

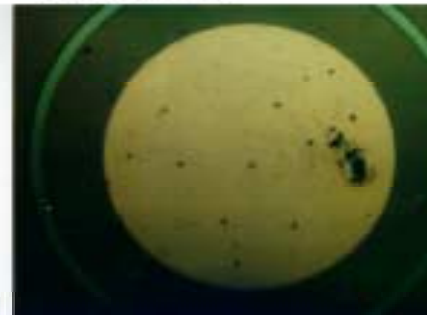


before stress

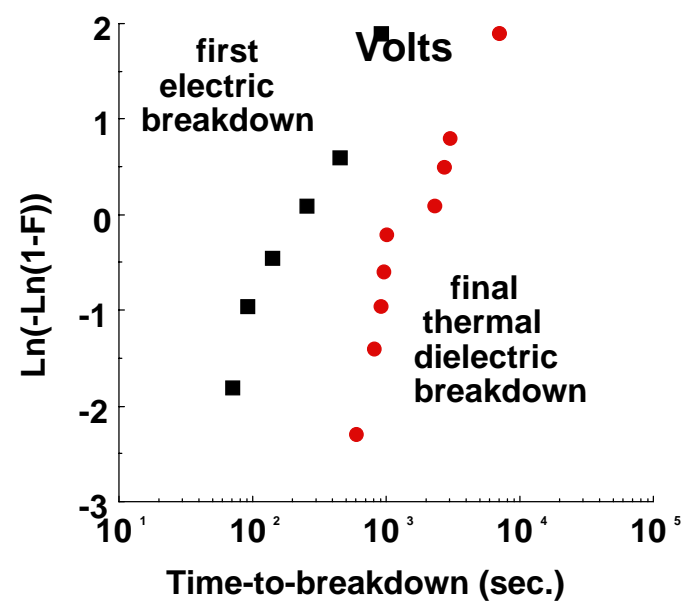
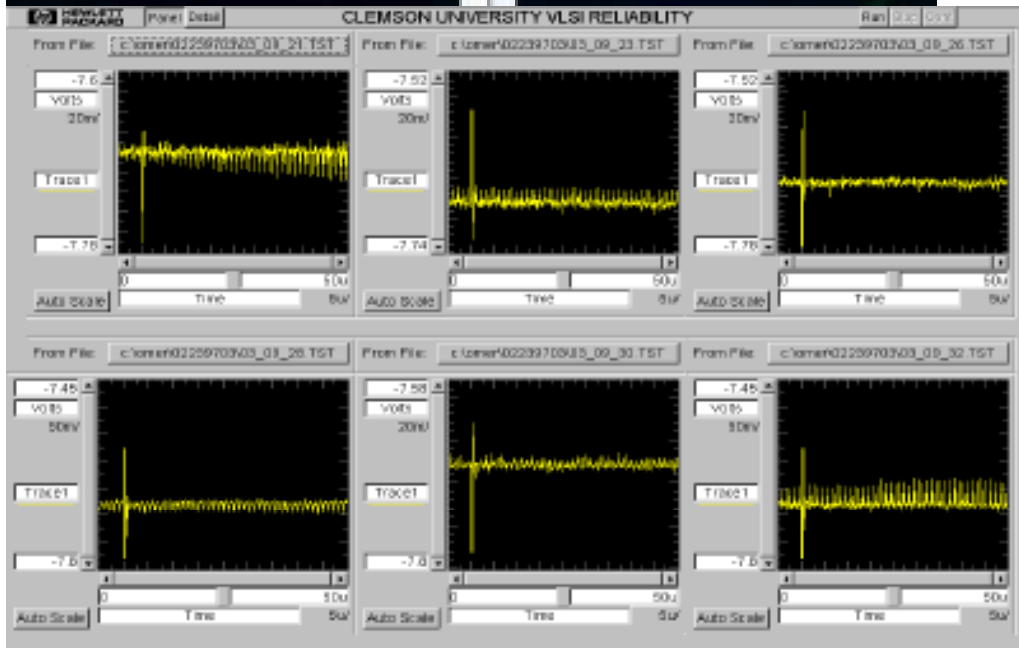
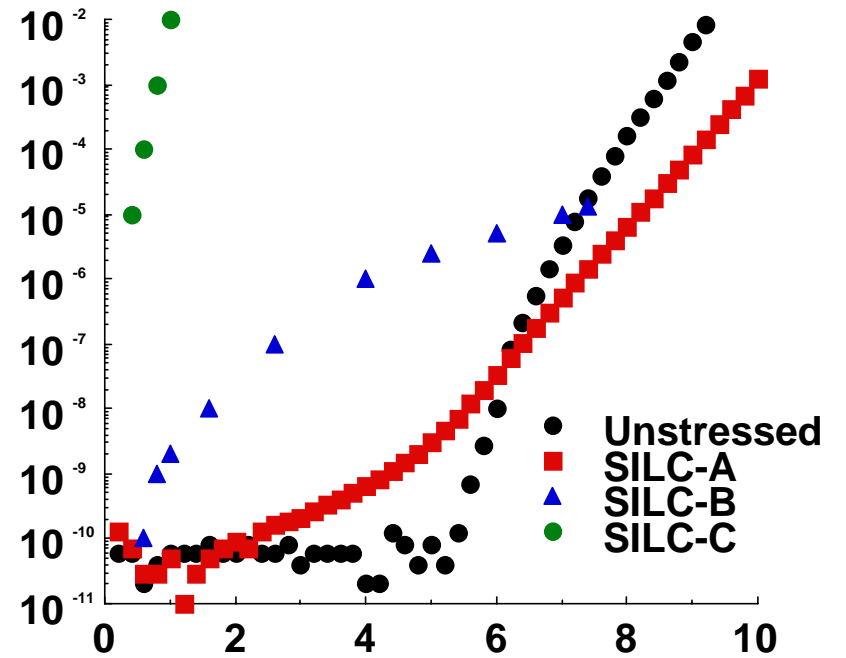
one spot

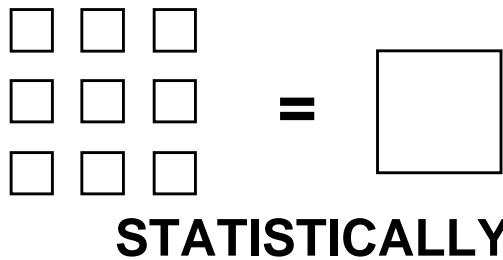
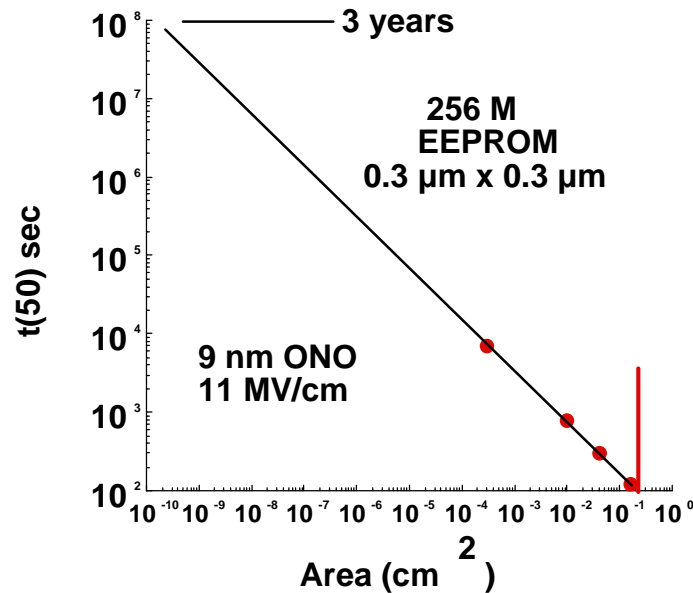
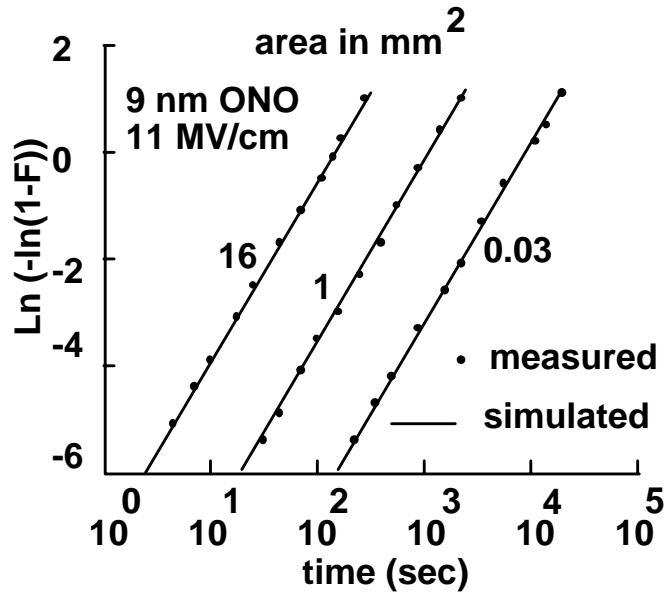
several spots

immediately prior to breakdown

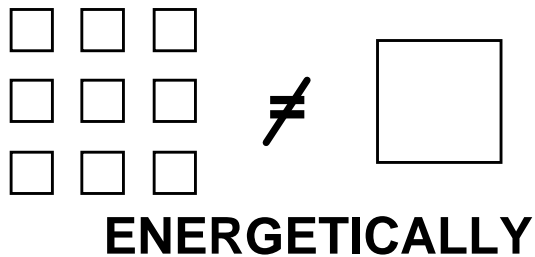


Current Density (A/cm²)





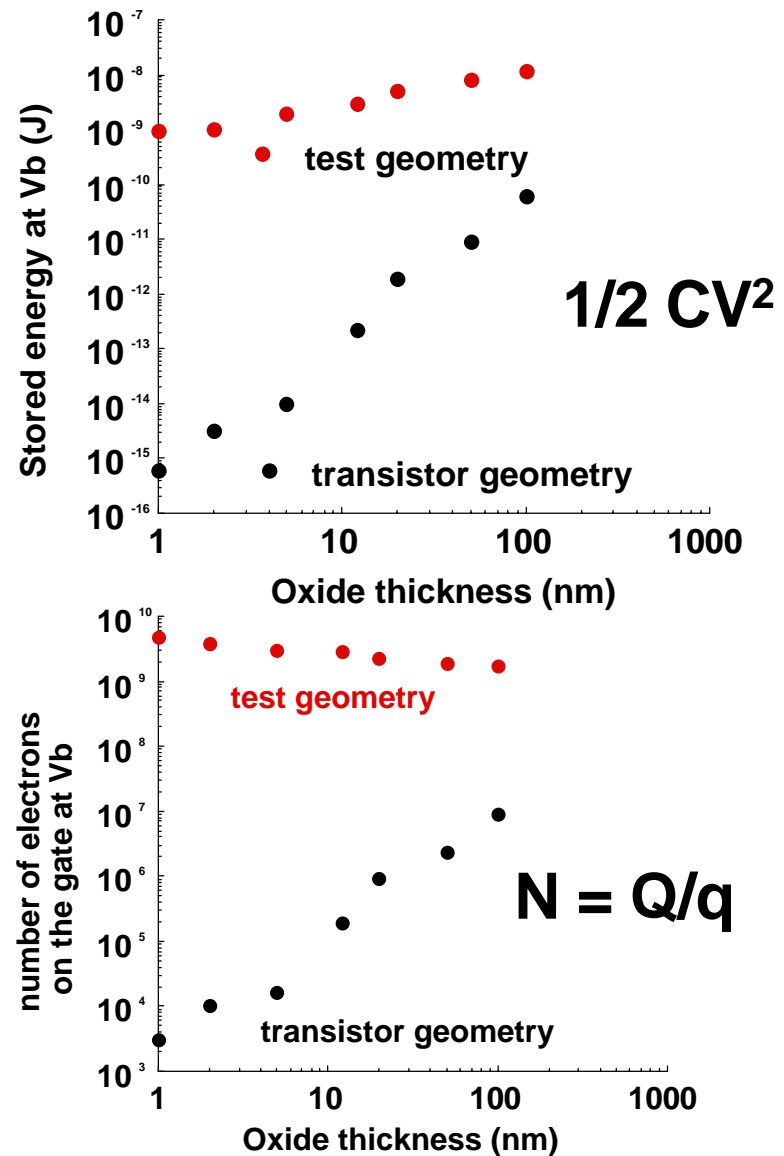
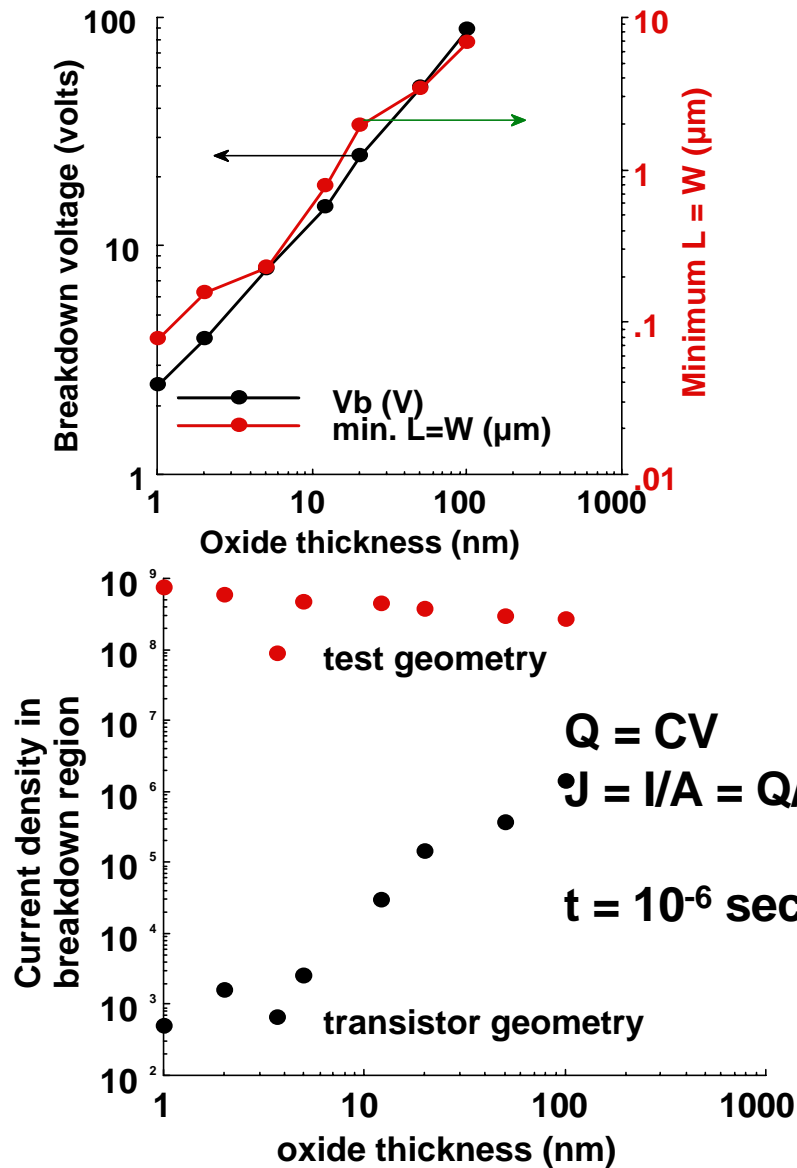
9 (1x1) = 1 (9x9) statistically



$1/2 CV^2 = 1/2 \epsilon A/t_{ox} V V = 1/2 \epsilon A E_{ox} V$
are not the same

• Breakdown may be proportional to V if the breakdown is thermally driven

• Will breakdown occur if the device is small and the stored energy is small?



Calculations done at the breakdown voltage Test geometry = 10^{-4} cm²
 Real geometry = $L \times W$ (minimum) Area of breakdown region = 10^{-12} cm²

OXIDE WEAROUT, BREAKDOWN, RELIABILITY IS IC SCALING LIMITED BY OXIDE RELIABILITY?

Yes, if your business is producing test structures.

No, if your business is producing minimum geometry transistors and integrated circuits.

Not enough stored energy or enough electrons on a node to trigger thermal (dielectric) breakdown.

Quasi-breakdowns may be important, I think.

**OXIDE INTEGRITY WILL ALWAYS LIMIT YIELD AND
RELIABILITY**