

Collaborative Research Programme Proposal

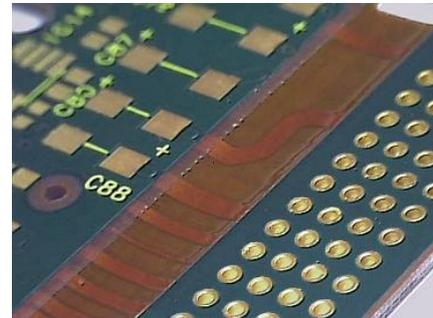
Assessment of Flex-Rigid PCB Substrates in High-Reliability Applications

The drive towards smaller electronics places constant pressure on space utilization and has led to the increased usage of flex-rigid PCBs in many applications.

Due to increasing circuit functionality enabled by smaller components, often with increasing i/o counts, the density of through hole, core and micro-vias has increased significantly with the number of mechanical drill hits per PCB and manufacturing panel, increasing in sympathy

The issues:

- Increased processing temperatures, may affect the reliability of flex-rigid substrates
- As soldering temperatures are increased, the substrate will expand more in the z-axis, thus increasing the corresponding strain on the copper barrel of the vias and potentially increasing the risk of material damage.
- During cooling, compression of the barrel of the via may cause plastic deformation in the copper, resulting in resin recession voids at the pre-preg layers.
- Propensity for multi-layer substrates to delaminate may be increased and electrical insulation properties may be disrupted.
- The flex layers in flex-rigid PCBs are polyimide and unconstrained. The effect of this on via reliability is unknown.



Picture courtesy of Graphic Plc.

The solution

The National Physical Laboratory, in conjunction with the Technology Innovation Fund, is launching a collaborative "Research Club" with industry to investigate the reliability of a range of flexi-rigid substrate structures after processing at lead-free soldering temperatures.

The benefits

- To provide the partners with a test method and data, enabling them to measure the effect of higher temperature soldering (result of being lead-free) on reliability of electronics substrate structures
- To improve partner confidence in the reliability of PCB flexi-rigid substrates in a lead-free soldering environment
- Access to detailed results during the project including
 - Intercomparison of inclusion/exclusion of non-functional pads
 - Effects of the number of reflow profiles on flex-rigid reliability
 - Performance of different aspect ratio vias
 - Relative performance of polyimide vs epoxy rigid builds
- Ability to influence project variables during the project
- Interaction and knowledge exchange with other flex-rigid end-users

Proposal Outline

An investigation by thermal cycling of test substrates is proposed, using a test vehicle to explore the effects of a variety of process variables on the reliability of flexi-rigid structures. The project scope will be decided on by participating partners, but as a guide, may include:

- Removal of non-functional pads
- Build structure (polyimide rigid + polyimide flex, 10R+2F, 8R+4F, 4R+8F)
- Build structure (FR4 rigid + polyimide flex, 10R+2F)
- Surface finish (ENIG, bare copper)
- Reflow soldering (3 and 6 LF passes)
- Via aspect ratio (8:1 and 6:1)

Phase 1: Initial project meeting to agree design, materials and fabrication variables as well as timescales and test methodology with partners

Phase 2: Design test structures incorporating agreed variables into via chains in range of flexi-rigid builds. Confirm test structure design and flexi-rigid builds with partners

Phase 3: Liaise with fabricator partners to build test structures. Condition test structures through reflow soldering profiles

Phase 4: Thermal cycle test structures (-55 to 125°C) to maximum of 2000 cycles with constant monitoring of via chains. IST testing of similar structures. Analyse failures and produce intercomparison weibull plots. Micro-section example failures to determine failure mode.

Phase 5: Present results to partners at final partners meeting and provide written report.

Funding

- A joining fee of £5,000 will be required to become a member of the Flexi-Rigid Research Club. 100% of this will be used to fund the project.
- NPL's Technology Innovation Fund will provide 2 days' worth of funding for the project per *Research Club* member
- Project contributions will be invoiced after the project start. NPL will require a company PO prior to the project start

To express your interest in the above project please contact either:

Peter Benson, Technology Innovation Fund Manager
020 8943 8746, peter.benson@npl.co.uk

Or for more technical discussions, please contact the project leads listed below:

Please contact either of the following:

Martin Wickham
Tel: 0208 943 7150
martin.wickham@npl.co.uk

Chris Hunt
Tel: 0208 943 7027
chris.hunt@npl.co.uk