto 1/(Effective\ Field)^2]$
- Not cost-effective to meet thickness margin requirements

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