**Motivation and Introduction**

Printed circuit boards (PCBs) are the backbone of all electronic devices; they act as interlay wiring and are responsible for the mechanical stability. Most PCB’s consist of fibre reinforced polymers and Copper. The polymeric faction acts as dielectric and mechanical carrier whereas the Cu is responsible for the electrical connectivity. In order to overcome design limitations and to enhance the functionality, multi-layer PCBs are manufactured. In such boards up to 14 layers of Cu and polymer-composite are laminated together.

This stacking bears an intrinsic source of failure because the different types of materials have a high difference in their thermal expansion coefficients. This and the polymeric shrinkage during solidification can lead to failures such as cracks in the dielectric or delamination between Cu and polymeric parts. The latter one is the main cause of failure in PCB’s subjected to thermo-cyclic loading. Such thermo-cycles occur during fabrication of the boards, in the soldering cycles during mounting of components on the boards and during service when, for example, a mobile phone is exposed to the sun. In the last decades a lot of effort has been made to overcome these issues, mainly by introduction of new composite materials, new processes and improved overall process control.

**Innovation and Testing Procedure**

The project team took up the challenge to find methods for testing and detailed understanding of near to perfection engineered interfaces between Cu and Polymer-composite.

The new developed method consists of special designed sample build up, a so called 4 point...
bending test, coupled with a finite element (FE) simulation tool for secure evaluation of analyti-
cally gained results. The test is sketched in Fig. 1. As shown, the test specimen consists of eight
Cu sheets, fixed together by 7 polymer compo-
site dielectrics.

When a bending experiment is performed, the
force raises constantly till the fracture strength of
the sample in the notched area is reached as
shown in Fig. 2a. At this point a crack forms at
the notch and is deflected at the weakest inter-
face as shown in Fig. 1a, leading to a load
plateau in the force displacement curves. The
force-displacement curves are the basis for the
further evaluation and interpretation of interface
toughness in PCB materials. Only with simula-
tion, as shown in Fig. 2, it is possible to account
for the nonlinear material behaviour and the
friction between the sample and testing device.

The resulting interface energy is calculated
considering all mechanical properties of the test
species, details are summarized in [1]. The FE
code was summarized in an easy to use plug-in
called “Bending Test” and transferred to compa-
ny partners where it is used in house.

The project generated a deep insight into the
main causes of delaminations in printed circuit
boards via the design of a suitable test method
for high quality PCB’s. The main impact of this
project is the knowledge build up regarding
interface strength and the new testing method.
The first one could be directly used by fabrica-
tion partners for the optimization of the manufac-
turing processes; the second one is now part of
the process-design and qualification routine at
AT&S and Panasonic Austria. It should be one
cornerstone in the development of next genera-
tion PCBs for highly loaded applications.

[1] R. Schöngrundner, et al., Adhesion energy of
printed circuit board materials using four-point-
bending validated with finite element simul ations,
Microelectronics Reliability (2015)