Test vehicle for studying thermal conductivity of die attach adhesives for high temperature electronics

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Outline

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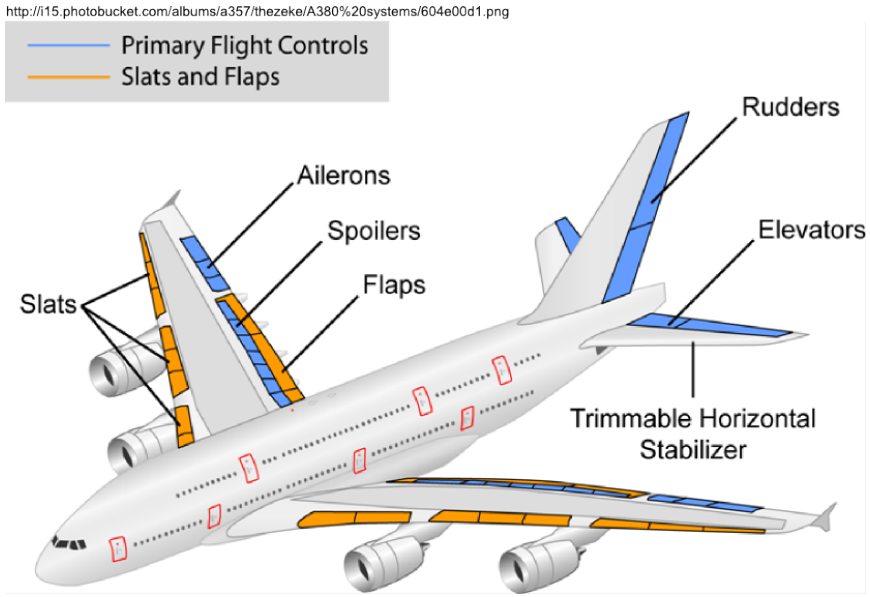
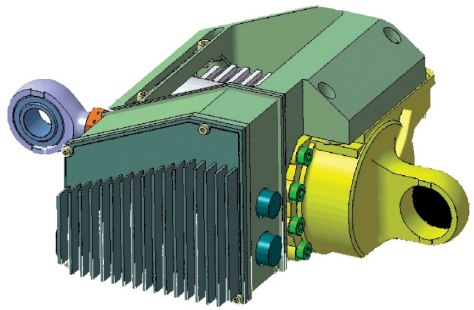
All Electric Aircraft Concept

- Removal of all Aircraft hydraulic and Pneumatic systems
- All are replaced with Electro-Mechanical Actuators (EMAs)
- Engines to supply **Propulsion** and **Electricity** only

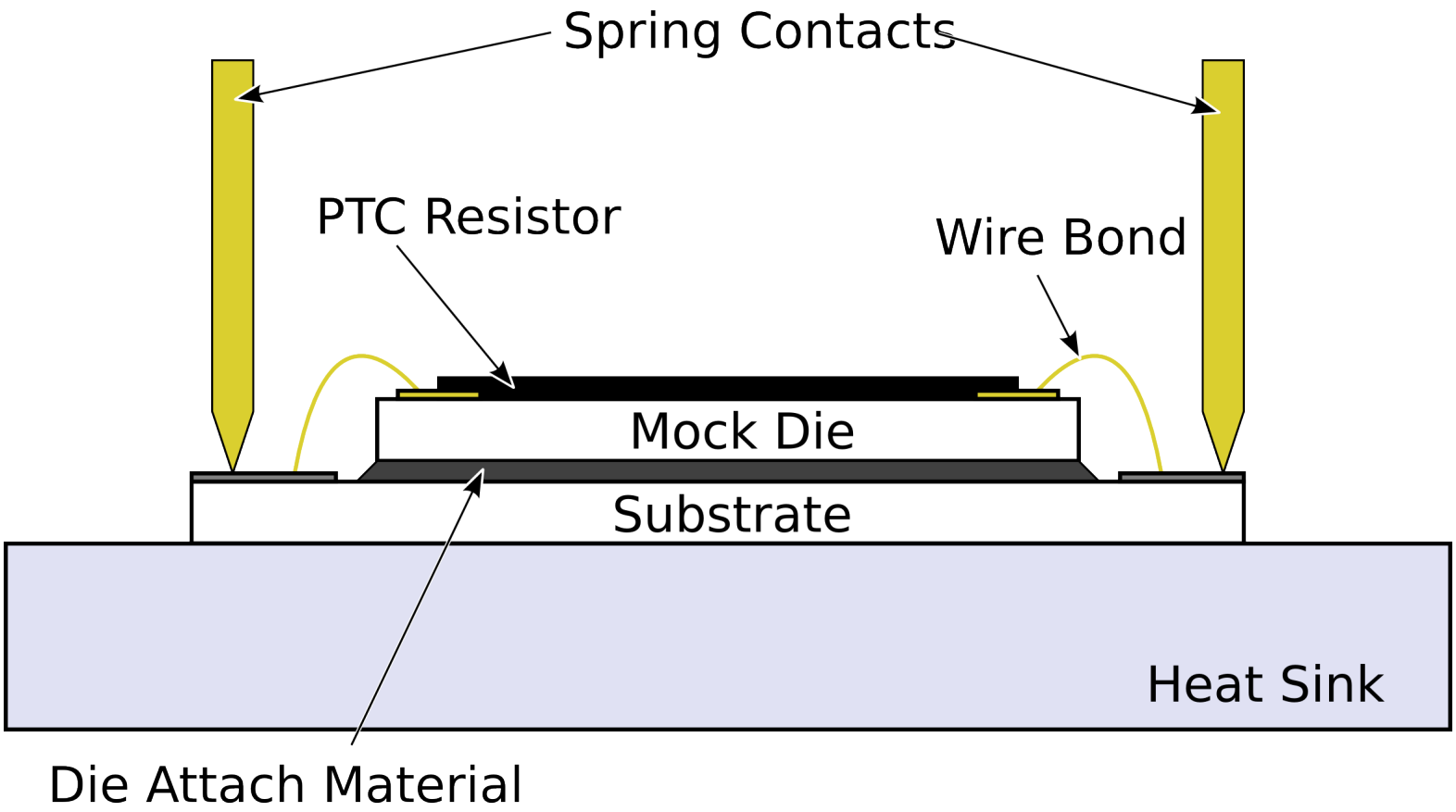


- Necessity for **high temperature electronics**
- High reliability, **high temperature packaging**

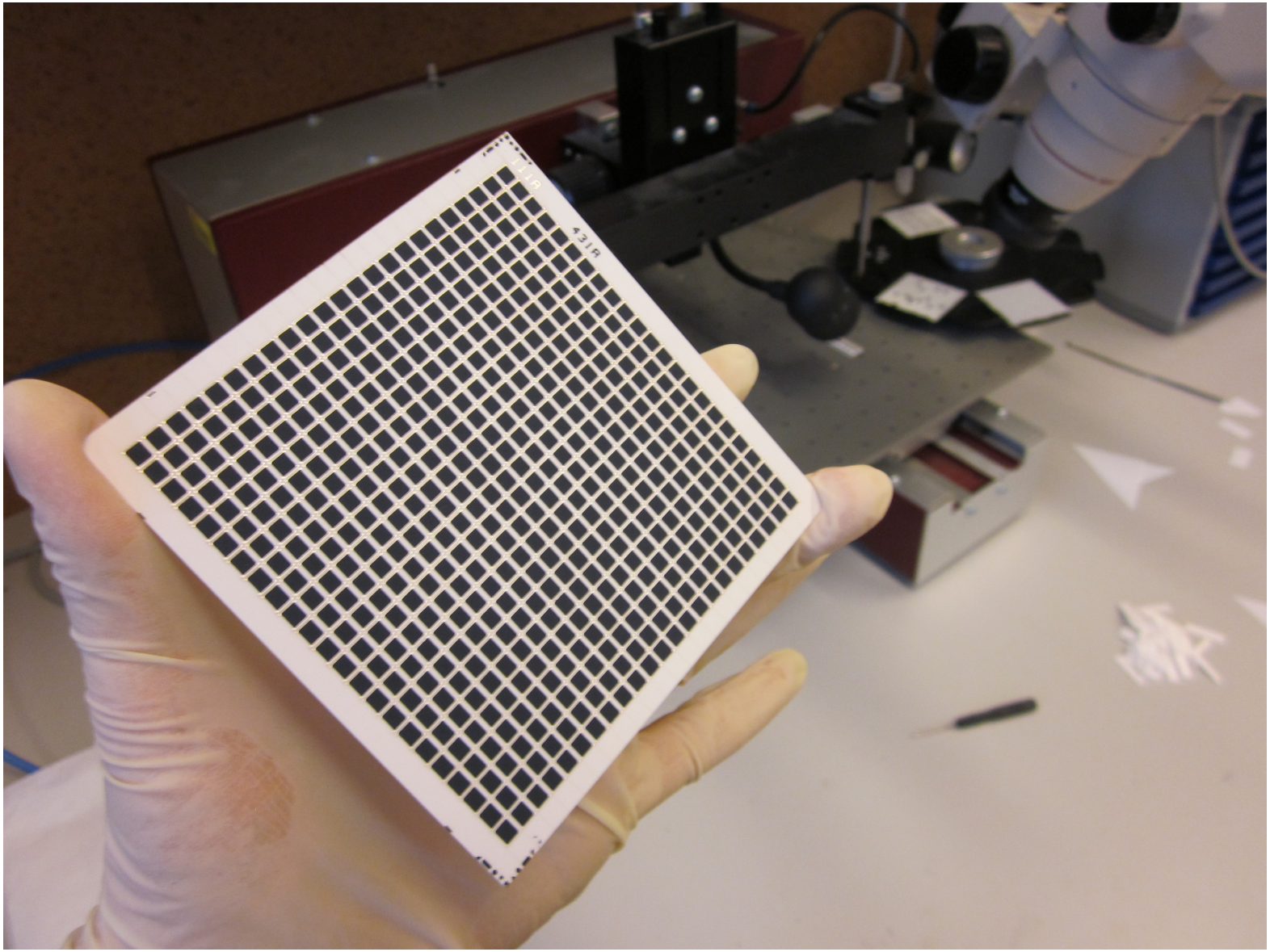


Outline

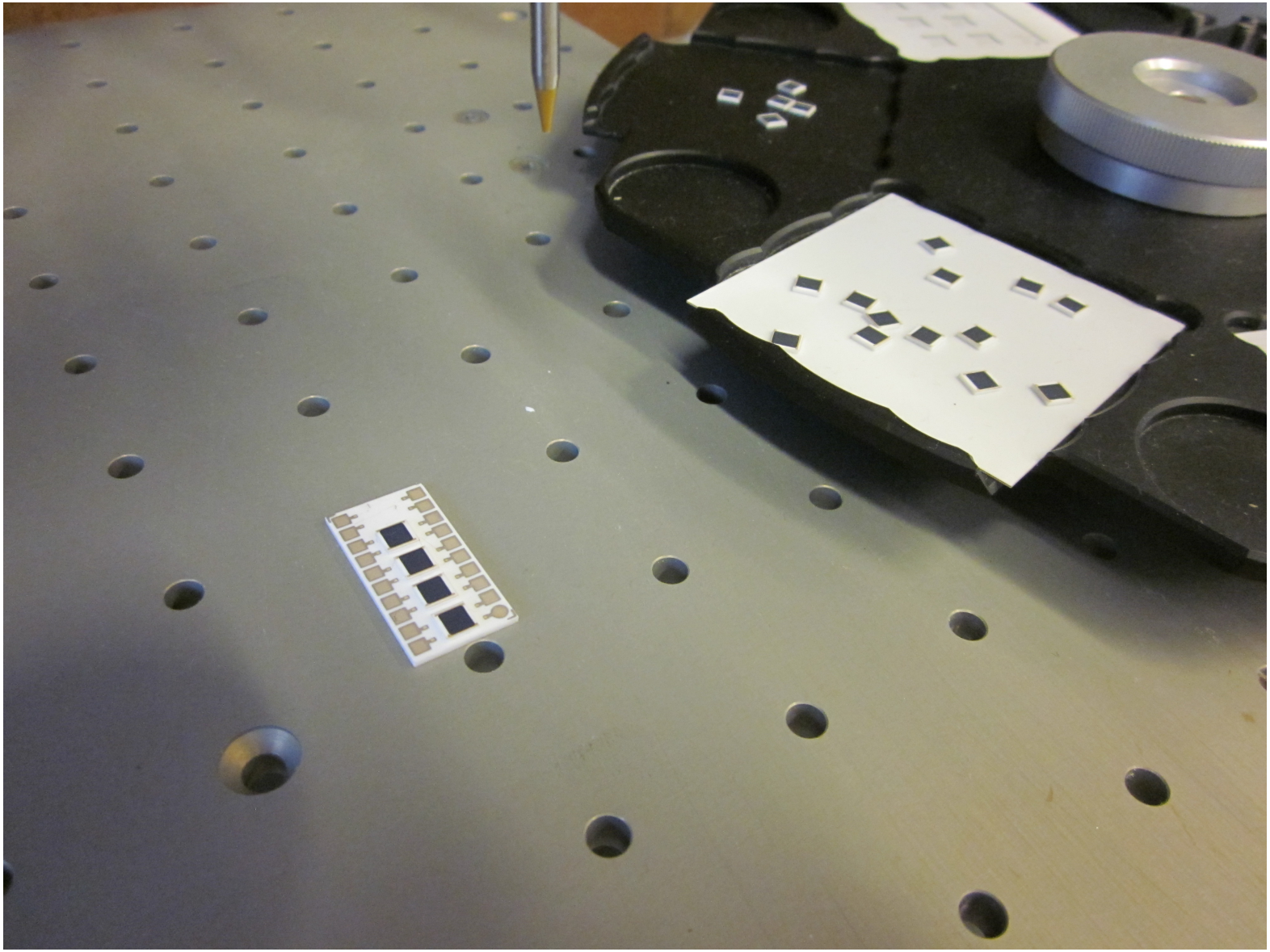
Test Rig


Spring Contacts
PTC Resistor
Wire Bond
Mock Die
Substrate
Heat Sink
Die Attach Material

Mock Dies



Assembling Test Vehicle



Outline

System model

- Heat capacity of die
- Thermal conductivity of die attach
- Dynamic model describing temperature decay
- Describes a system that **decays exponentially**

$$\Delta T = \frac{Q}{S} \tag{1}$$

$$\Delta T = \frac{-L}{kA} q \tag{2}$$

$$\frac{-L}{kA} q - \frac{Q}{S} = 0 \tag{3}$$

$$\Delta T = \Delta T_0 e^{\frac{-kA}{LS} t} \tag{4}$$

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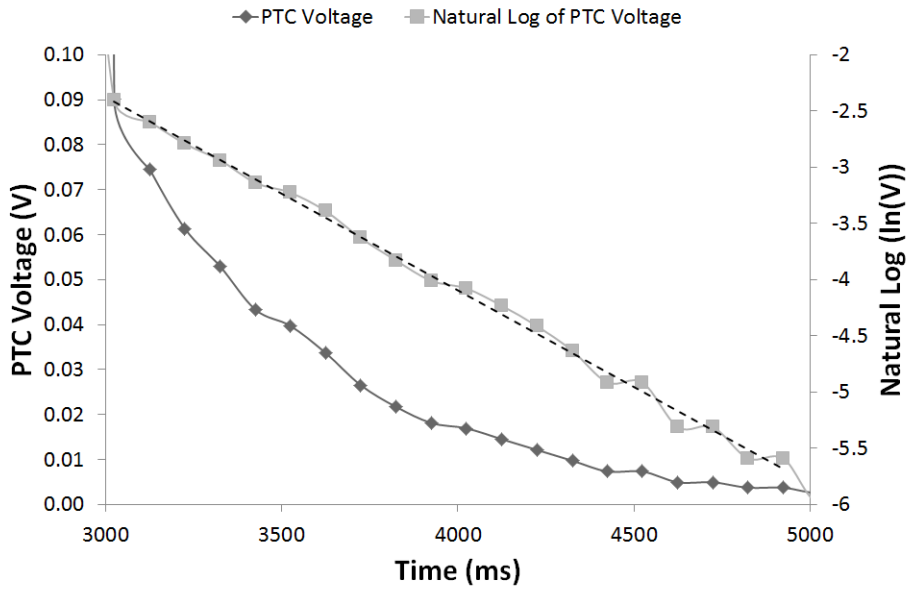
Output

- Decay in temperature is **exponential**
- Shows good **agreement** with the model



- Time constants measured (0.55, 0.72, 0.62, 0.61, and 0.66 seconds) for each die

Thermal Conductivity Estimation

$$\tau = \frac{kA}{LS} \qquad (5)$$

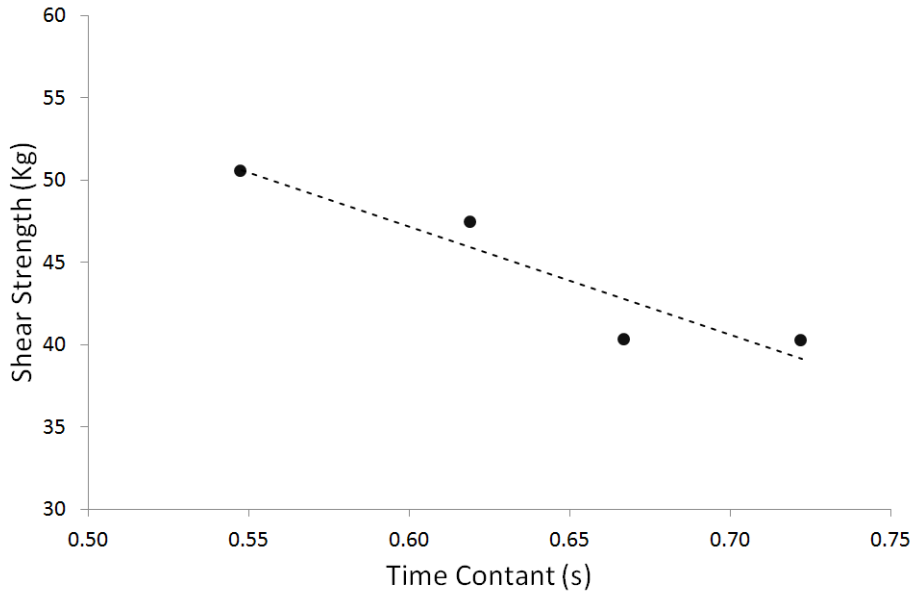
$$k = \frac{LS\tau}{A} \qquad (6)$$

- $L = 50\ \mu m$
- $A = 16\ mm^2$
- $S = 27.2 \times 10^{-3}\ \frac{J}{K}$

- Thermal conductivity calculated (0.15, 0.12, 0.14, 0.14 and $0.13 \frac{W}{mK}$) for each die
- STYCAST 2741 — $0.33 \frac{W}{mK}$

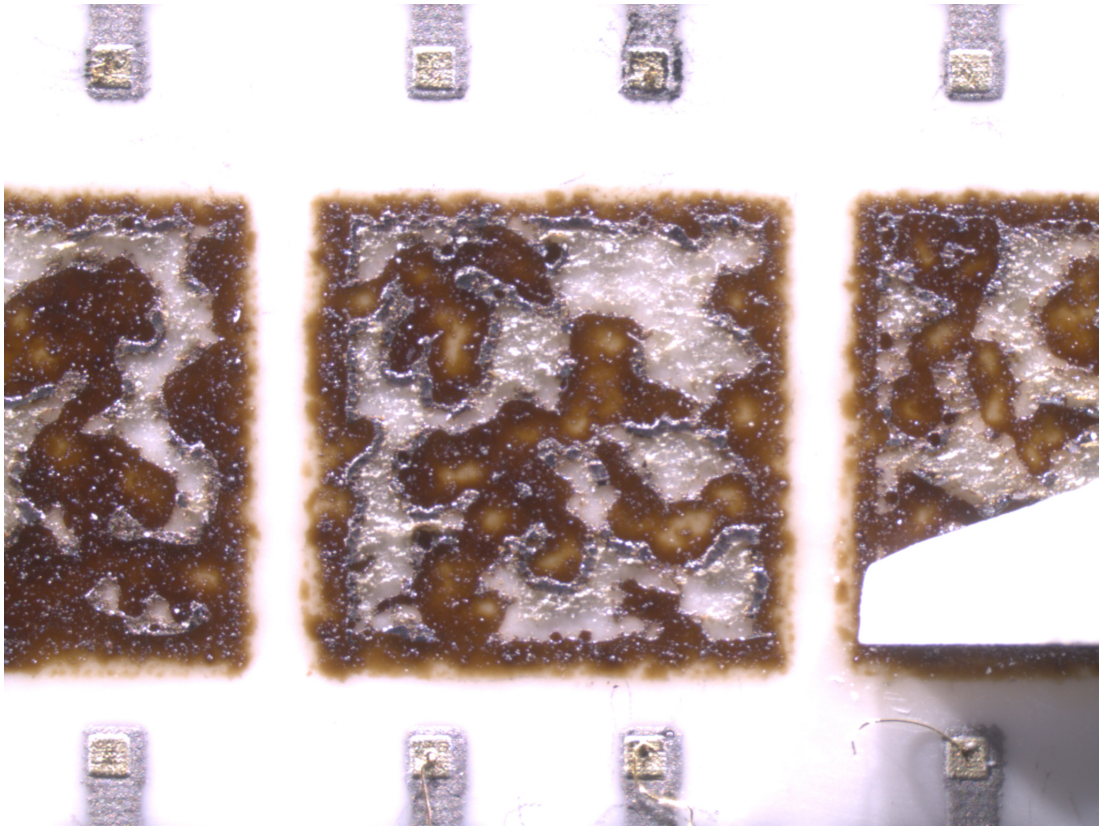
Shear Strength

- Shear strength test **can be used in conjunction** with this method
- Here decreased **time constant** has an increased **shear strength**



Visual Inspection

- Shows that **voids** were present under the die
- Leading to a **reduction** in thermal conductivity



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Conclusions

- Thermal conductivity measurement method presented
- Test Vehicle and Test Rig constructed
- Model developed showing good correlation with output
- Thermal conductivity could be estimated
- Shear strength test and inspection under microscope performed

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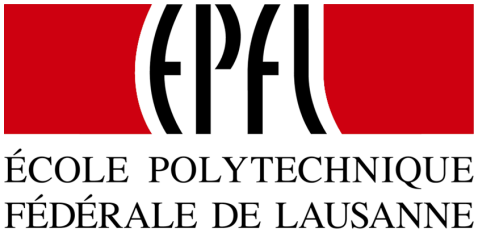
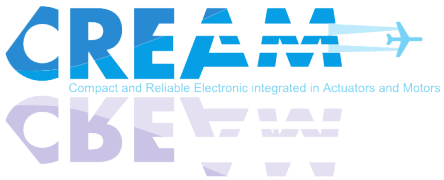
Thank you for your attention





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