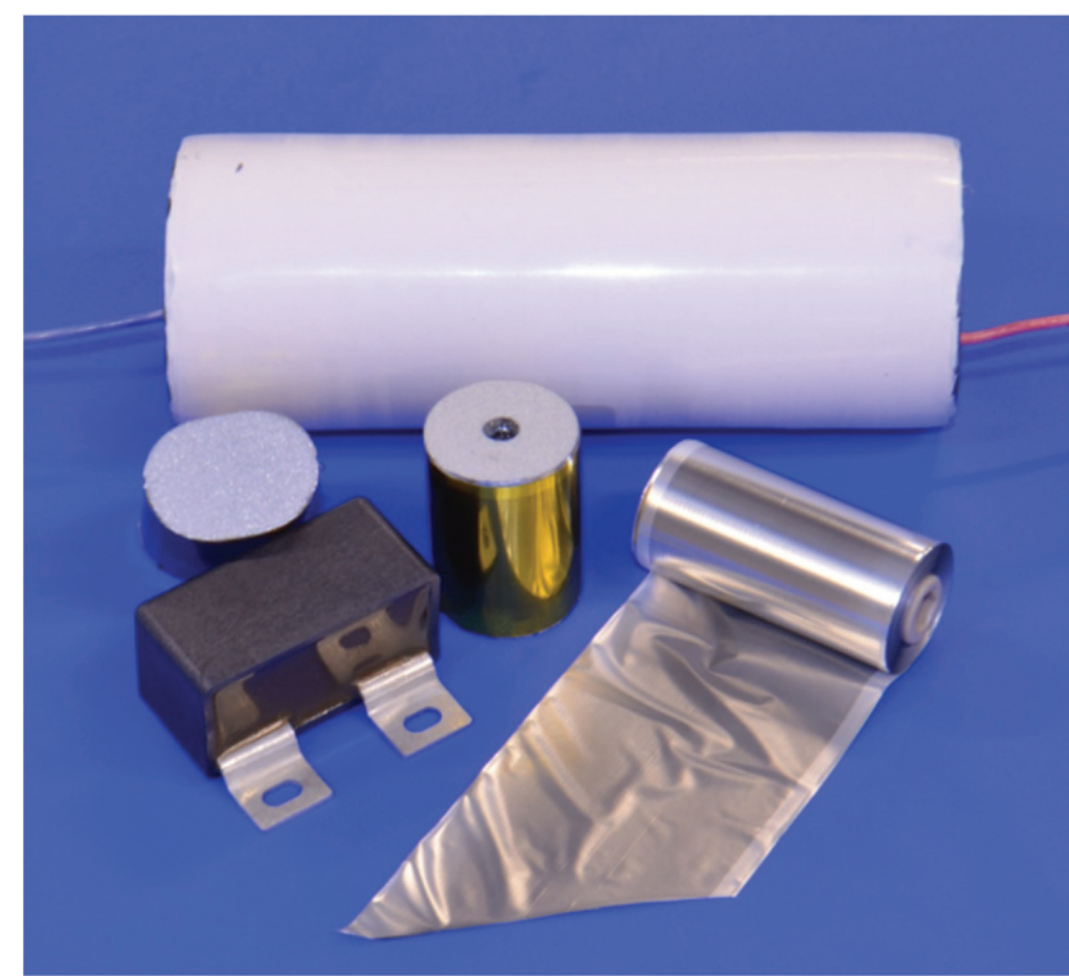


# APEC 2018 Self Clearing of Metalized Film Capacitors



## Introduction to Clearing

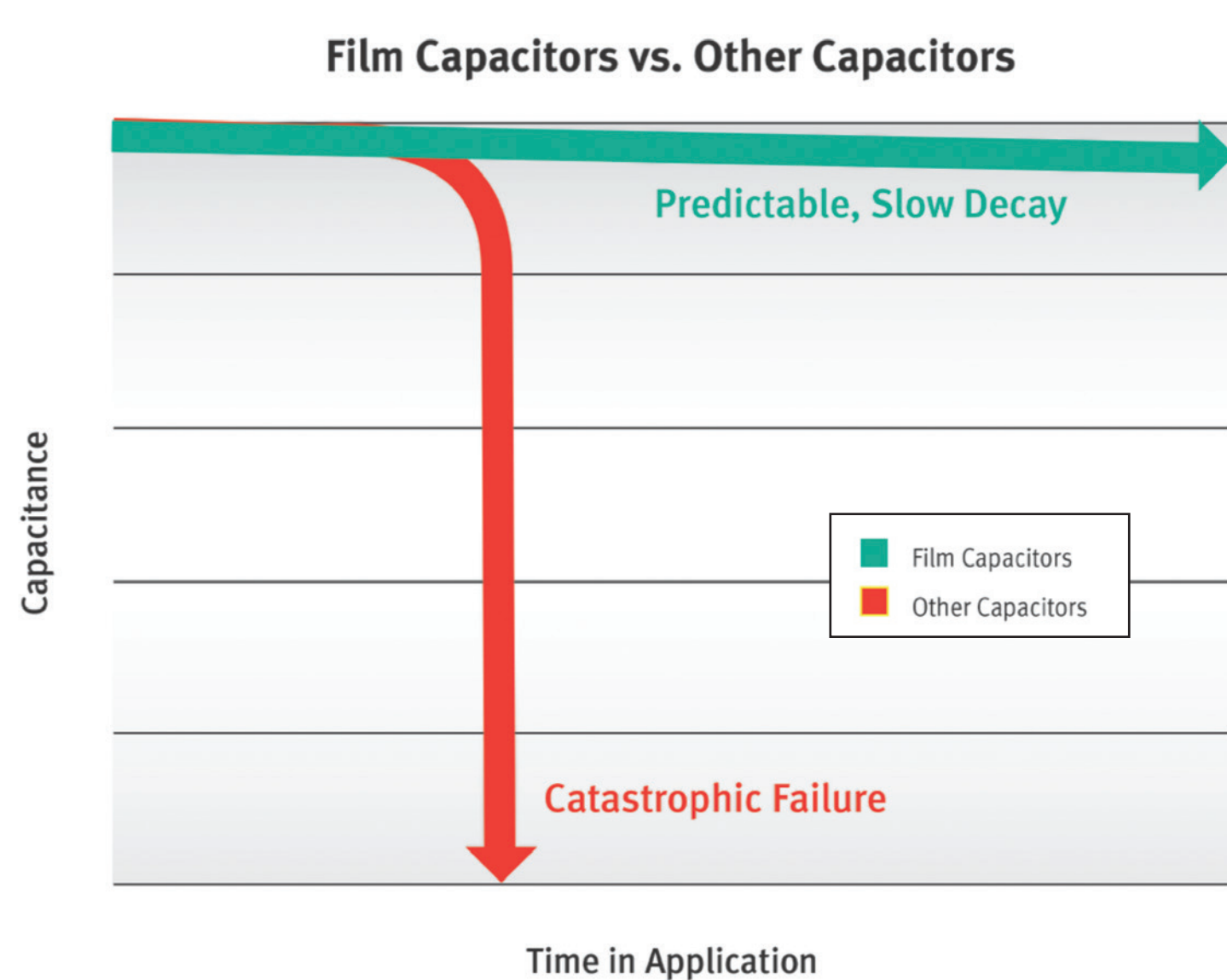
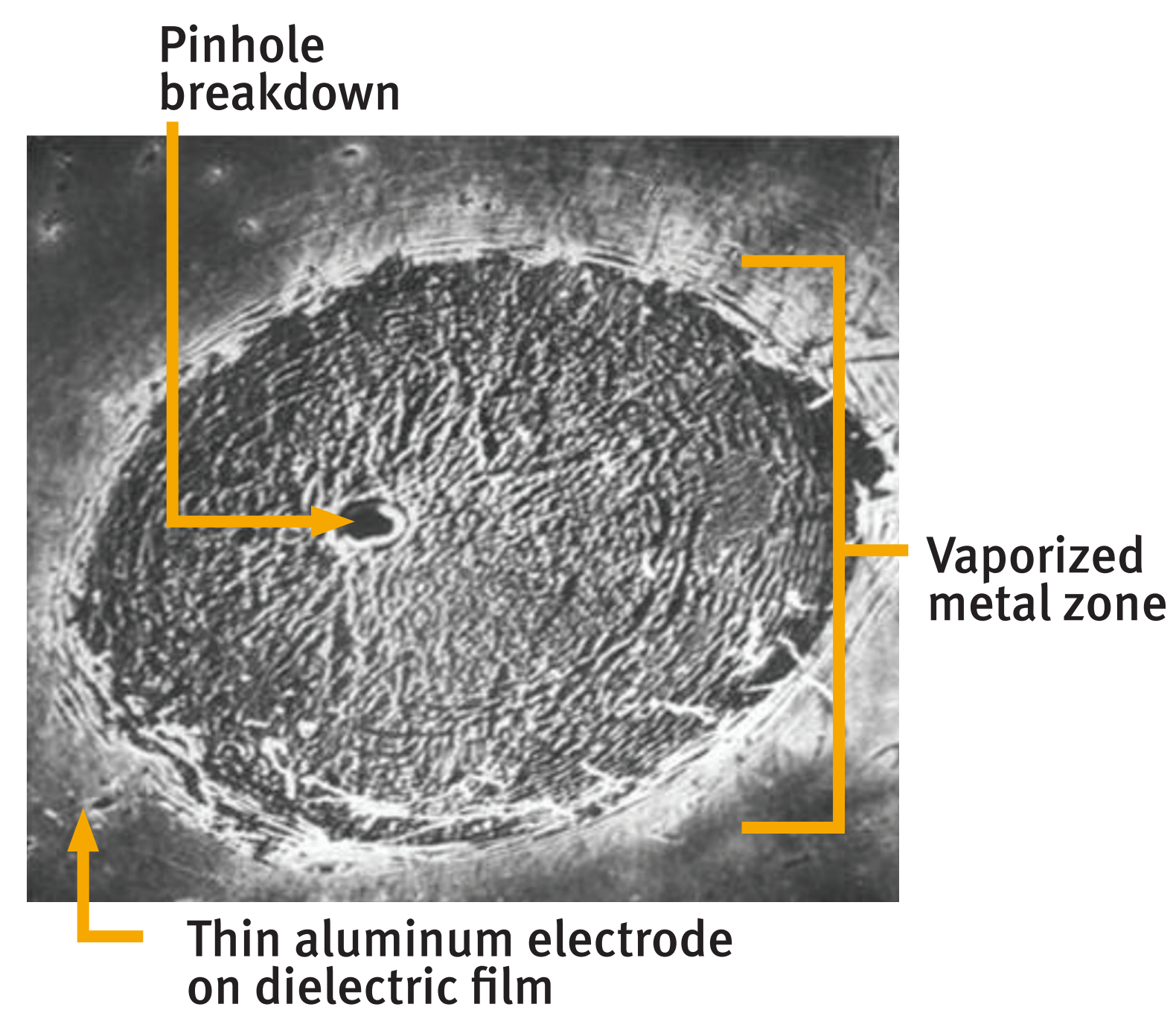


### Benefits of Film Capacitor Technologies

- Stable, high reliability
- Wide range of capacitance and voltage values
- High current handling
- Low DF (dissipation factor)
- Capacitance stability over frequency and temperature
- Self healing (clearing)

### What is Self Clearing?

- A flaw in the metalized film material results in a dielectric breakdown
- Localized heating causes combustion of the film, removing the surrounding metallization
- A self clear isolates the fault from the rest of the device



### What is the Benefit of Self-Clearing?

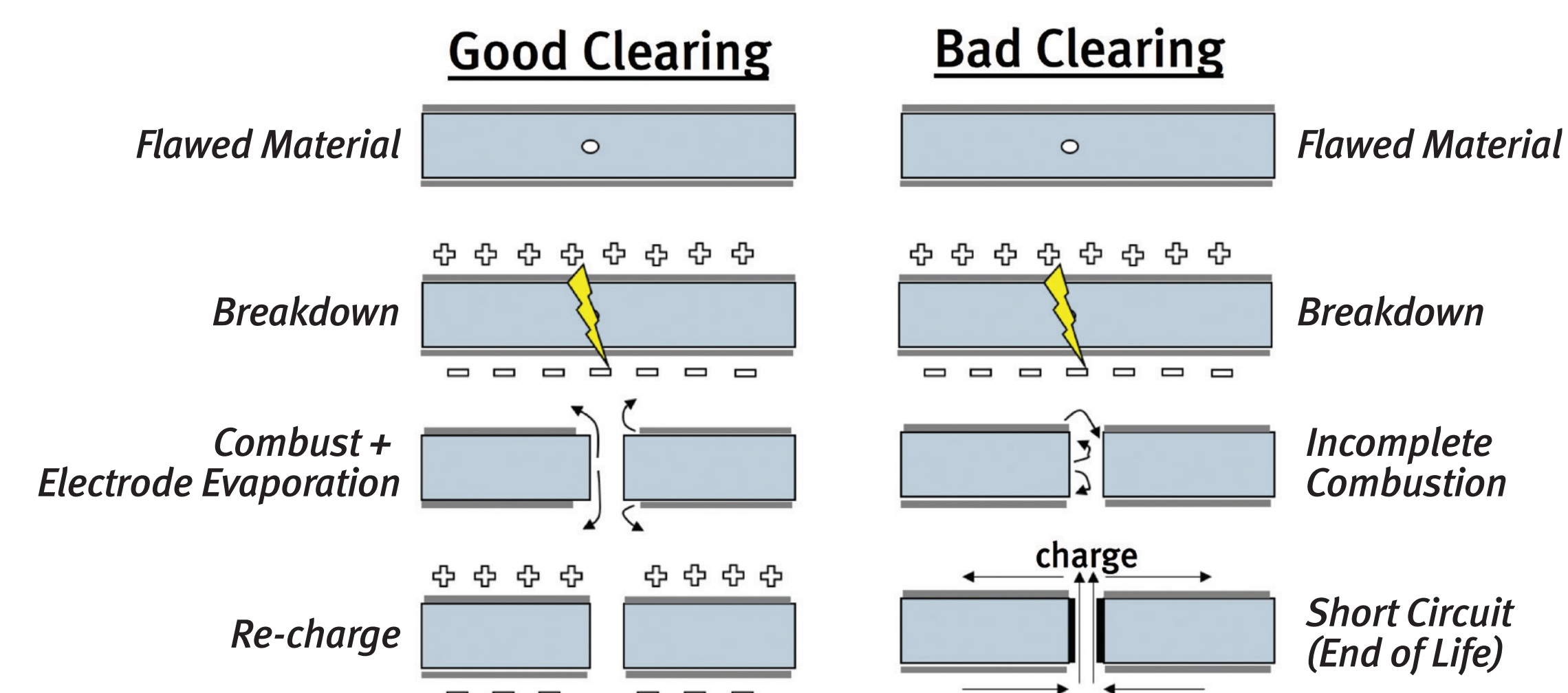
- Accept a population of flaws in film material
- Ability to tolerate overvoltage transient events
- Predictable performance enabling degradation monitoring and end of life determination

*The ability for a capacitor to clear depends strongly on the dielectric polymer and physical construction*

## Dielectric Clearing

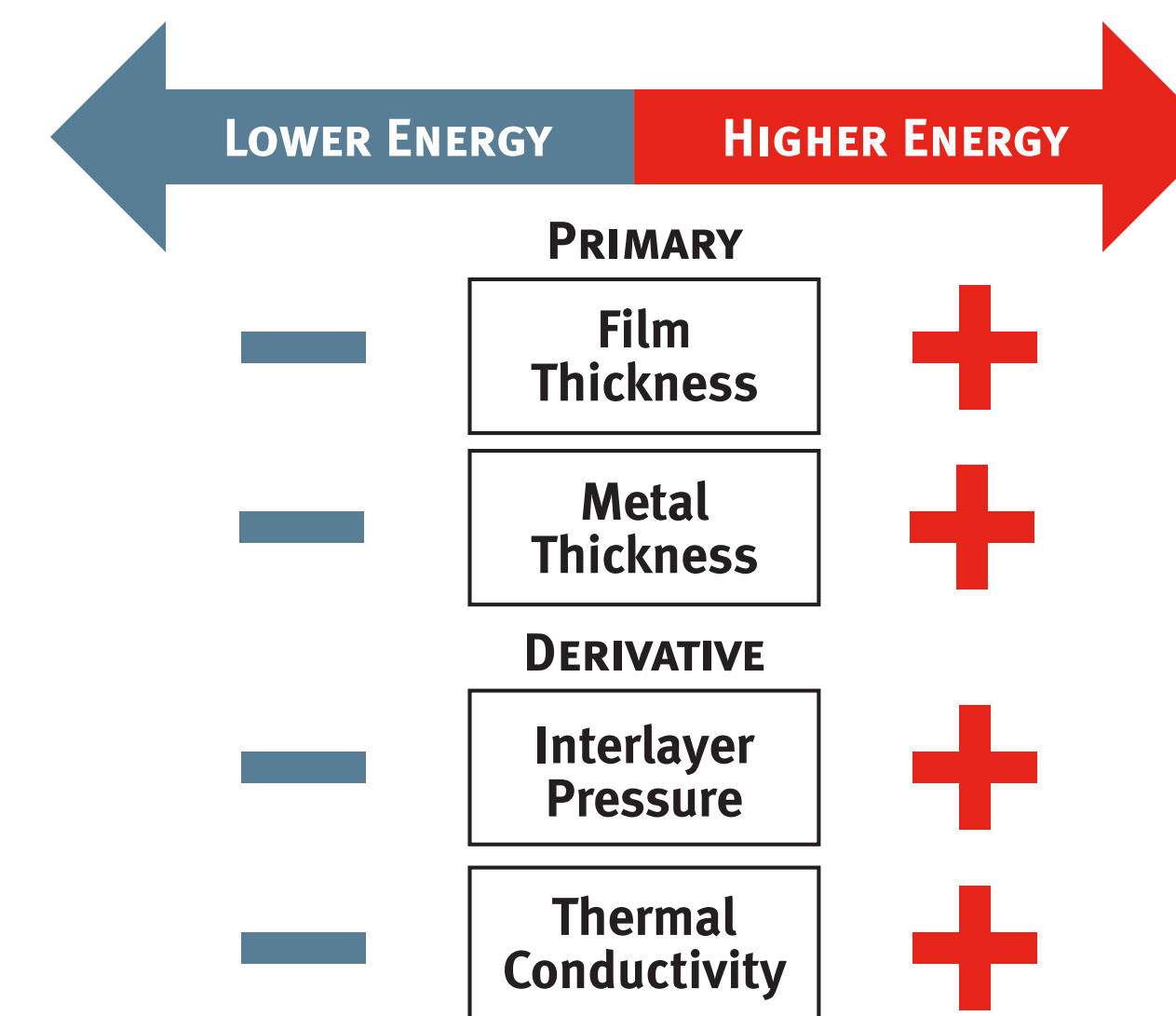
### Good vs. Bad Clearing

- A good clear completely combusts the material in the fault area, “clearing” away the weak point
- A bad clear enables a conductive pathway in the fault area, resulting in device damage or catastrophic failure



### Influences on Film Clearing

- Manufacturers can control several aspects of capacitor design to influence clearing energy
- It is desirable to control the energy of clears in order to
  - Avoid bad (catastrophic) clears
  - Minimize capacitance loss
  - Prevent weak spots from forming



### Limits of Clearing

- Even optimized designs can clear poorly when pushed to extreme voltages or temperatures
- Each film material responds differently to these stresses
- Capacitor specifications account for self clearing limits

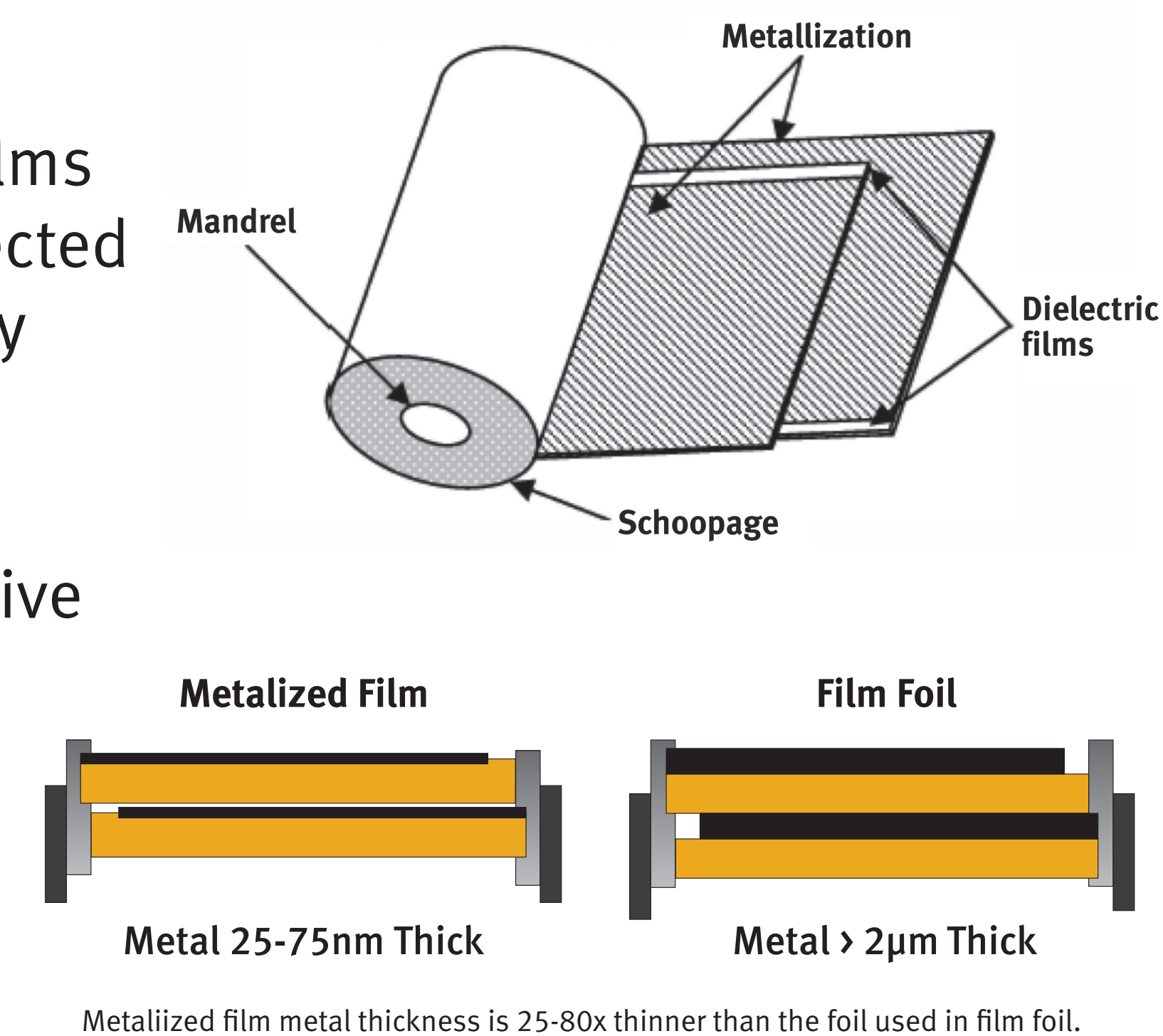
### Metalized Film Capacitor Application Limits

Film Material	Typical Max Temperature (°C)
BOPP	85-105
PET	85-125
PEN	125
PPS	125
PTFE	225

## Capacitor Construction

### Physical Design

- Built from two metalized films wound together and connected on each end with end-spray
- Film-foil capacitors are constructed from separate dielectric film and conductive metal foil
- Film-foil designs do not effectively self clear



### Designing a Self Clearing Capacitor

- Optimized clearing at the film level can have consequences at the device level
- Designers must consider these tradeoffs in order to meet customer needs while maintaining clearing performance

Design Parameter	Optimization	Tradeoff
Film Thickness	Reduce Thickness	Reduce maximum voltage rating
Metal Thickness	Reduce Thickness	Increase ESR
Section Aspect Ratio	Balance	Width $\equiv$ Thermal Conductivity Radius $\equiv$ Interlayer Pressure

### Conclusion

- Clearing is a key feature of metalized film capacitors
- Clearing enables metalized film capacitors to have stable, predictable, and robust performance
- Manufacturers must balance device design to achieve reliable performance

