LIQUID THERMAL INTERFACE MATERIALS

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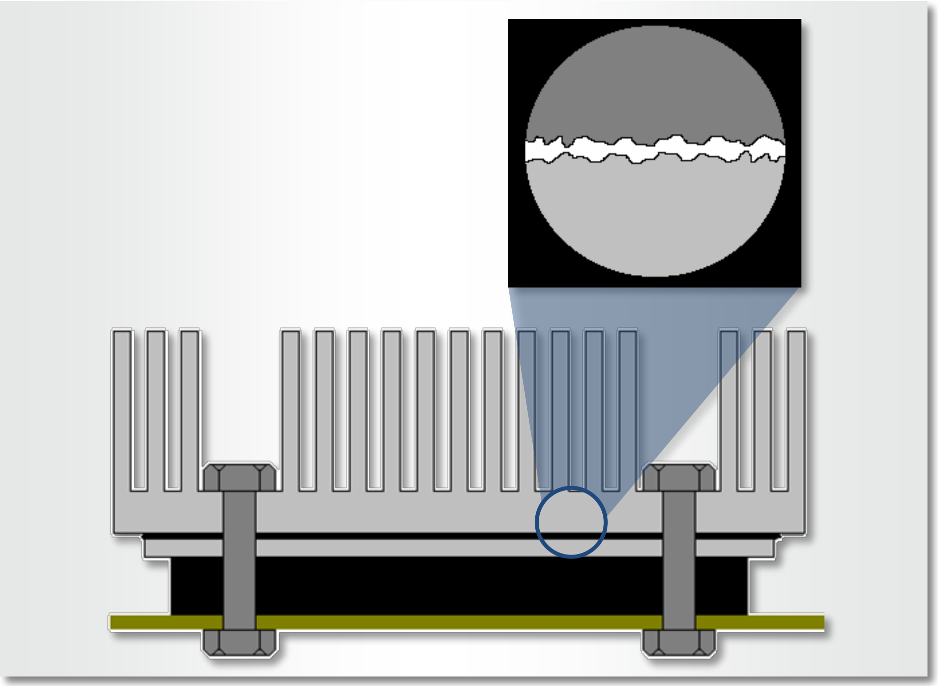
Efficient Thermal Management

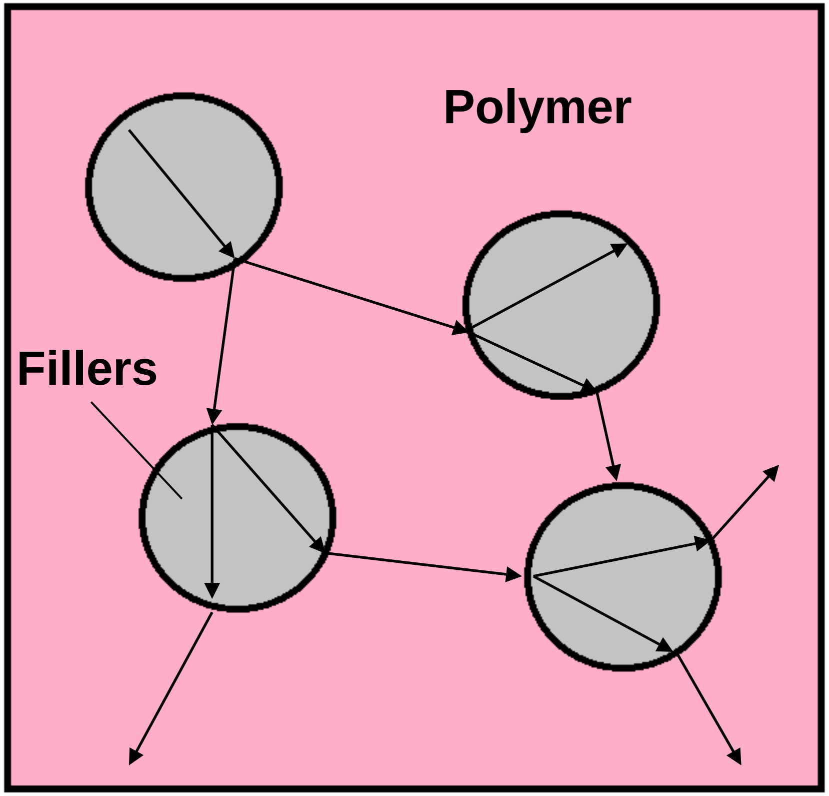


- In-efficient Heat Transfer
  - Air pockets within the path
  - TC from air = in-efficient ?

Replace Air with a high efficient thermal conductive Material

Filler in polymer

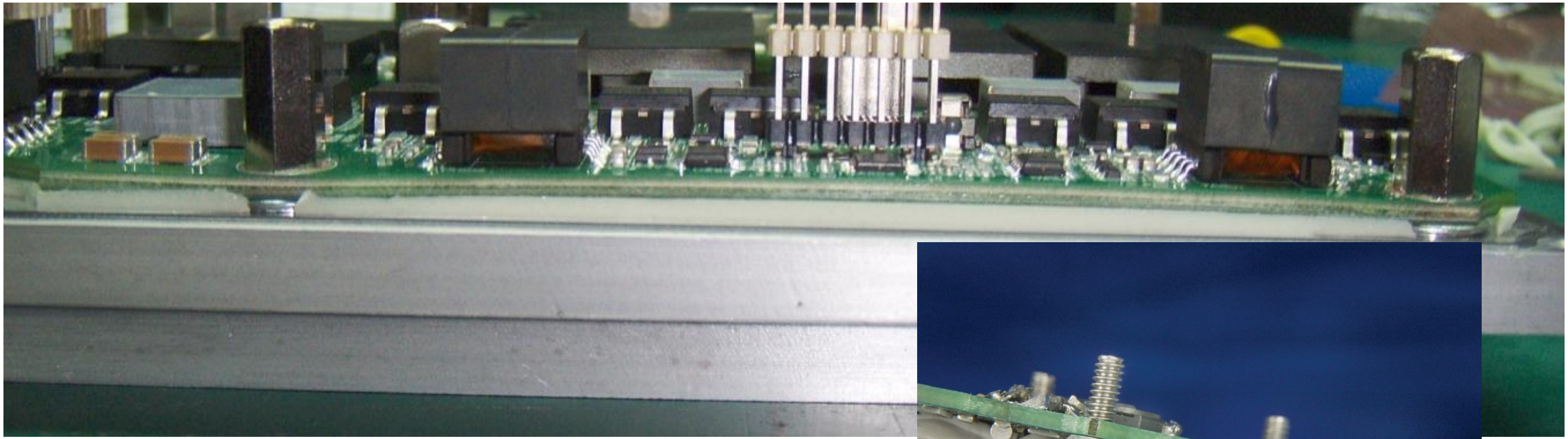
Material	Thermal Conductivity (W/m-K)
Air	0.025
Polymers	0.2
Aluminum oxide	30
Alumina hydrate	25
Aluminum nitride	175
Aluminum	200
Boron nitride	30-600
Silicon dioxide	10
Silicon carbide	100-200
Graphite	120-165
Diamond	2000

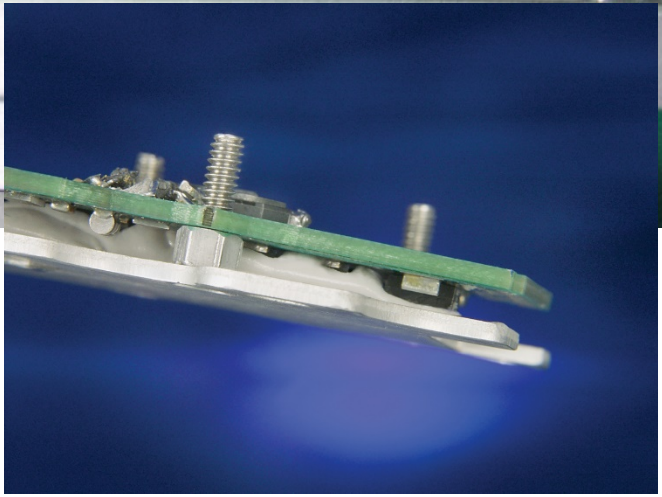


Liquid Dispense Thermal Interface Materials

Benifits of Cure in Place Liquids

- Low Assembly Stress

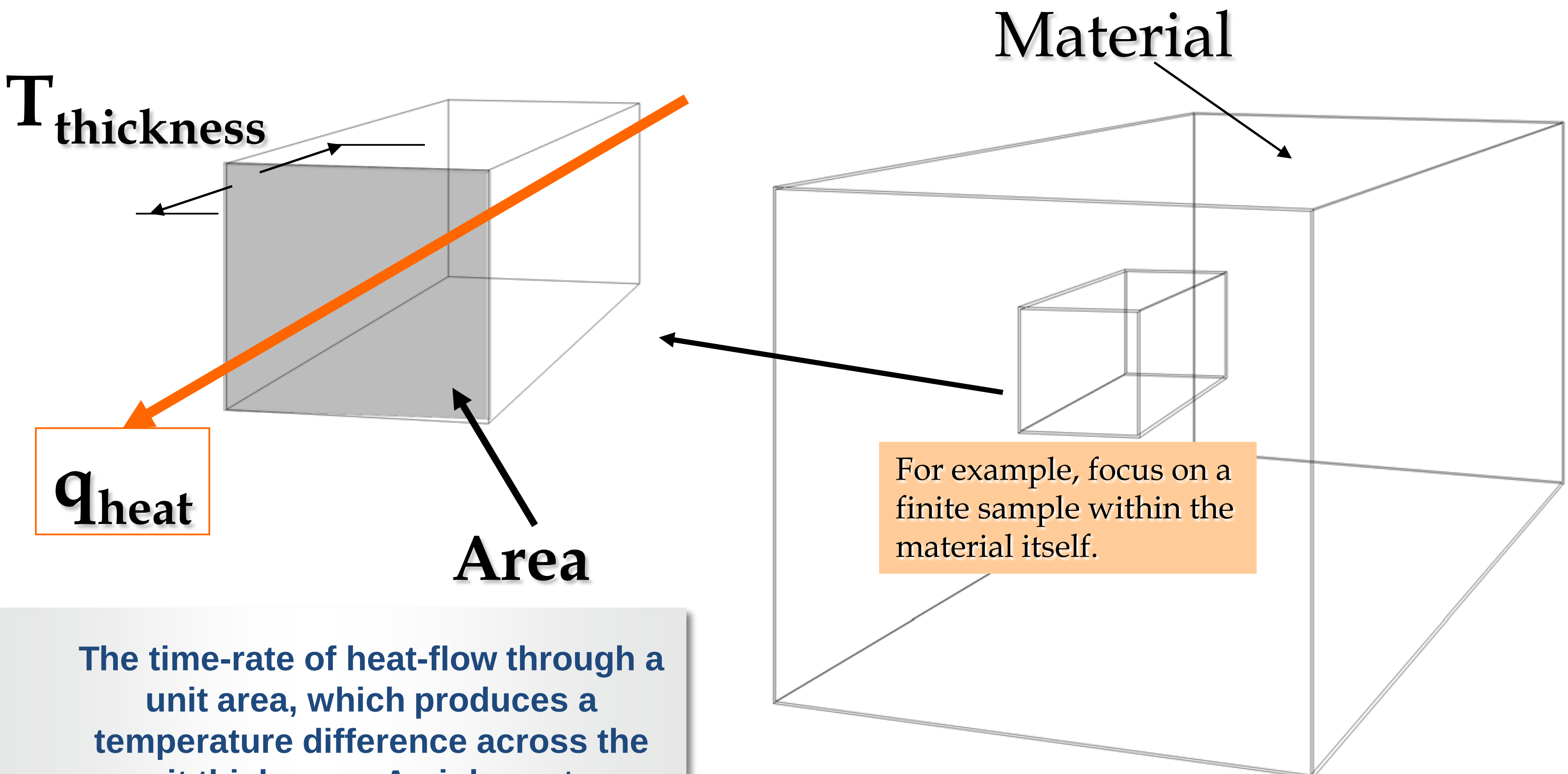




- Conformability
- Optimized Material Usage
- Logistics Simplification
- Thermal Performance and Cost

Thermal Conductivity

Defined

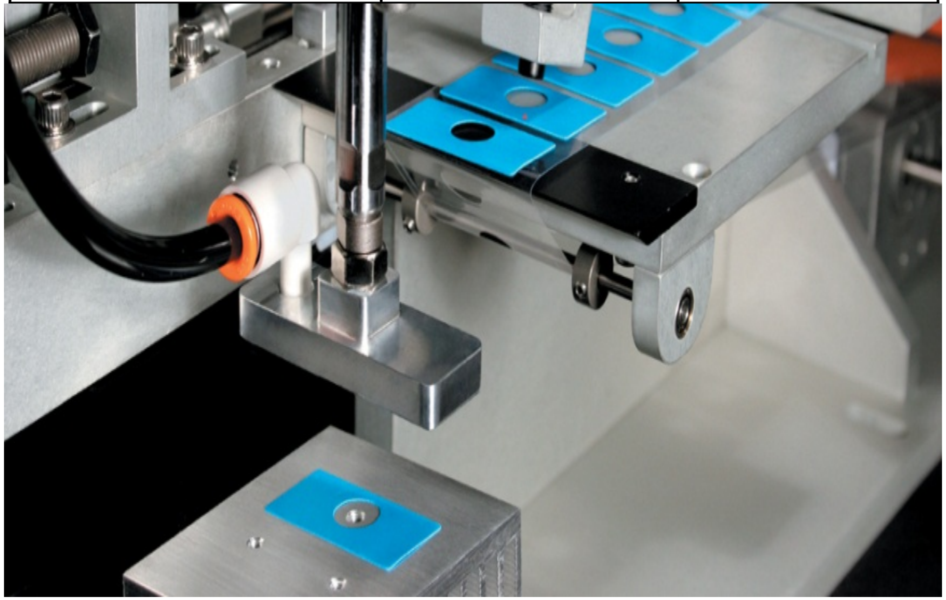


The time-rate of heat-flow through a unit area, which produces a temperature difference across the unit thickness. An inherent or absolute property of the material.

Typically measured in W/m-K

Thermal Conductivity (W/m-K) vs Thermal Resistance (C/W)

	Gap Pad	Liquid TIM
Thermal Conductivity W/m-K	2	1.8
Thermal Resistance °C/W	3.03	2.05

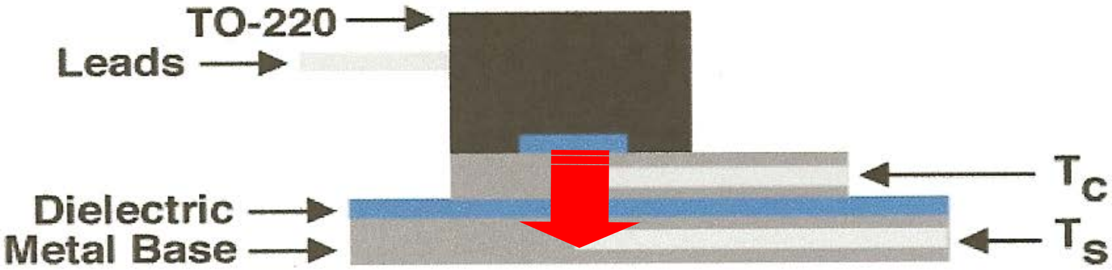


Thermal Conductivity = Material
Thermal Resistance = Application

Thermal Resistance

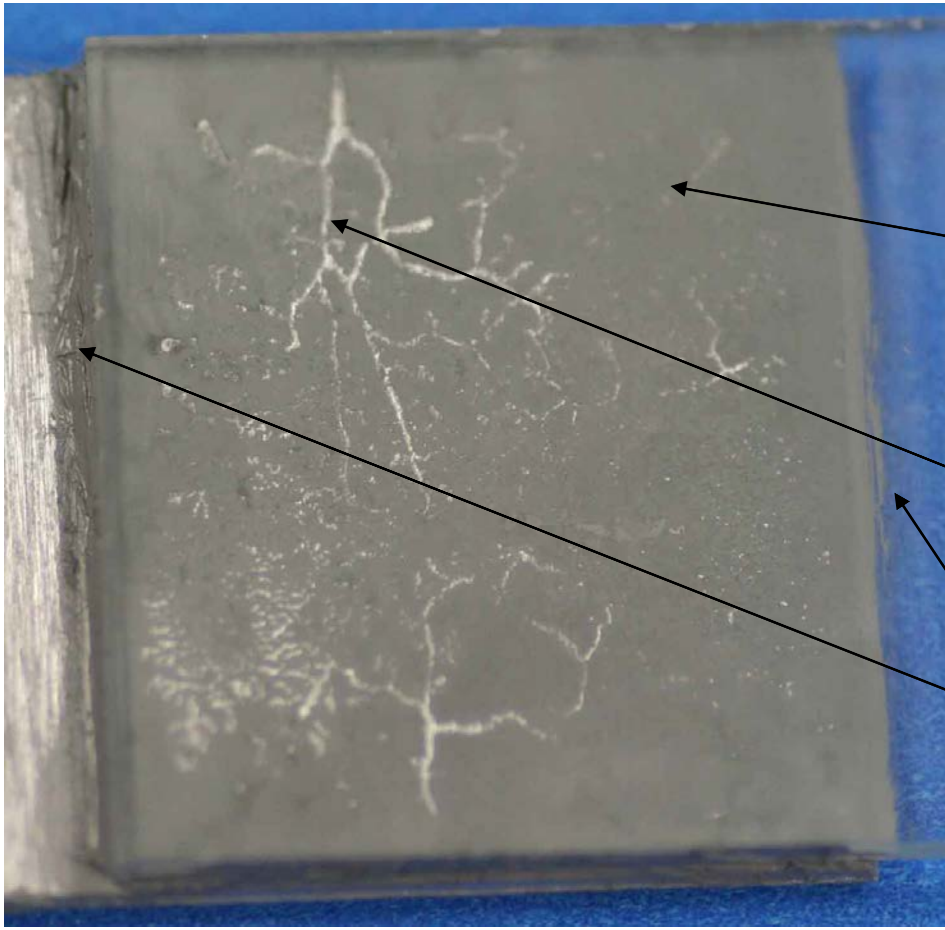
Mapping TO-220 Testing

Thermal Impedance per Bergquist RD Test
Thermal Performance (25ºC Cold Plate Testing)



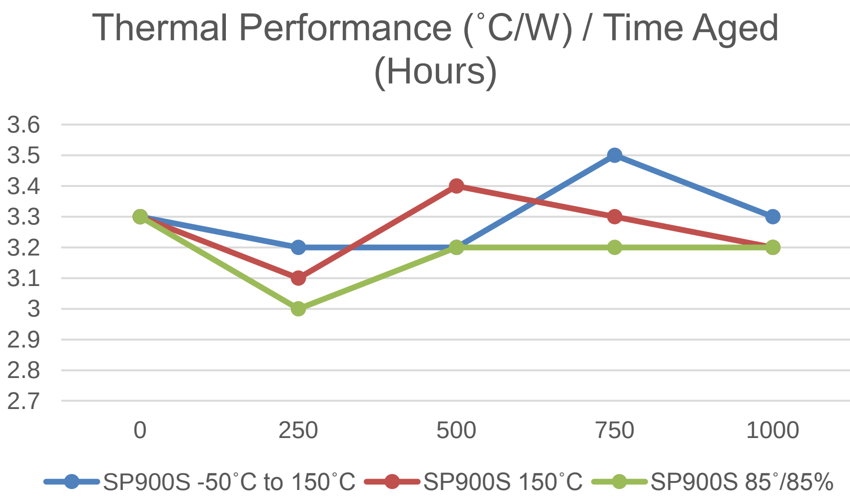
The thermal performance of an assembly measure by the ratio of the temperature difference between two surfaces to that of steady state heat flow through them.

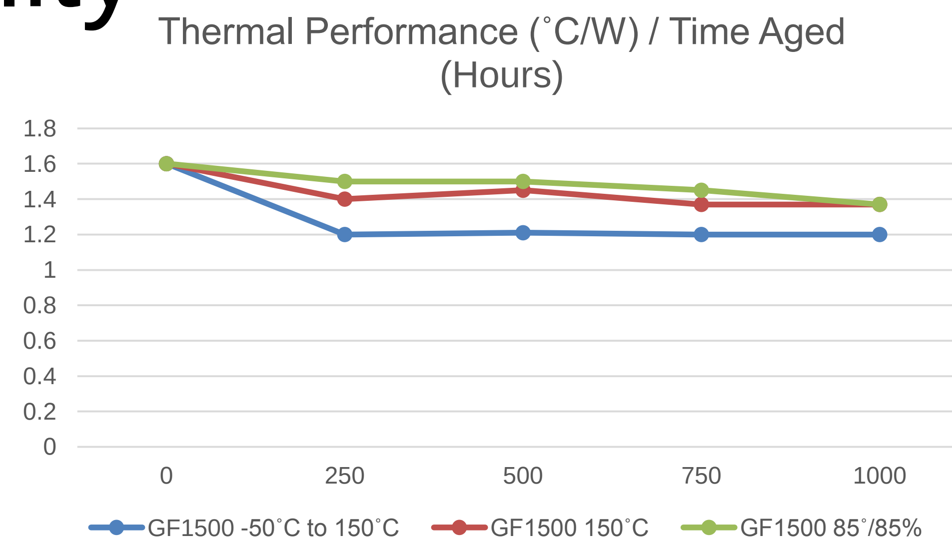
Typically units (˚C/ Watt) include interfacial Resistances

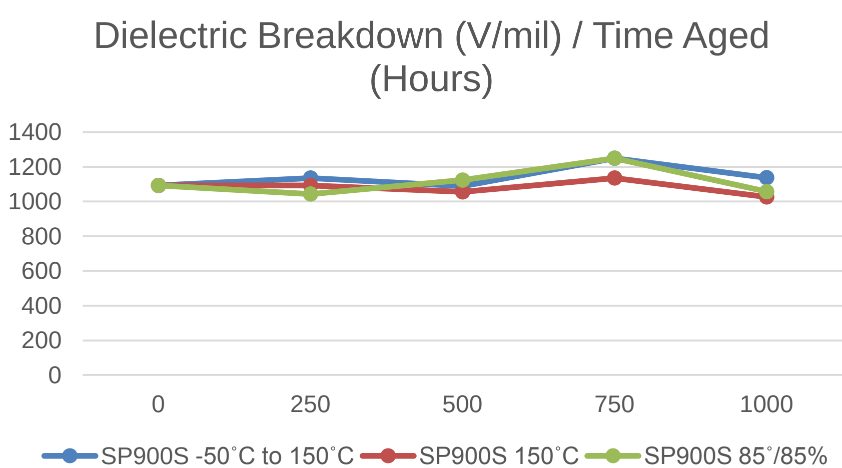


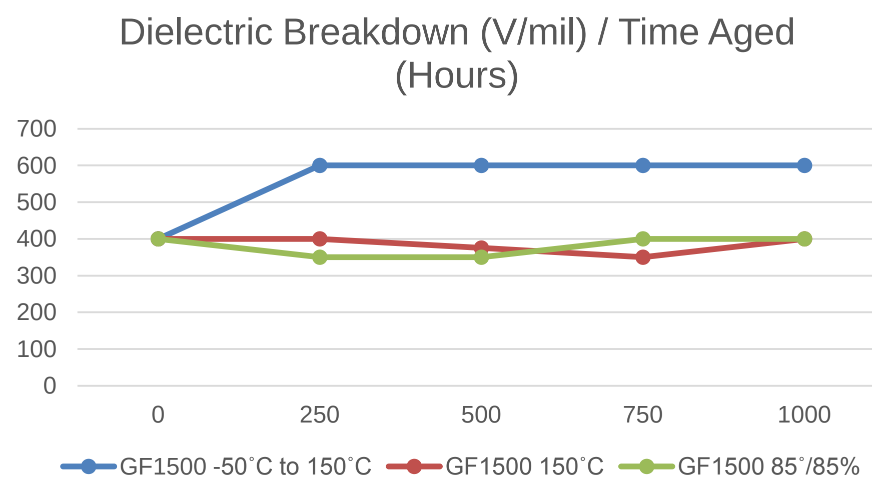
- **Void Formation**
  Air inclusion in the TIM during application to heat sinks. Lack of flow during assembly due to high viscosity or not enough material applied can limit the coverage of the TIM.
- **Pump Out**
  Occurs during power on and off where there is CTE mismatch.
- **Dry Out**
  Loss of polymer content from the TIM. Leads to increased viscosity and increased contact resistance.
- **Flow Out**
  Loss of TIM from the interface due to gravity or other accelerations

Reliability







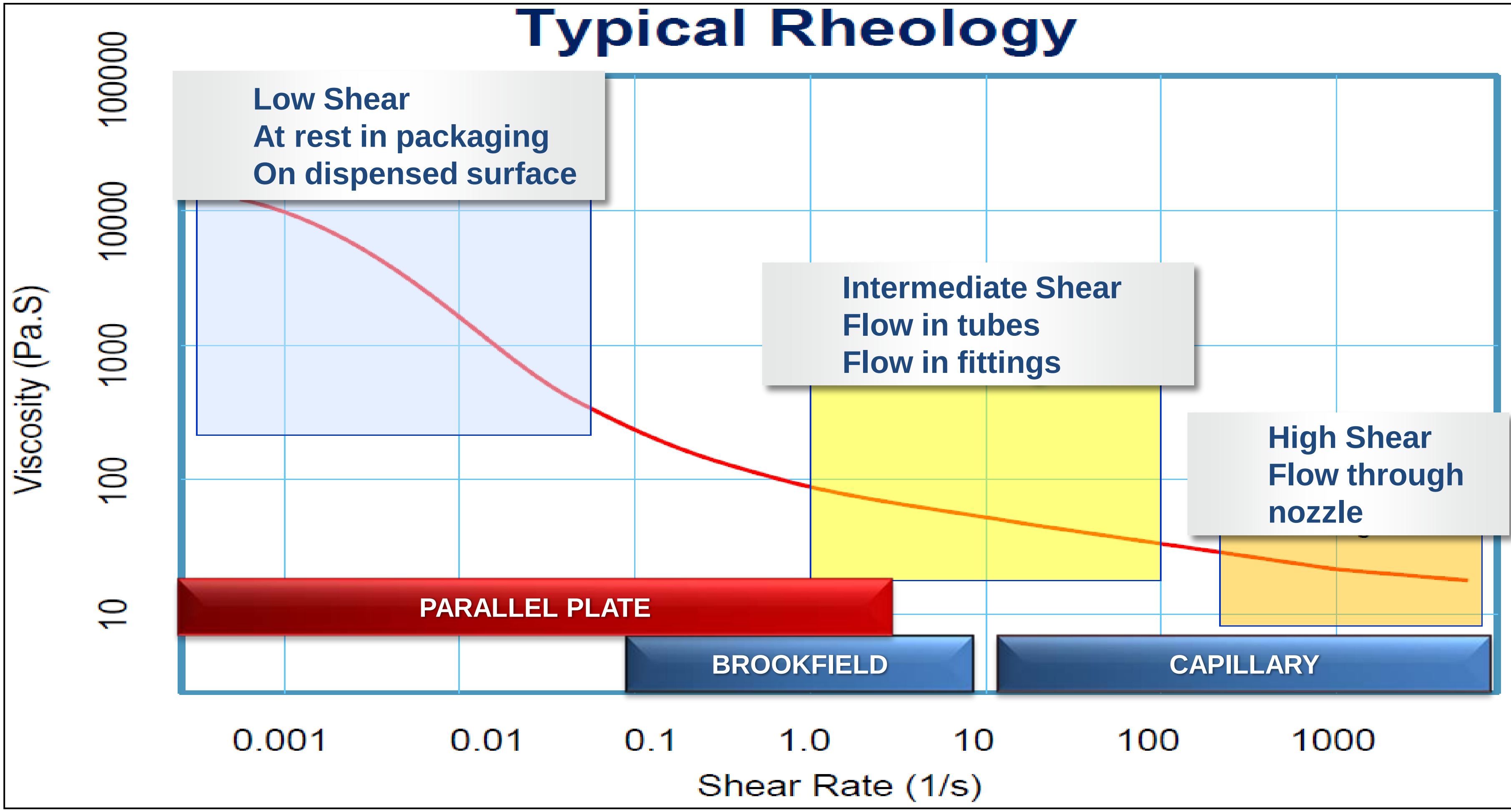


Viscosity

Self Leveling to Slump Resistant

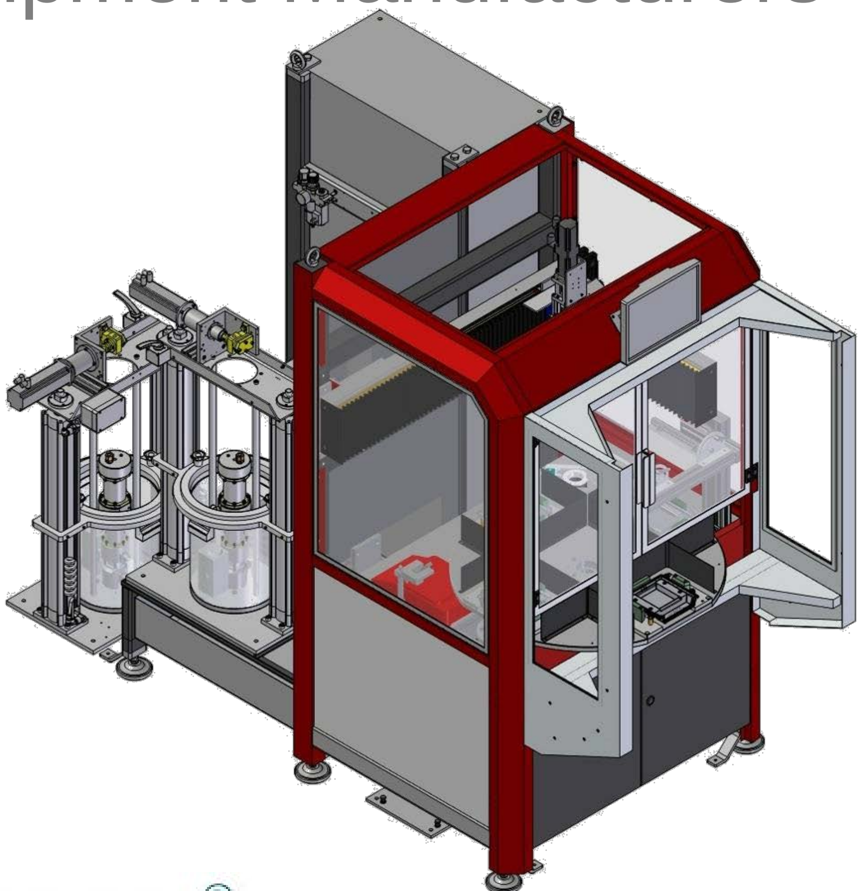
Rheology & Measure of Viscosity

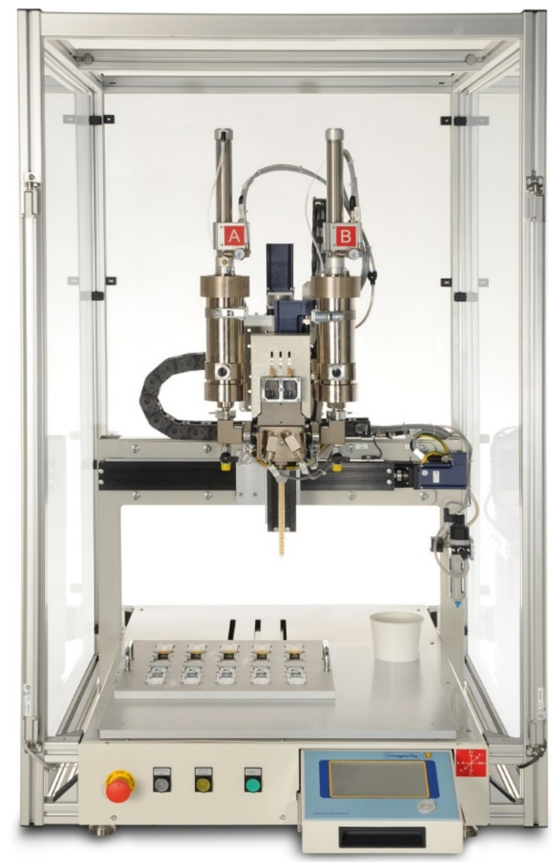
Three Distinct Rheology Zones



Liquid Dispense Alliances

Equipment Manufacturers





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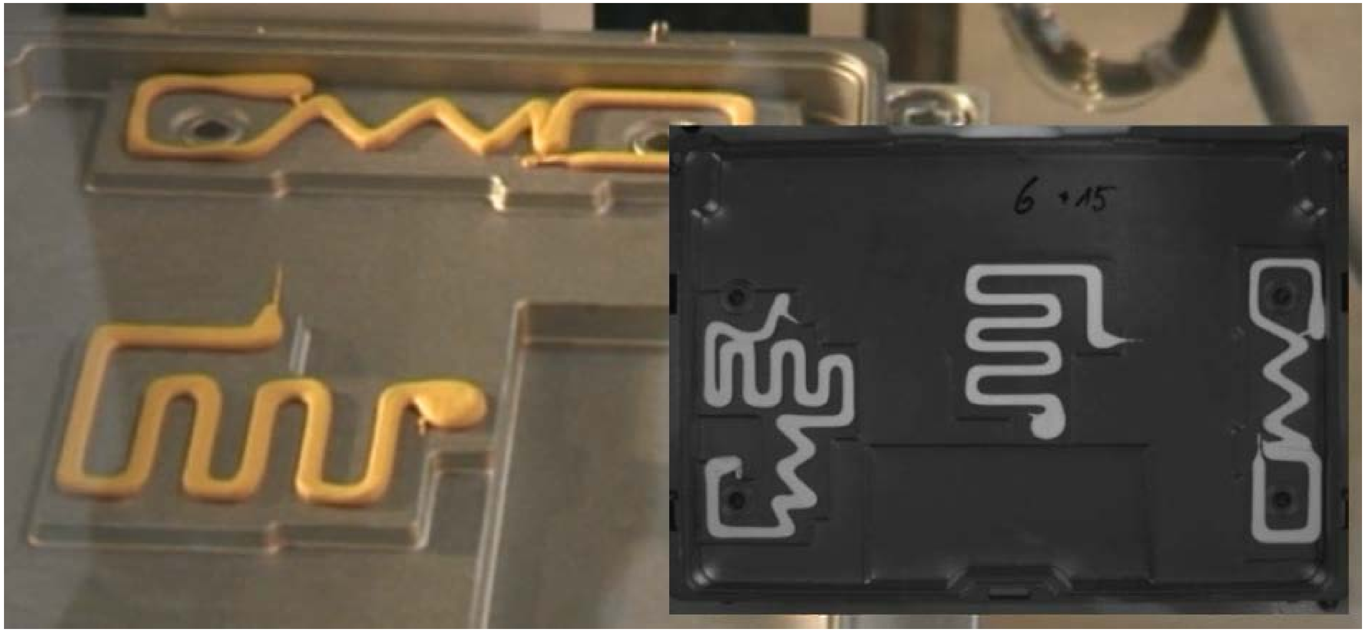
Liquid Dispense Thermal Interface Materials

Quality

- Manually placed pads risk failures – human factor
  - Risk enhanced with multiple pads in one module
- Liquid dispense utilizes automated equipment
  - Slump resistant materials = repeatable bead
- Cameras to quality check the dispense pattern



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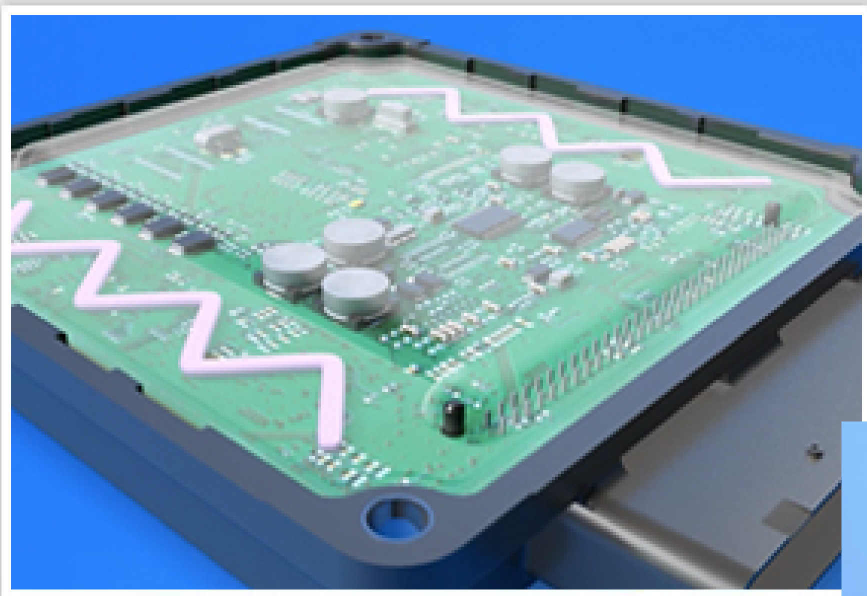
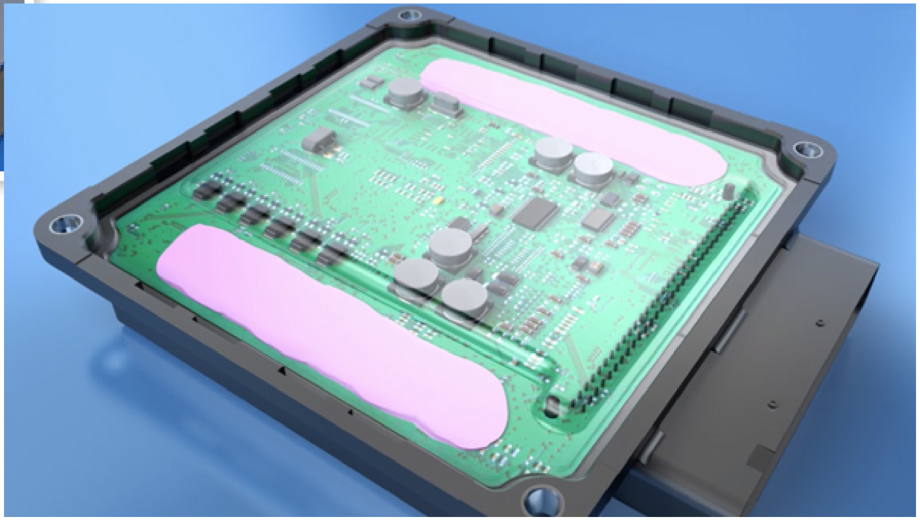
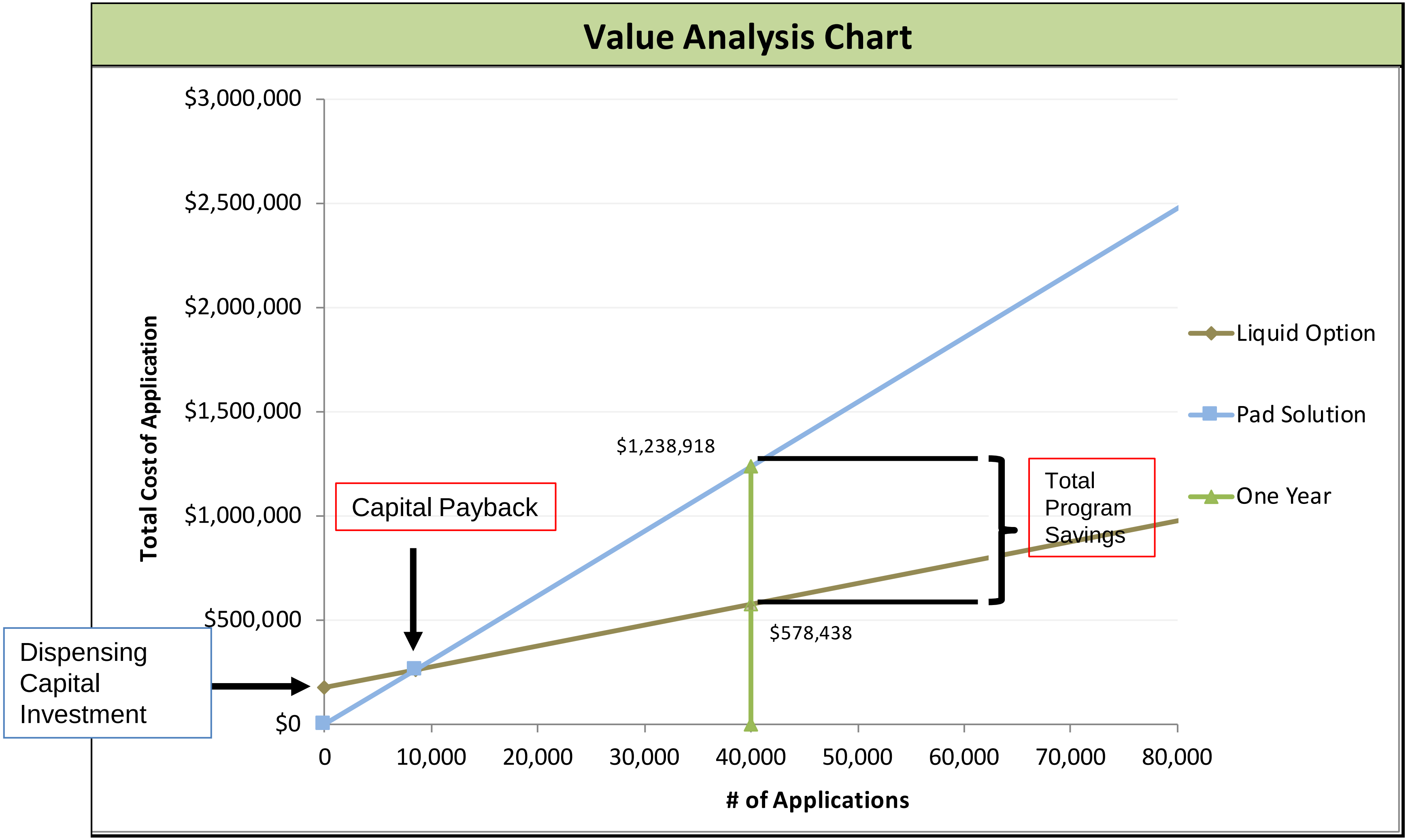
Air Entrapment





Value Analysis Chart



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