Optimisation of industrial production of low-force sensors – adhesive bonding of force-centring ball

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Sensor & sensing principle

Basic force sensor (left, alumina cantilever) & LTCC cantilever version (right)

Goal: replace soldering of ball by adhesive bonding

Advantages
• No need for expensive special metallisation of cantilever and ball
• Allows use of glass balls: better thermal & electrical decoupling; low-cost
• One less solder reflow cycle: reduced leaching of metallisations (more critical issue with modern lead-free solder)

Issues
• Ensure positioning without the strong capillary forces present with soldering
• Ensure sufficient bonding strength

Approach
• Print "cuvette" for mechanical centring of ball

Optimised cuvette geometry & formulation

Optimised cuvette with square geometry to allow easy evacuation of excess adhesive in the corners & new formulation with 41% Al2O3 + 1.7% ethylcellulose EC-300-48 ("EC") showing much better printing characteristics

Optimised adhesive composition & resistance to solder reflow

Comparison of different adhesive formulations (** = simulated soldering cycles, 5/15 min at 260°C)

• Epo-Tek H70E2 selected: good strength & right rheology
• Resistance to solder reflow not problematic
• Sufficient strength for all tested ball materials

Conclusions
• Adhesive ball mounting process successfully developed to replace solder attachment:
  1) Depositing a 'cuvette' layer for mechanical centring
  2) Placing & bonding the ball with a second 'glue' layer

• Simpler processing than soldering; fewer solder reflow cycles
• Proper positioning of ball achieved
• Obtained strength levels acceptable by a large margin