Electronic Components

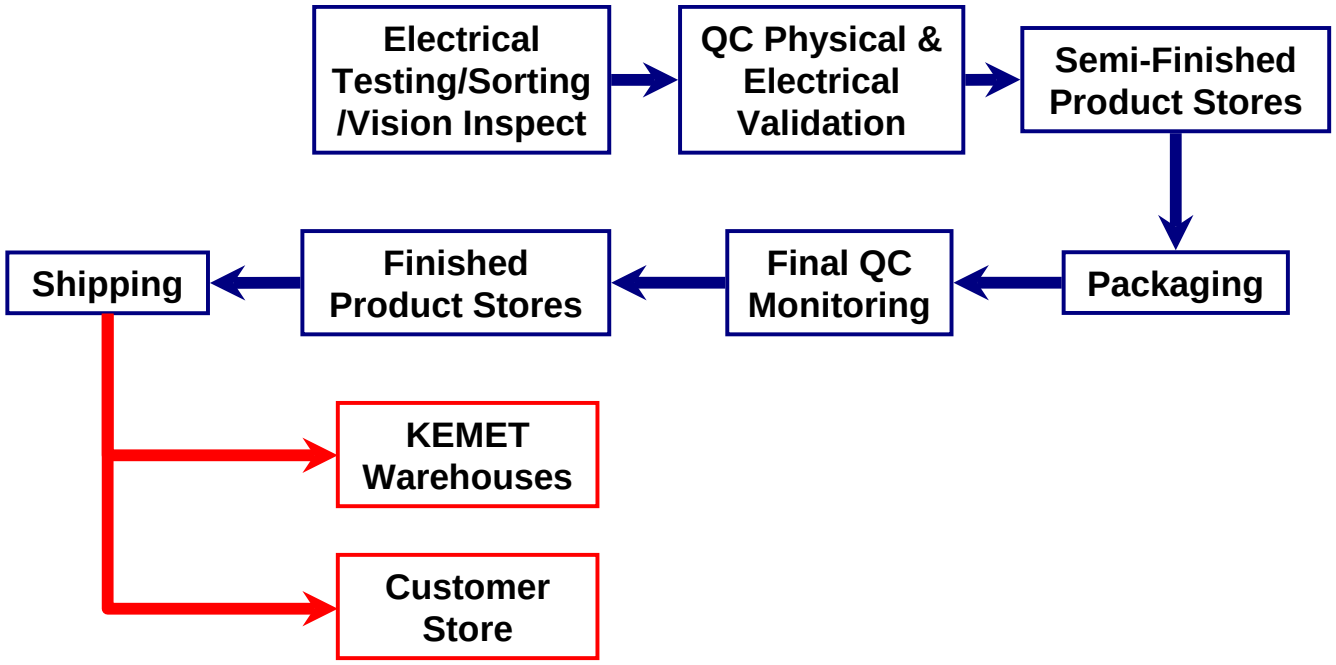
KEMET

CHARGED.®

Ceramic Capacitors (MLCCs)

Design and Characteristics

Test/ Sort/ Packaging/ Shipping



Electrical Sort

Vision Sort

Tape & Reel

All KEMET MLCCs are 100% Screened

- **Cap / %DF / IR / DWV**
- **Vision**

Electronic Components

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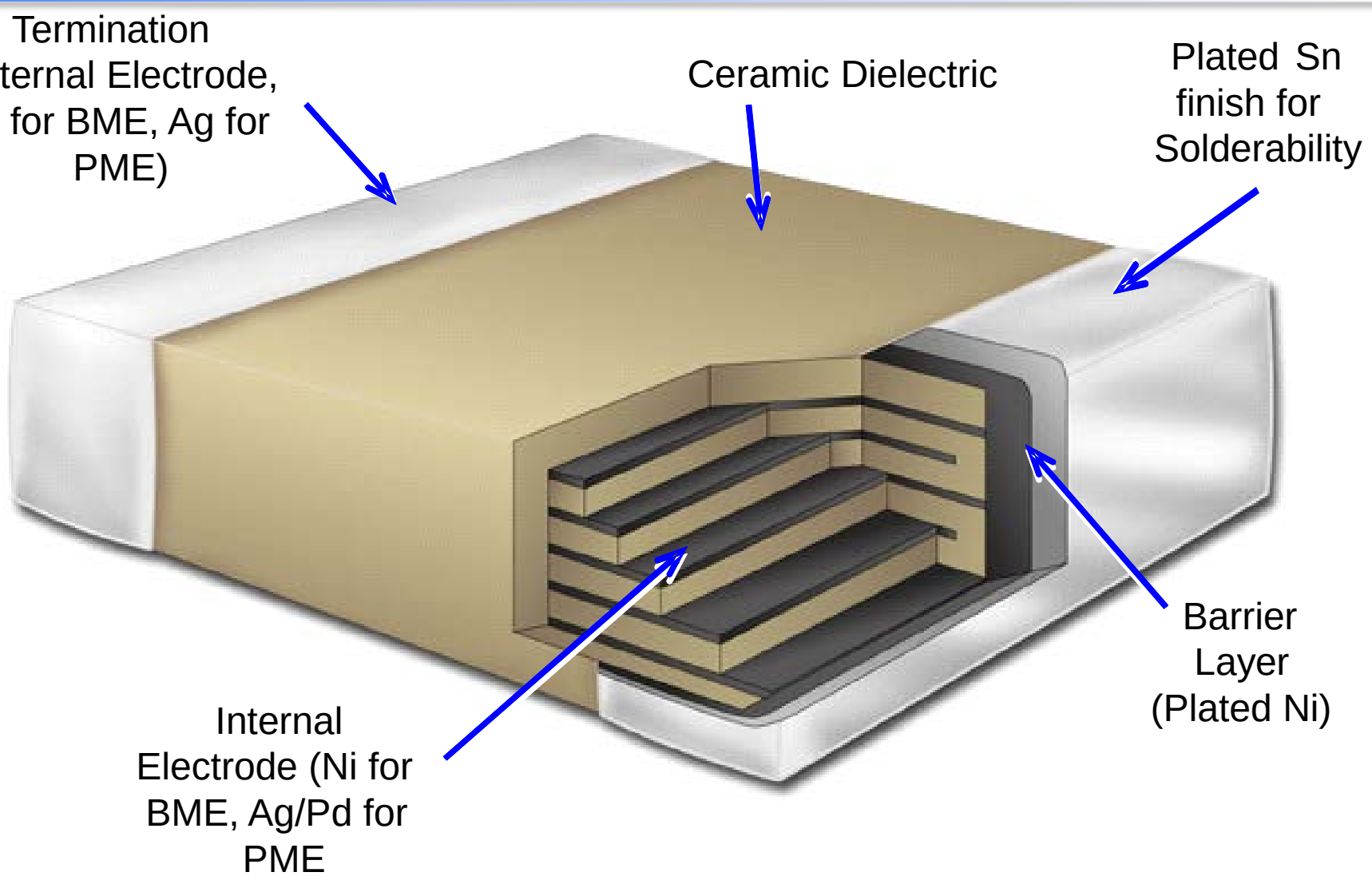
Ceramic Capacitors
Flex Cracking

Multilayer Ceramic Capacitor (MLCC)



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Typical Crack Signatures
MLCC Cross-Sections

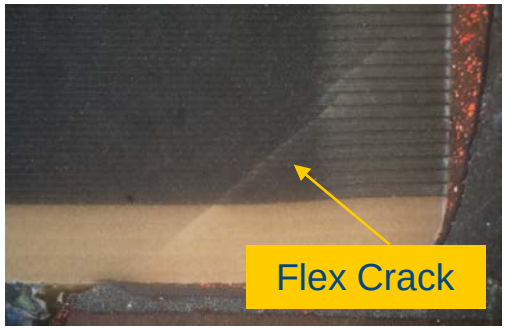
The major sources MLCC of cracks are:

- Mechanical damage (impact)
  - Aggressive pick and place

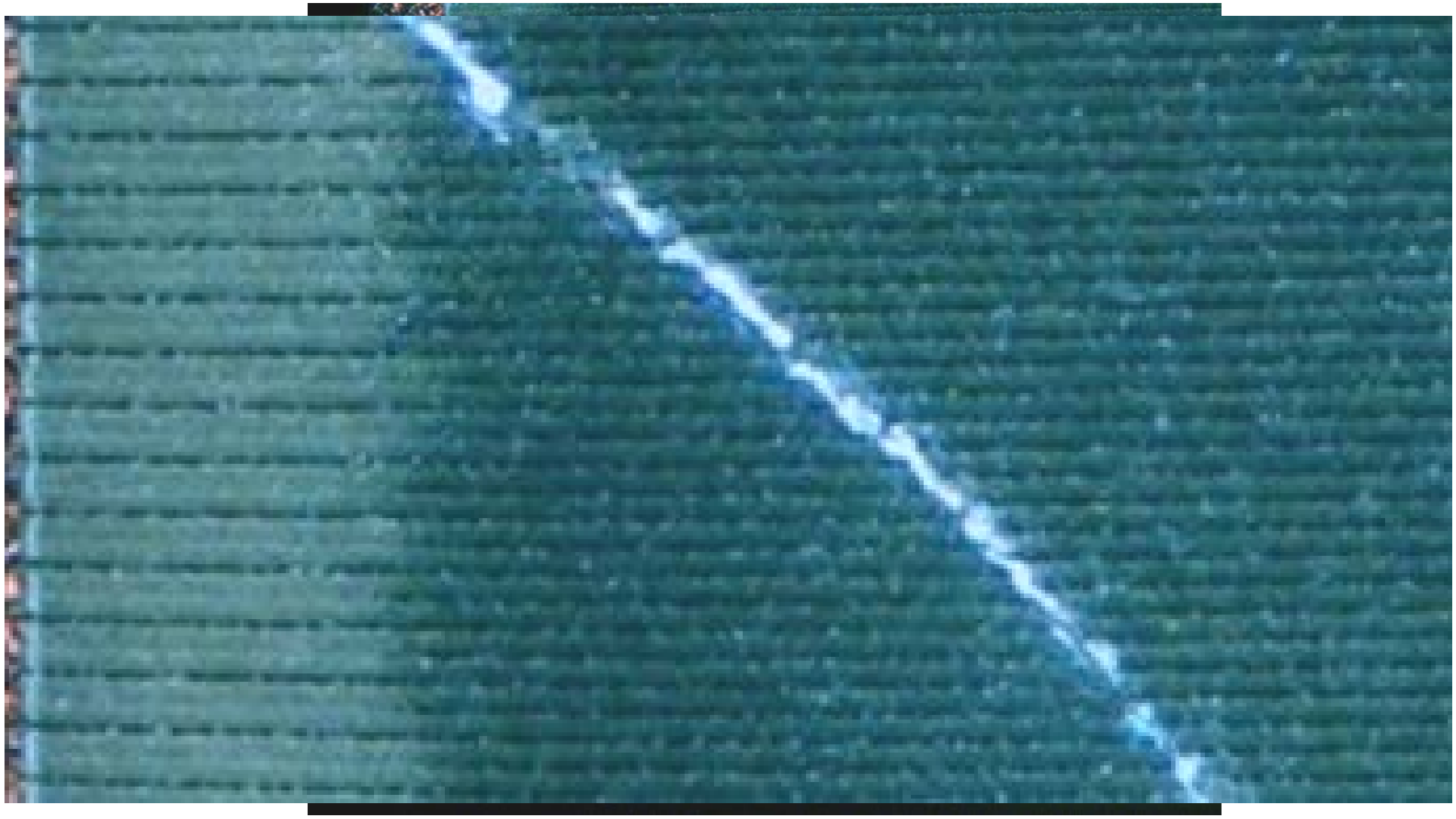
Failure is not always immediate!

Failure mode is not always deterministic!

- Flex or Bend stress
  - Occurs after mounted to board
  - Common for larger chips (>0805)



Flex Cracks



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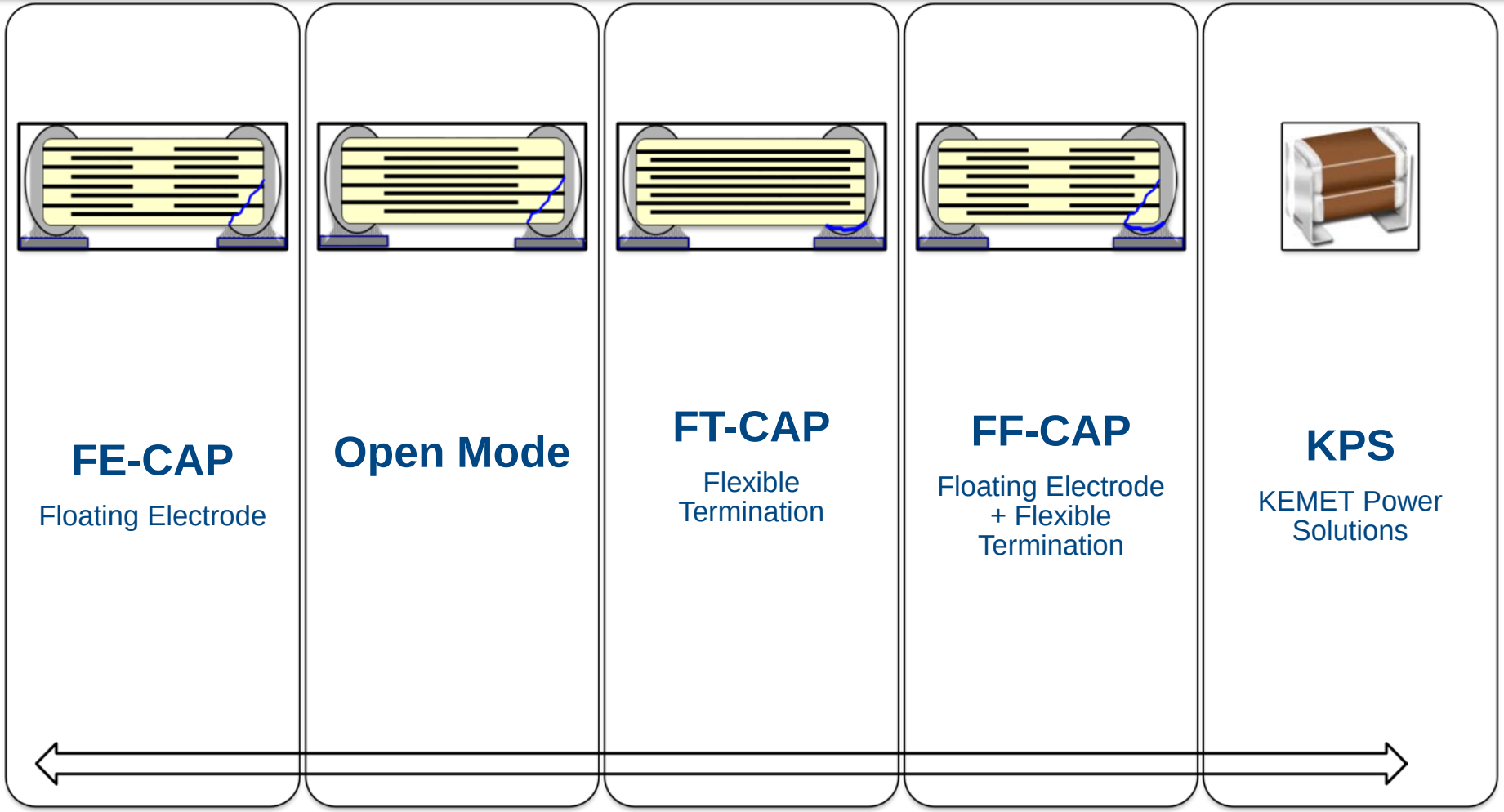
Flex Mitigation Technology



Data Sheet: http://bit.ly/y7G4V2

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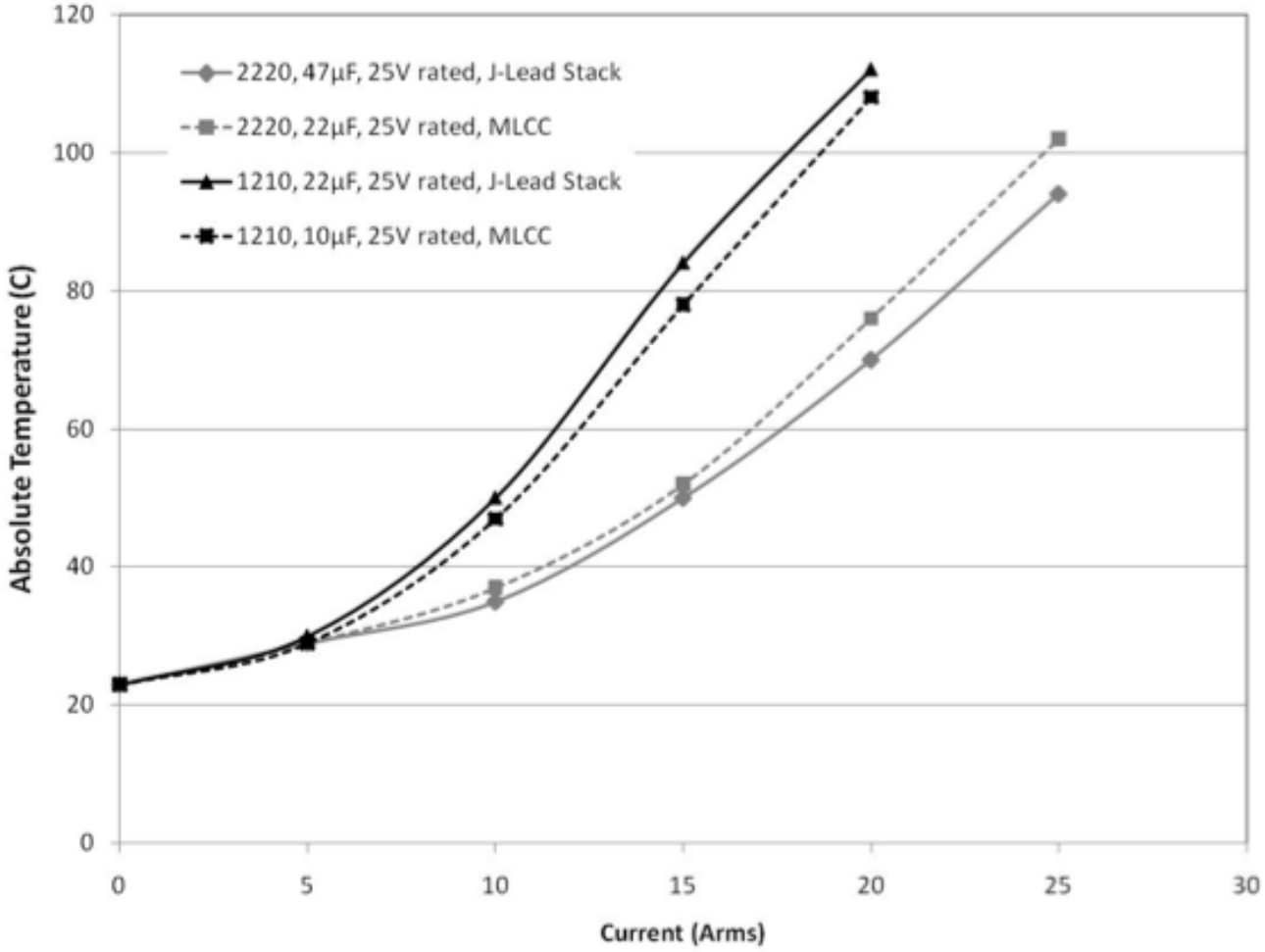
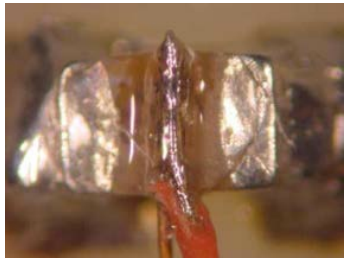
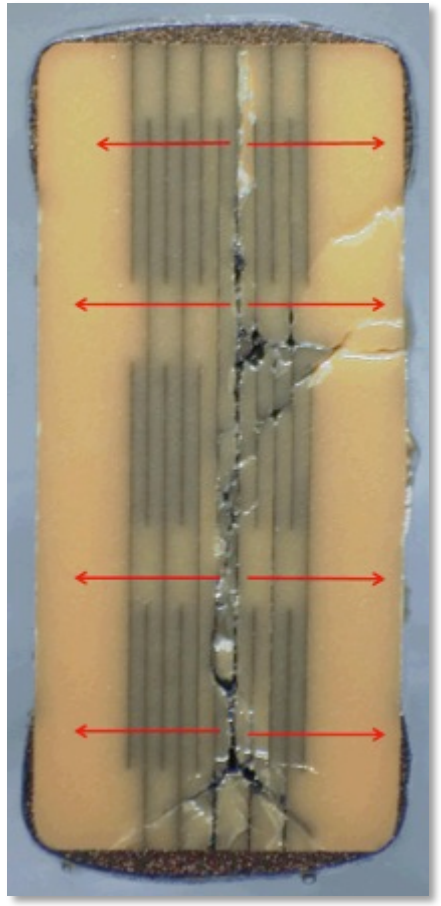
Ceramic Capacitors
AC Self-Heating

J-Lead compared to MLCC

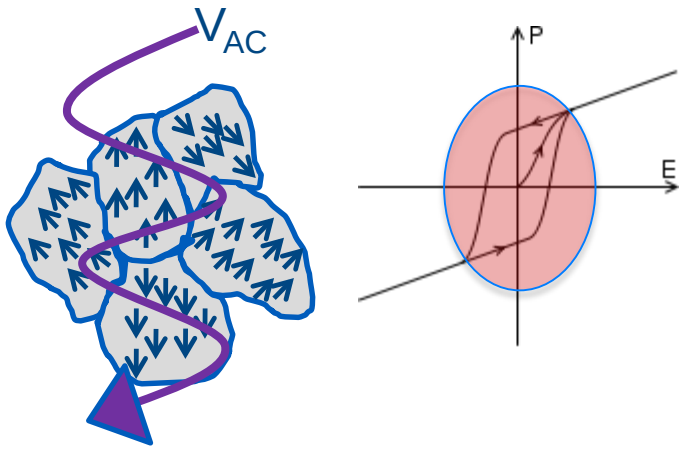




Self Heating due to Dielectric Absorption



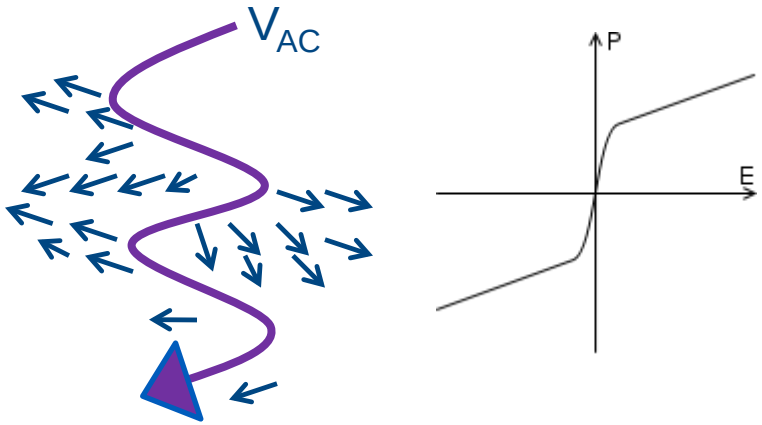
Class 2 (X7R, X5R, etc) $BaTiO_3$
Ferroelectric



Ferroelectric permanent dipoles in *domains* align with the AC Field

Domain wall heating &
Signal distortion

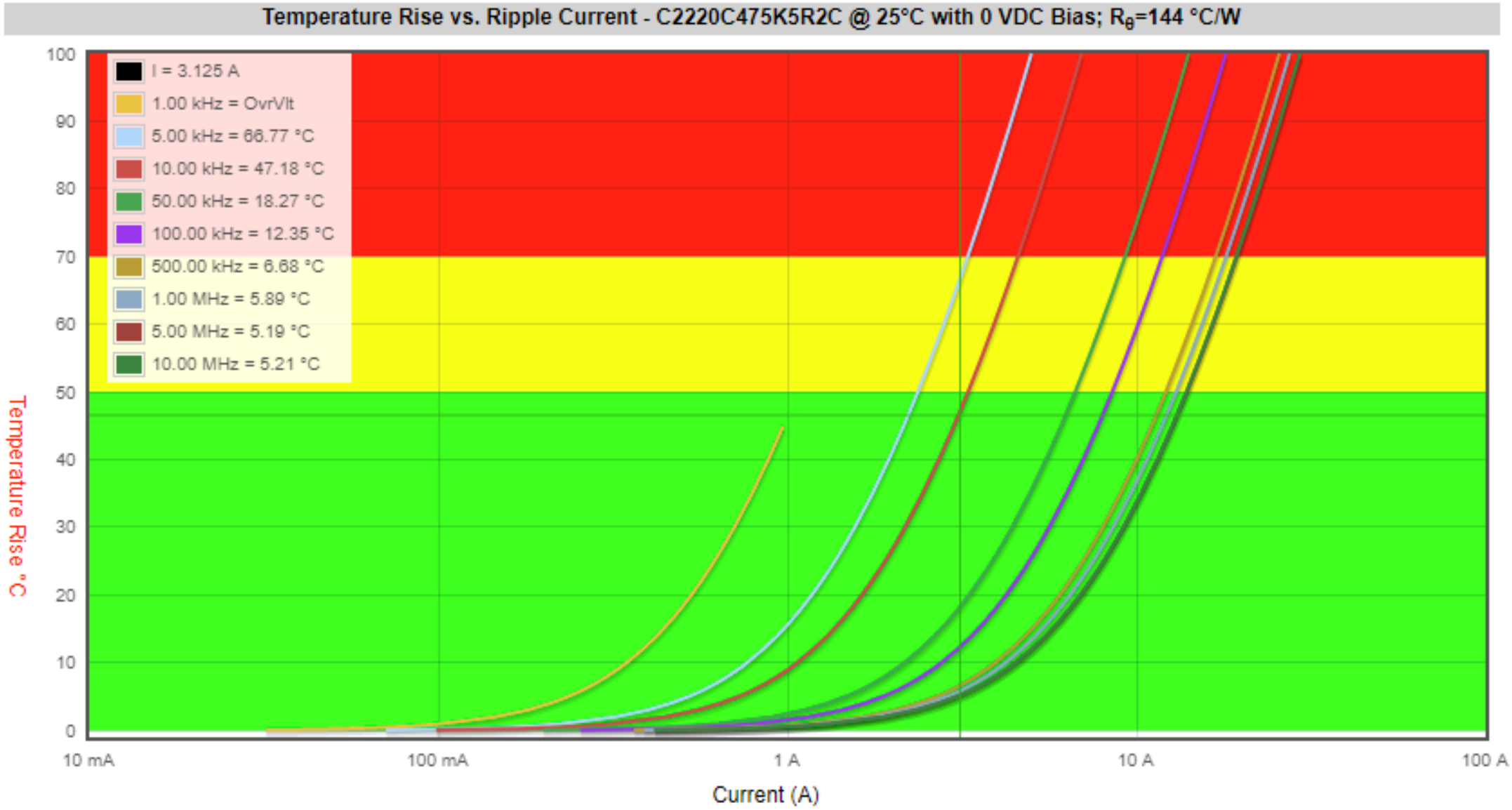
Class 1 (C0G, U2J) $CaZrO_3$
Paraelectric



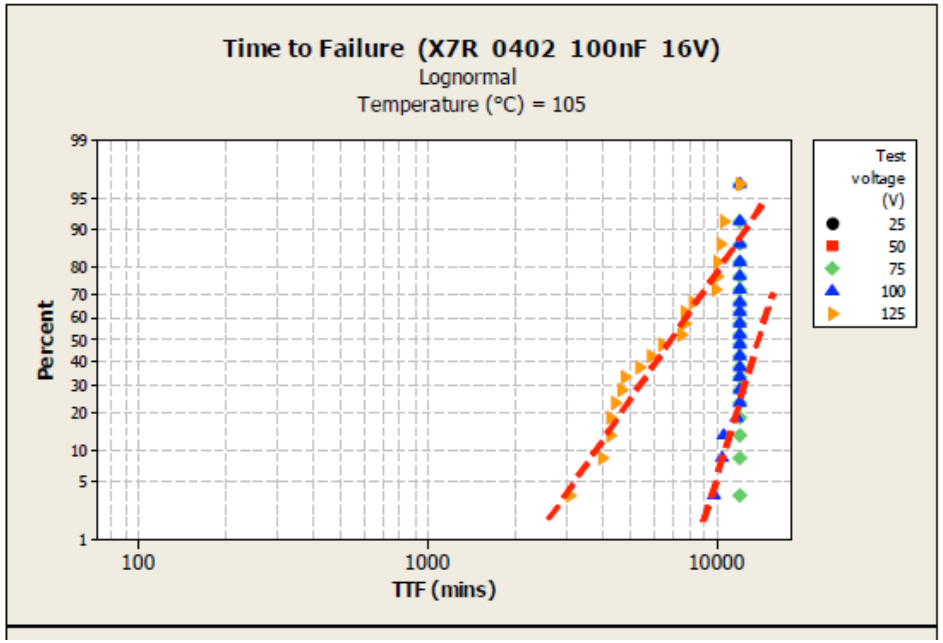
Paraelectric spontaneously created dipoles align with AC field

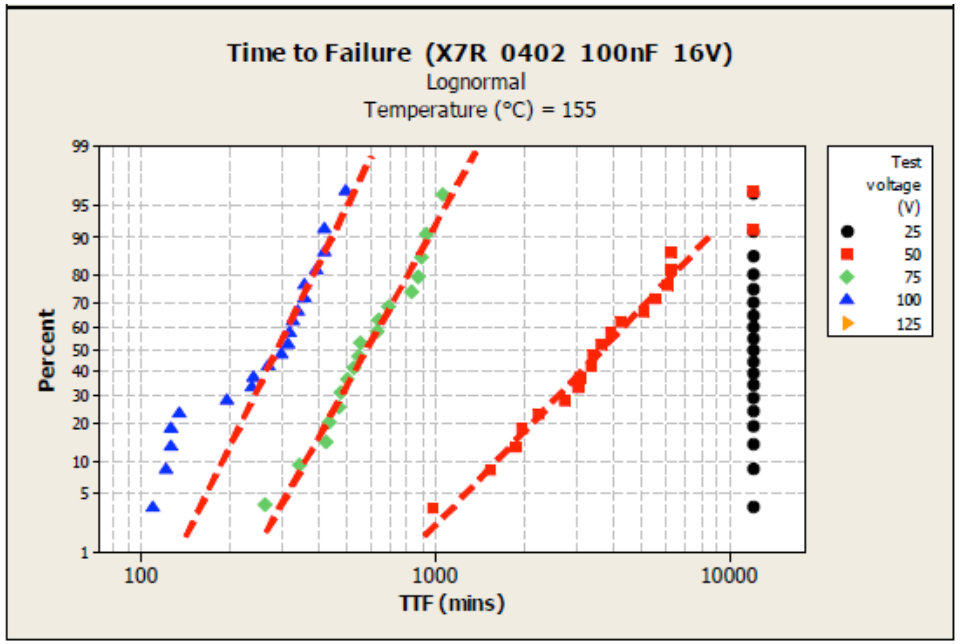
No domains, so
No Domain wall heating &
Reduced signal distortion

X7R Stack Self Heating



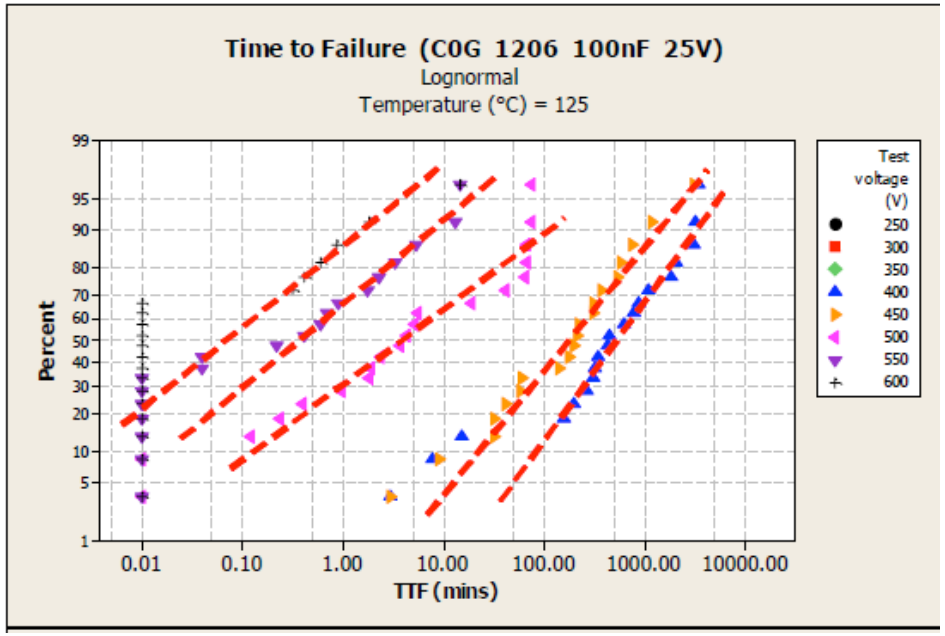
Over Stress: BME X7R Barium Titanate

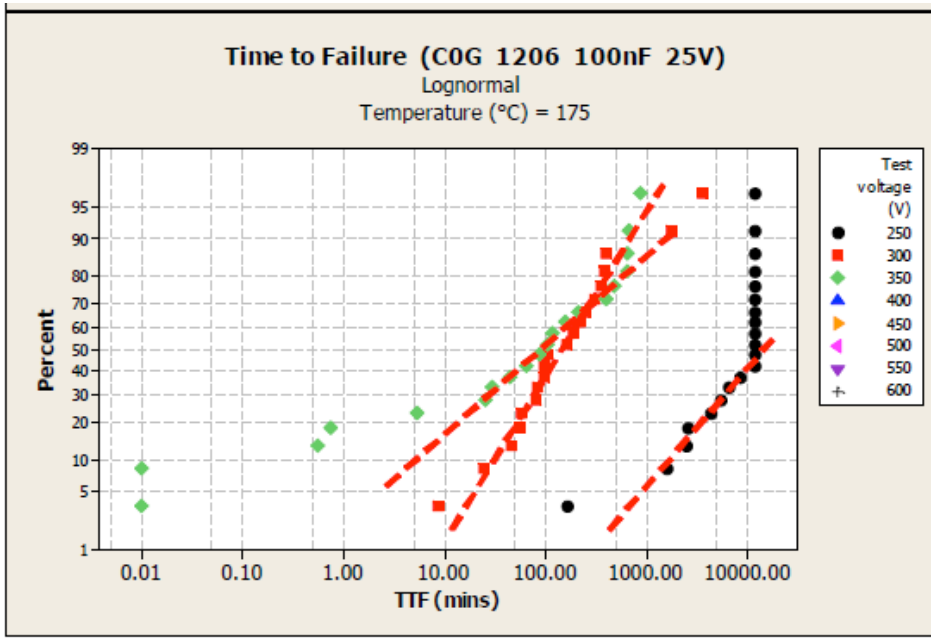




1. Under rated conditions, failure takes a long time.
2. Accelerated temp/voltage shows bathtub plot
3. Something is wearing out the dielectric

Over Stress: BME C0G Calcium Zirconate





C0G BME takes incredible overstress before wearout.

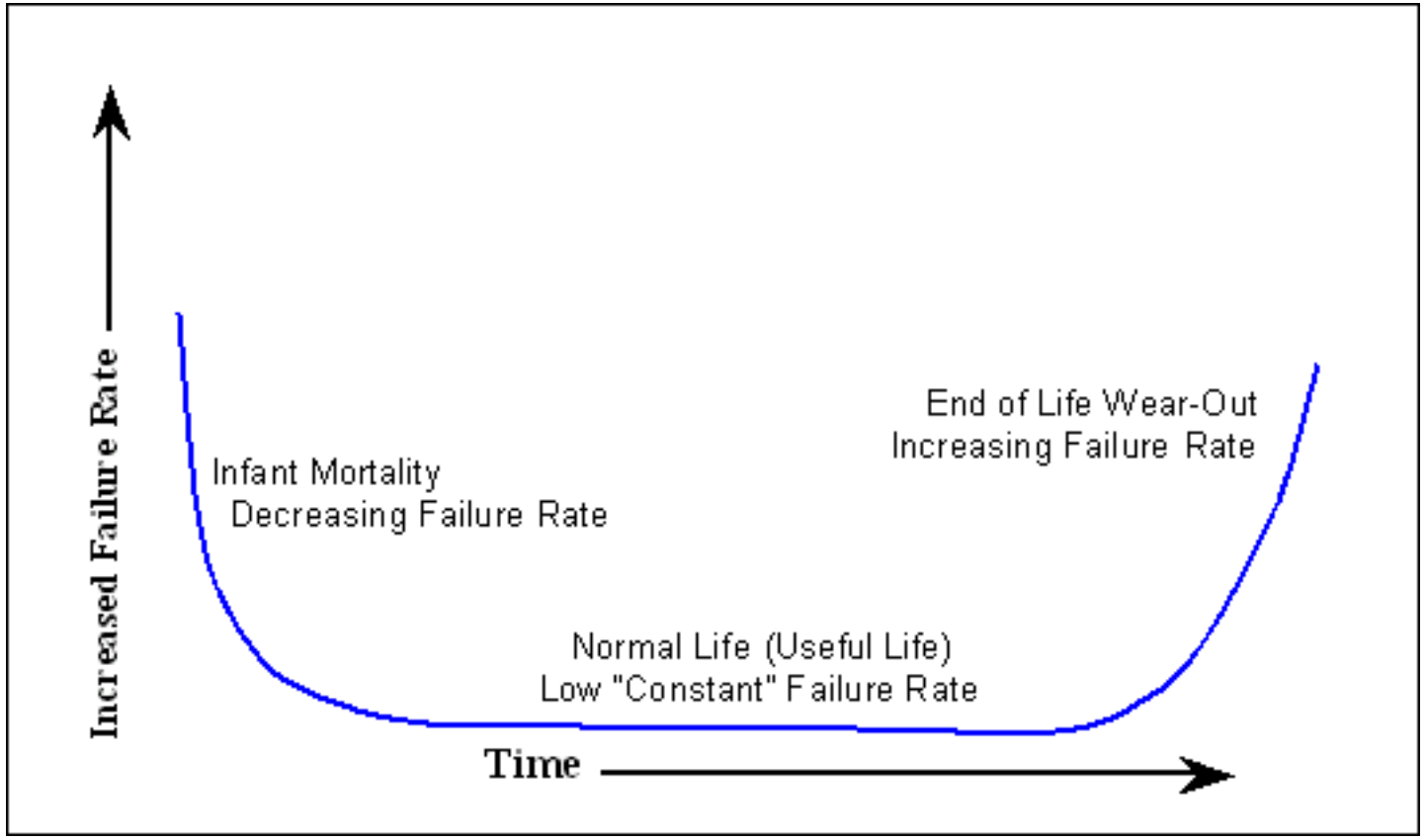
What's different?

Barium Titanate vs Calcium Zirconate

Predicted Median Time to Failure

Part Number	Dielectric Family	Rated Voltage
0402 100nF	X7R	16
0603 100nF	X7R	50
1210 1µF	X7R	100
0402 1nF	C0G	25
1206 100nF	C0G	25

The Bathtub Curve
Hypothetical Failure Rate versus Time



Relative failure rate of an entire population over time

Ceramic Summary

Infant Mortality

Manufacturing Defects

100% Screening Reduces Them

Flex Cracking

Flex Mitigation

Not all flex cracked parts fail immediately

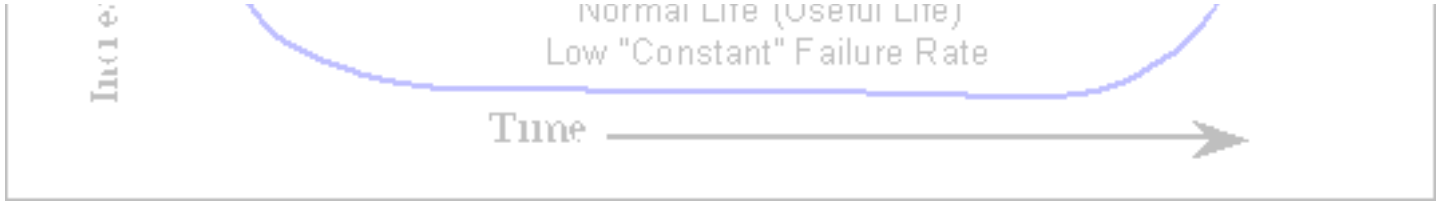
Wear-Out

10s to 100s of years at rated conditions

Derating helps, but is it necessary?

Oxygen Vacancies become mobile

More pronounced in X7R (Barium Titanate) than C0G (Calcium Zirconate)



Thank You