Application of Circuit Board Technology for Passives Packaging

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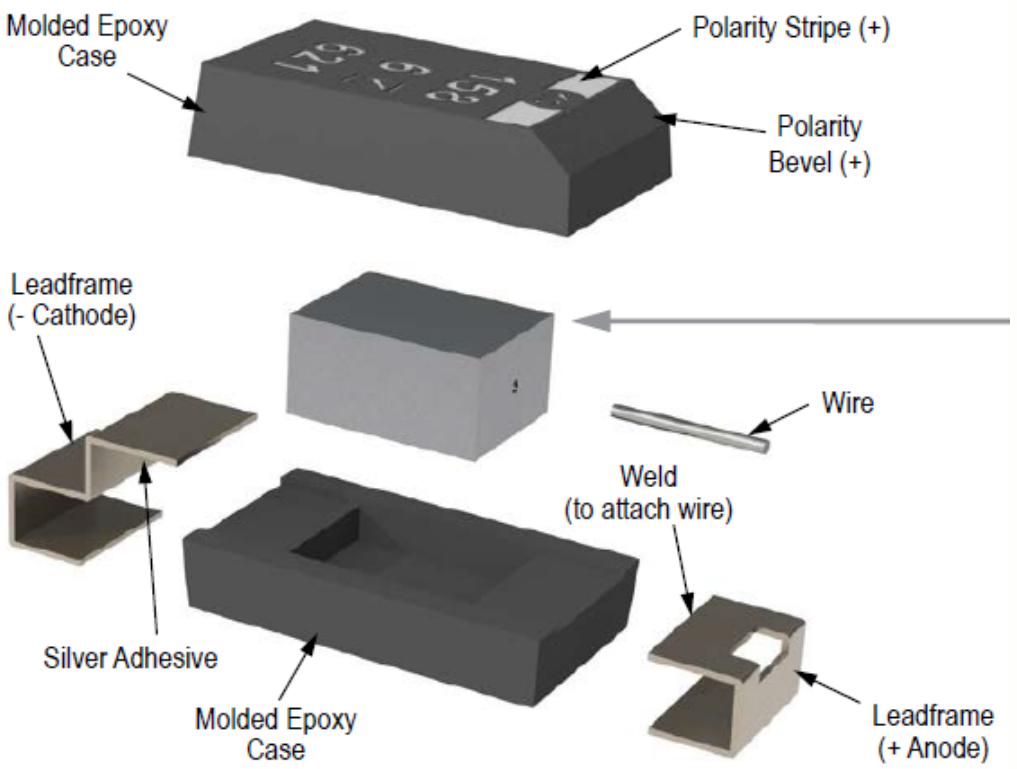
Background

- In review will be the use of circuit board manufacturing processes (PCBs) and the potential positive impact they can lend to the manufacture and reliability of valve metal capacitors
- Some of these positive impacts include:
  - Simplification of the manufacturing process
  - Improved volumetric efficiency
  - Improved features of the final device

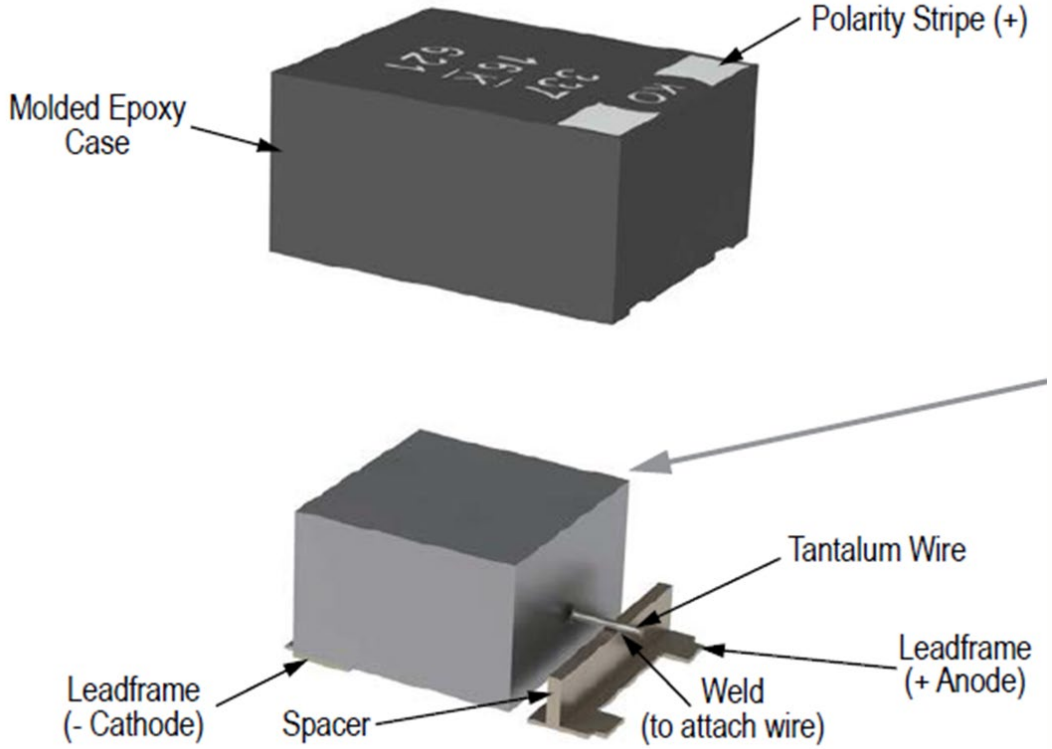
Typical Valve Metal Capacitors

- Shown are two typical capacitor constructions
- Both utilize leadframe and over molded construction

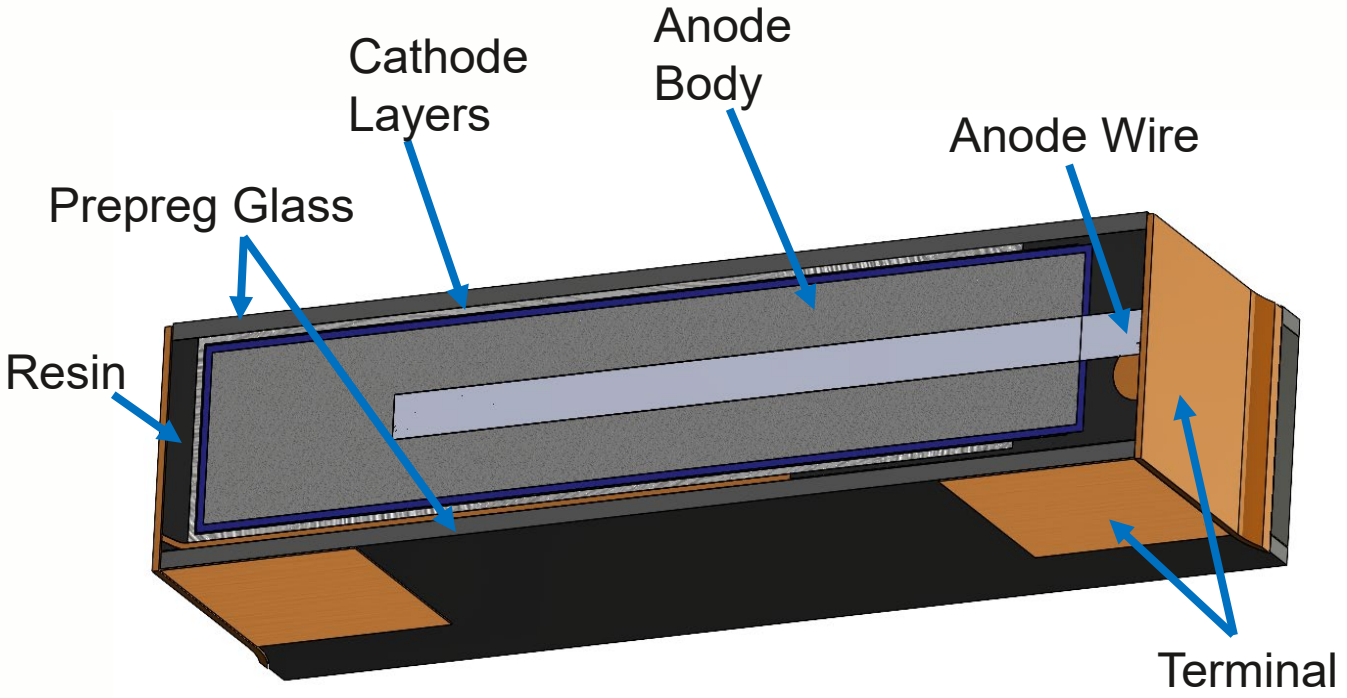
Standard Package

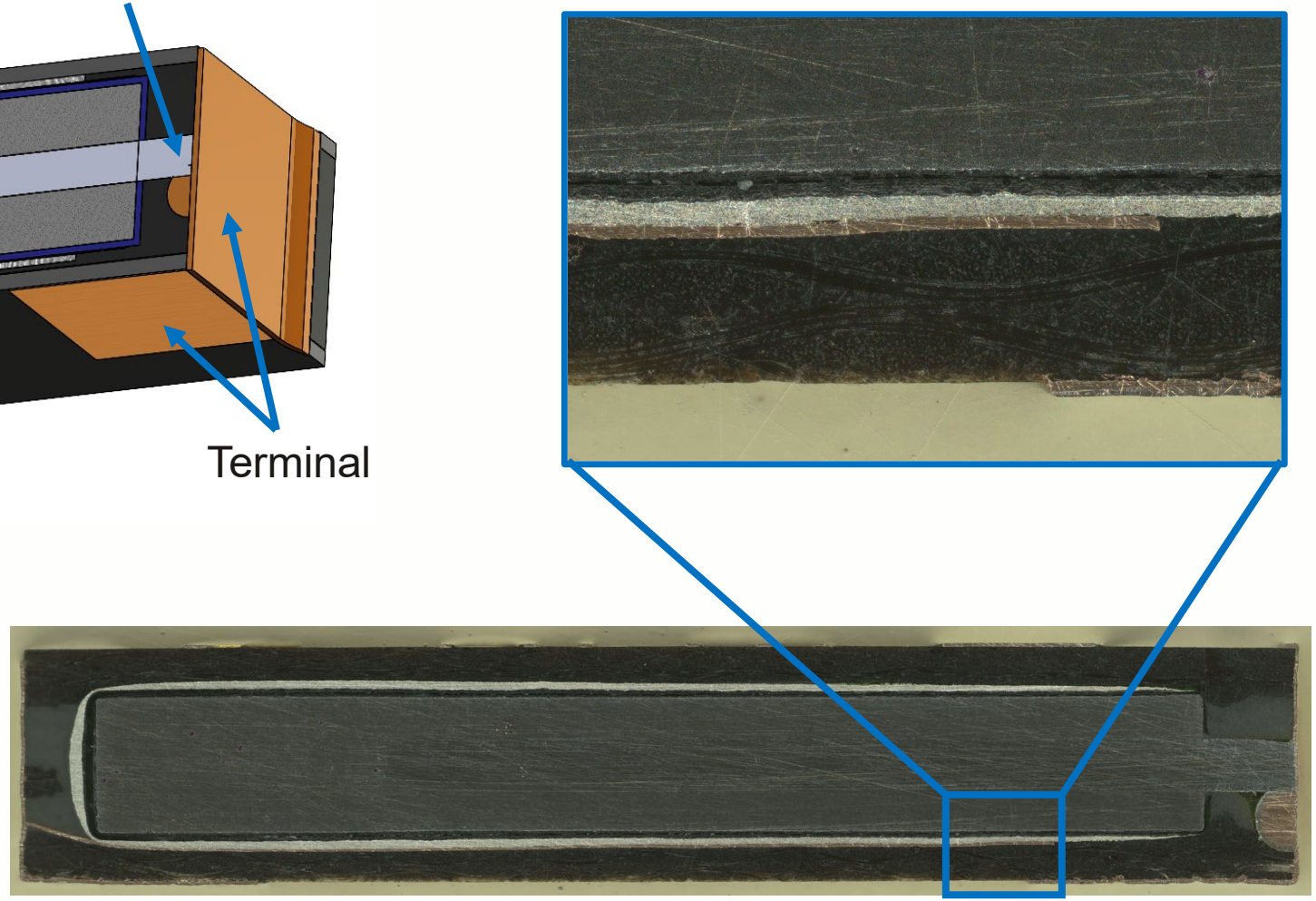


Facedown Package



KEMET Advanced Packaging (KAP) Construction





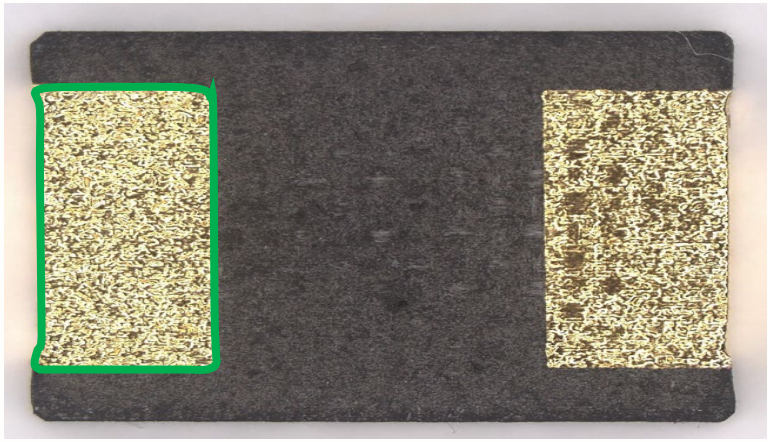
- Construction utilizes:
  - PCB lamination processes
  - via plating
  - Photolithography
  - board routing
- KAP refers to the integration of capacitors into the PCB structure to form discrete capacitors

Features

- Prepreg materials replace transfer molding resins
  - Introduces resin locally to the part to limit flow distance of the resin
    - Reduces chances of entrapping air and creating non-fill regions
  - The glass weave of the prepreg define the wall thickness
    - Provides tighter control over positioning of the internal components to maximize encapsulant thicknesses
- Vias are formed to intersect internal components and plated to form terminals on the capacitor surface
  - Plated terminals and connections reduce the space required to form electrical connections

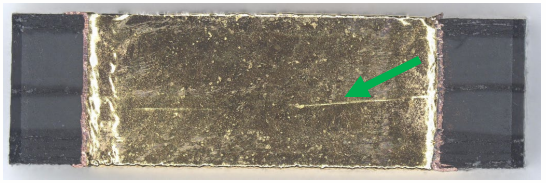
Egresses

New KAP Ta Chip



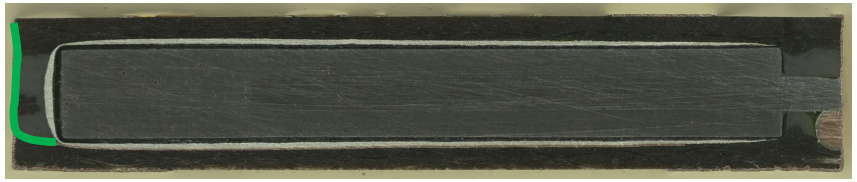
Encapsulant Quality

- With higher vacuum during encapsulation, voids in the resin layer are reduced
- Glass reinforcement provide strength to the thinnest encapsulant areas



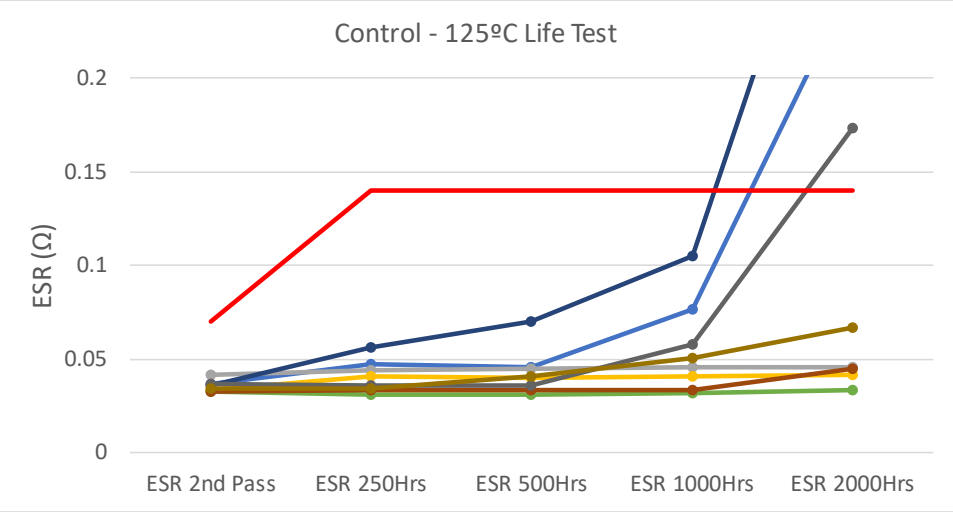
Resin to Metal Interfaces

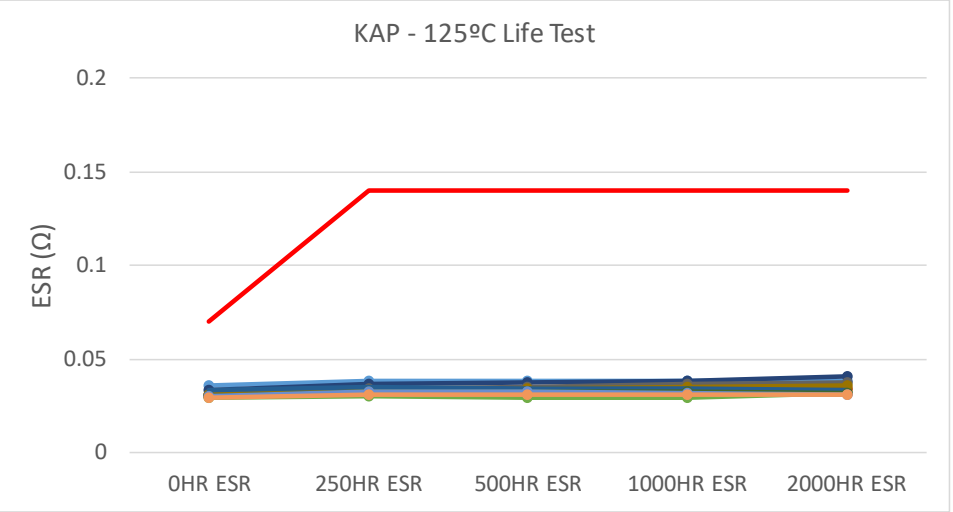
- Natural egresses at resin to lead interface are over plated providing reduction of the potential ingresses into the case
- The materials and process can reduce inherent egresses and thermally induced egresses



Case Integrity Performance

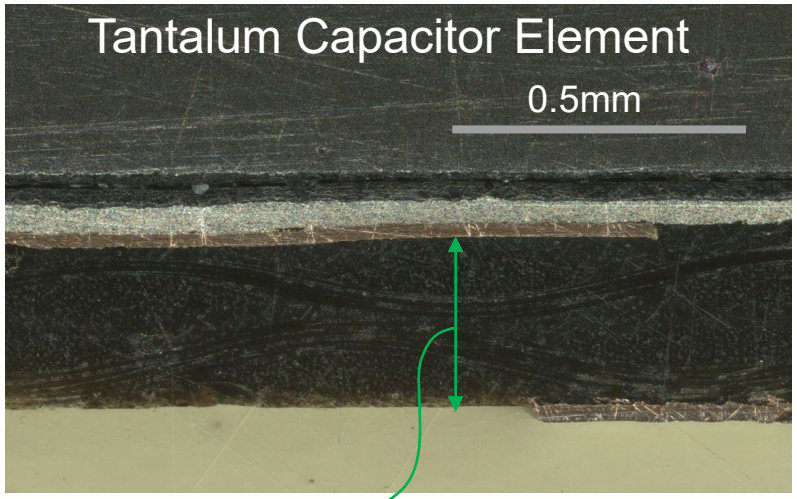
- Oxygen migration is one typical mechanism for ESR failure in life test for conductive polymer based components
- New packaging provides high integrity for protecting the internal capacitor components





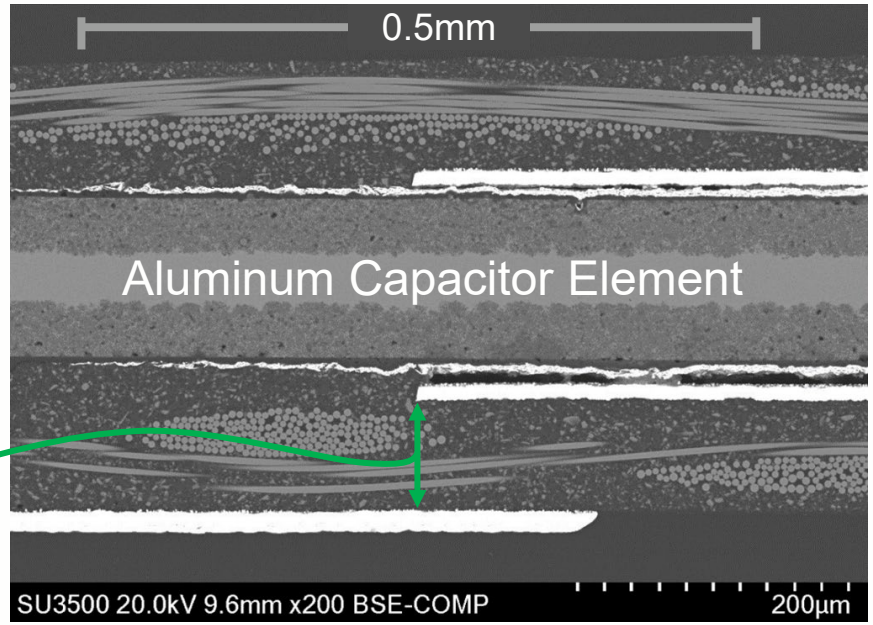
- Accelerated testing of internal components that are typically only rated for 85ºC operation for comparison
- Test designed to force components to failure

Height Reduction



~300um prepreg layer

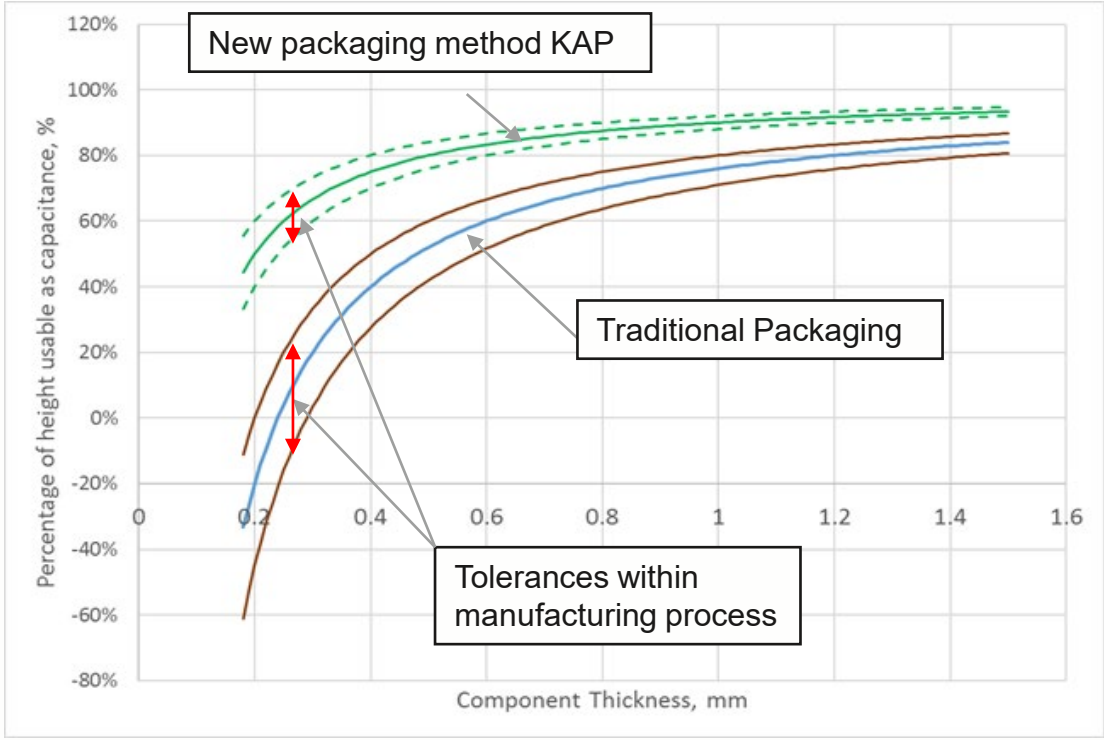
- The same process steps that make thicker encapsulant walls can be used for much thinner walls
- The ability to form thinner walls in the encapsulant provides more usable space for the internal components



~50um prepreg layer

Volumetric Efficiency

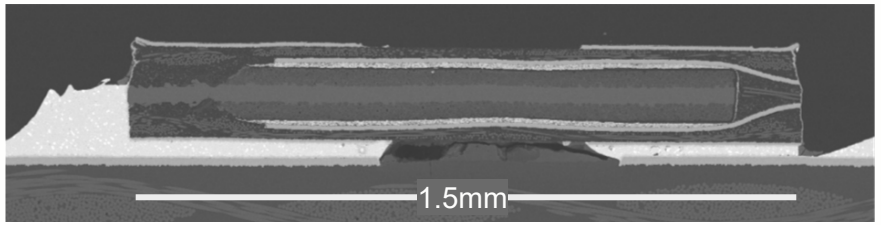
- Two major factors for traditional components in opposition to improving the volumetric efficiency are the leadframe and encapsulant
  - Leadframe is typically between 100 – 250 um thick
  - Transfer molding processes require precise locating of the internal components and sufficient space for resins to flow
- These factors have a smaller impact to the efficiency for thicker components but are much more limiting as component sizes are reduced

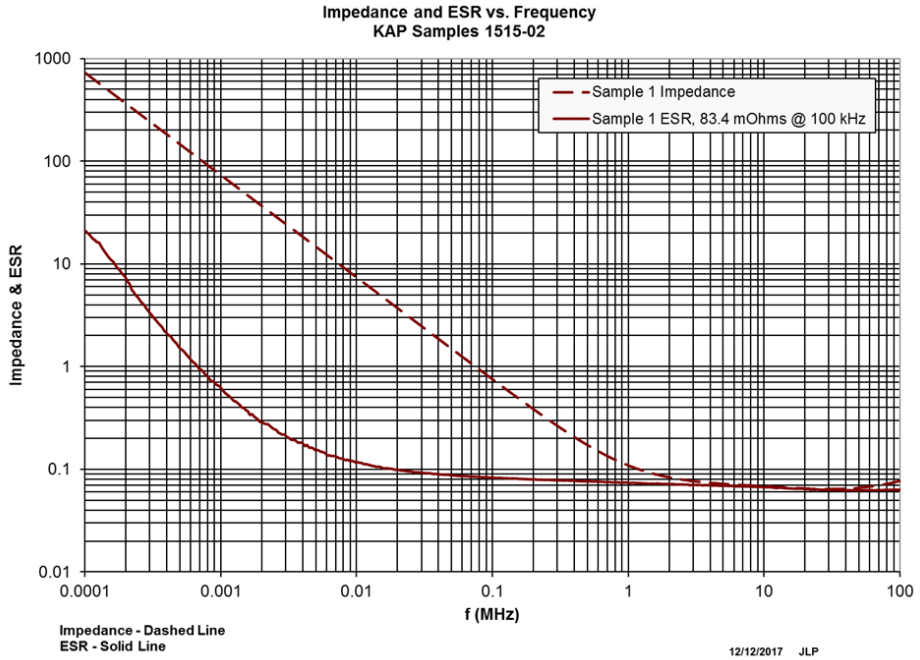


Manufacturing Flexibility

- KAP manufacturing uses PCB routing processes and via formation
  - Terminal connections are created using vias to intersect internal components
  - The final device shape is formed by the final routing process
- These methods provide for customized terminal locations and customize shapes
  - Non-standard rectangular sizes
  - Terminals in non-standard pad shape and locations
  - Curved and non-rectangular shapes
- Customizable terminal placement also allows for influencing of ESL

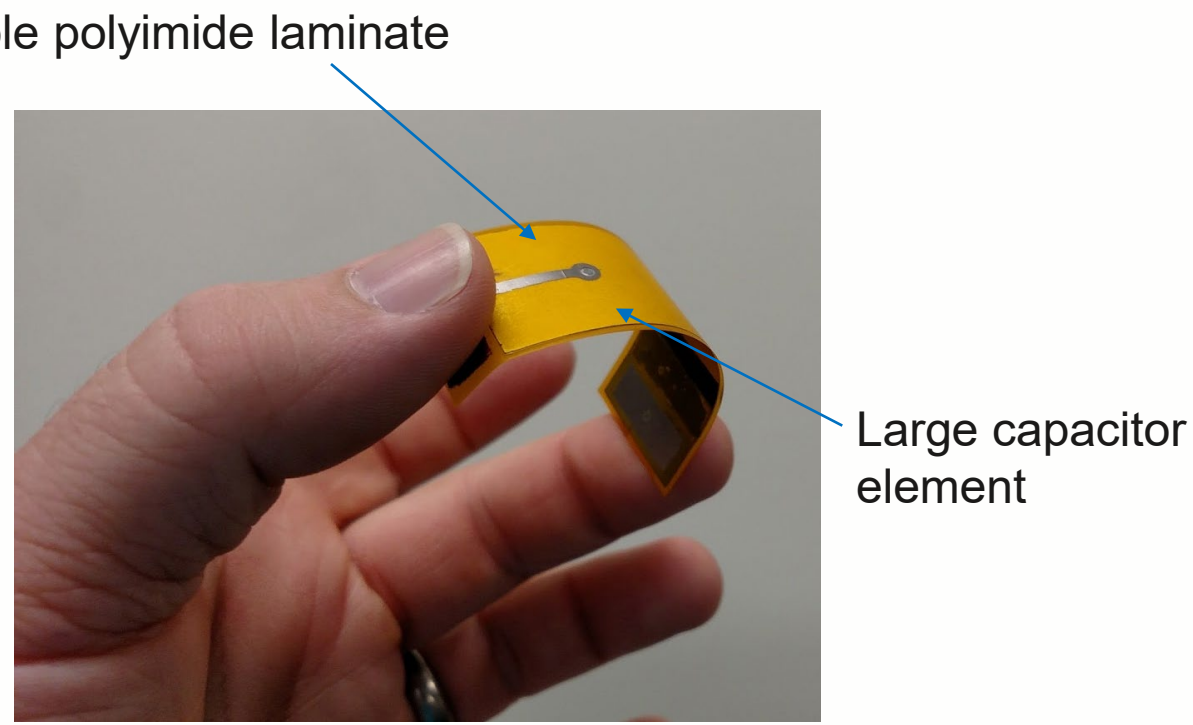
KAP Aluminum Polymer 1515-0.25mm





Flexibility

- As PCBs also come in flexible configuration so can the KAP devices
- Utilizing aluminum capacitor foils that are under 100um and conductive polymer cathode systems, the internal element can be as flexible as the polyimide laminate systems
- Early testing showed bend radius as low as 5mm



Conclusions

- PCB manufacturing techniques can be used to provide positive benefits for the efficiency of passive components and help achieve more value in existing components sizes
- These materials and processes can also provide higher reliability for some aspects of the passive components

Future Advancements

- As the technology for KAP advances, manufacturing improvements and accumulated reliability data will help progress embedding components directly in the circuit board