



EM Methodology Summary

Device Reliability, APTD

APTD

Advanced Process Technology Development

Electromigration Methodology

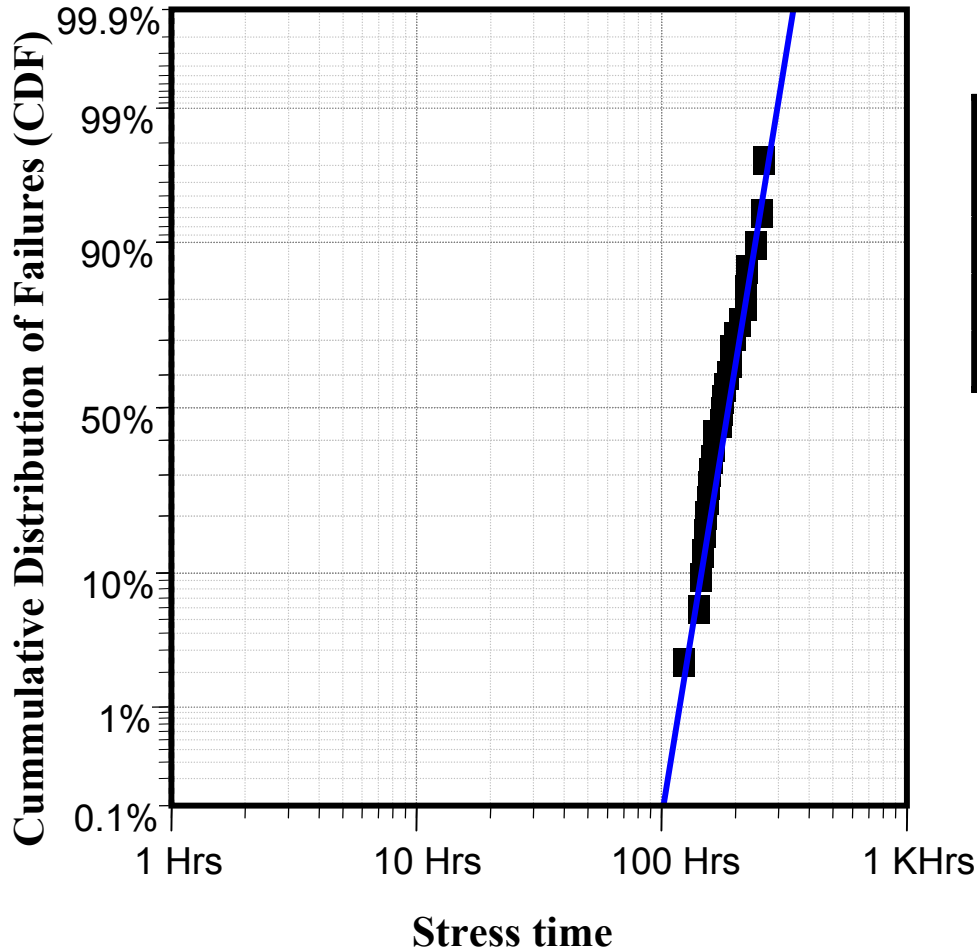
- **A Variety of different metal stripes, contact chains and via chain test structures are stressed at constant current density.**
- **800um long NIST test structure for Metal lines.**
- **Voltage is continually monitored and resistance is calculated.**
- **Failure criteria is resistance increase by 20% for metal lines and 100% for via/contacts. Time to failure is recorded.**
- **Using distribution of failure times t_{50} and $t_{0.01}$ % are calculated.**
- **Time-to-fail is extrapolated to use conditions using Black's equation:**

$$MTF = A \cdot j^{-n} \cdot \exp\left(\frac{E_a}{kT}\right)$$

A : Constant independent of Temp. and J
n : Current density exponent, 2.0
Ea : Activation Energy, 0.7 eV

- **Specification is less than 0.01% cum.failures at 10yrs of normal use at:
85°C, 5×10^5 A/cm²**
- **Electrical design rule guidelines are provided for designers to extrapolate lifetimes to higher temperatures and longer lifetimes, if necessary.**

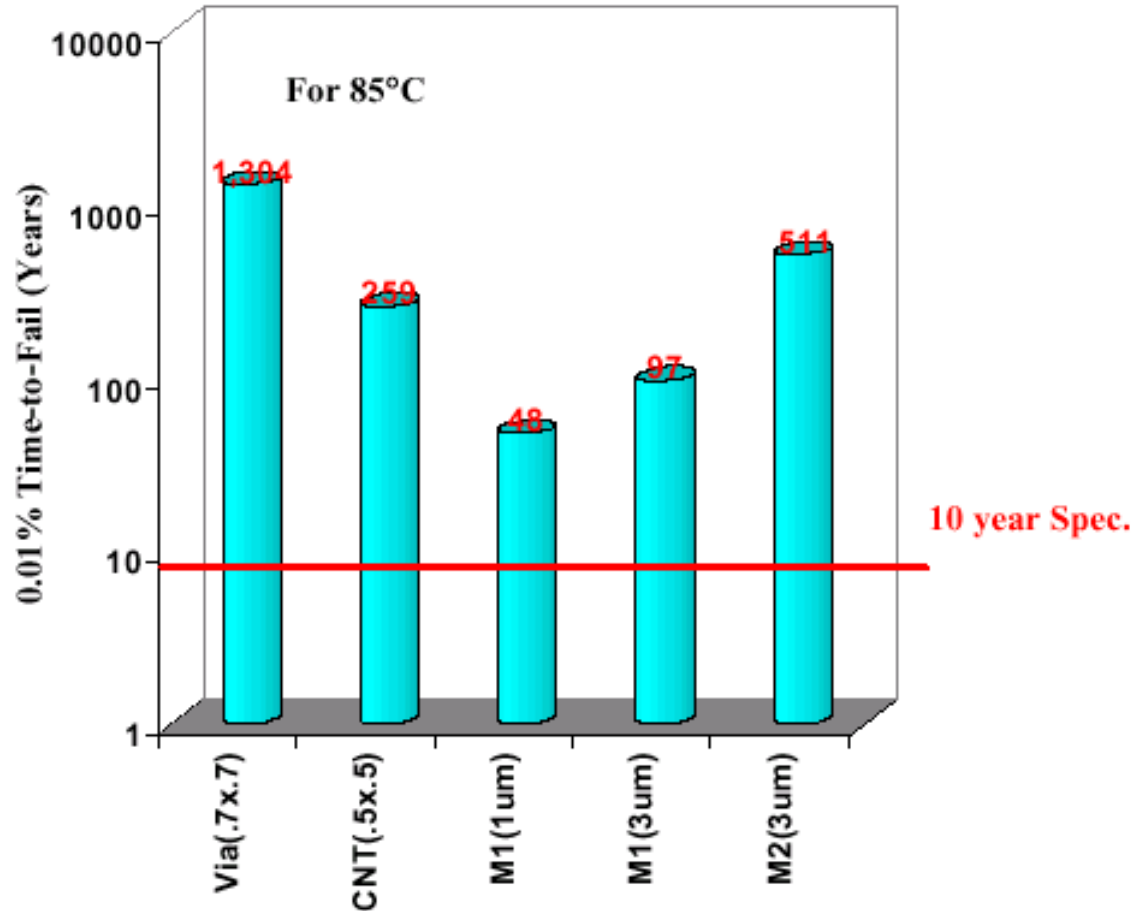
Typical EM Data



	175°C (T1)	200°C (T2)	225°C (T3)
1MA/cm ² (J1)		J1, T2	
1.5MA/cm ² (J2)	J2, T1	J2, T2	J2, T3
2MA/cm ² (J3)		J3, T2	

Annotations: A purple dashed line with arrows points from the J2, T1 and J2, T2 cells to the text "Calculate Ea". A red dashed line with arrows points from the J1, T2 and J2, T2 cells to the text "Calculate n".

Typical EM data (for a NSTE Process)



Typical Contact/VIA EM Lifetime @ $t_{0.01\%}$ monitoring Data (Sample from NSME Process)

