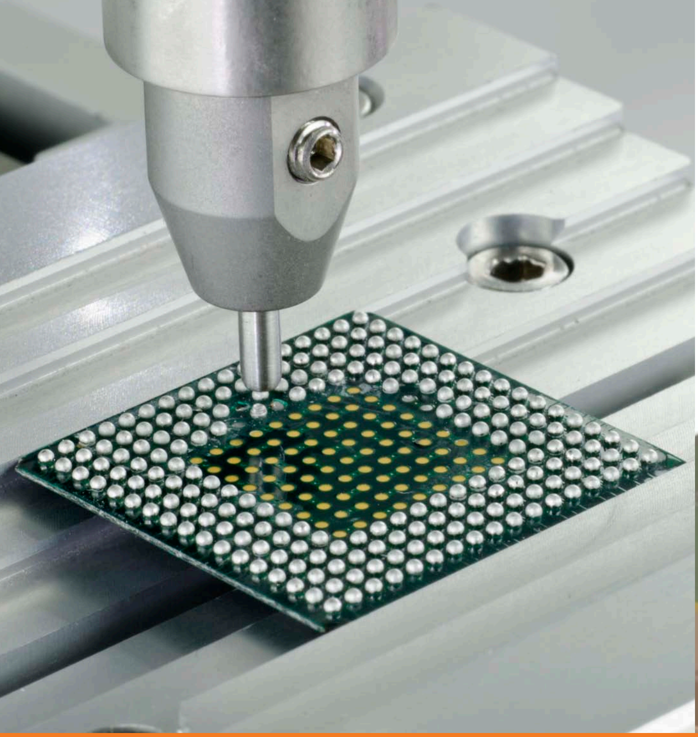
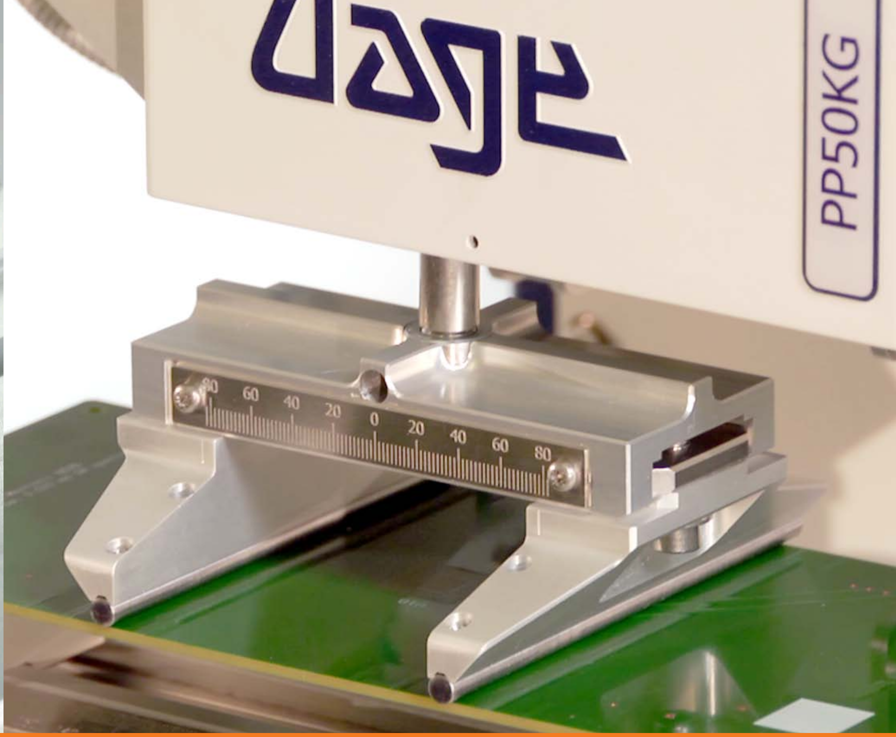




Low Cycle Fatigue of Individual Soldered Interconnect

Application Note

THE CHALLENGE

The solder joint is the weakest connection in a printed circuit board and cyclic strain from thermal expansion, vibration or bending can easily cause joint failure.

Fatigue is a major cause of solder bond failure and due to their small size, assessing the bond's fatigue resistance is far from straightforward.

Mechanical tests, performed isothermally, are different from those done by thermal cycling. Thermal cycling not only strains the connections, but big changes in microstructure can occur.

However, isothermal fatigue testing can be used to understand the affect of solder composition, reflow parameters, aging and pad materials on bond lifetime.

THE SOLUTION

The simplest way of straining a solder joint is to bend a test board on which the component has been attached. Bond failure can be monitored by measuring the resistance of two or more connections.

However, fatigue of solder is a complex subject and it sometimes helps to go back to basics and perform testing on individual bonds.

Bi-directional shear loading is a simple way of applying an alternating shear load to an individual bond. Interpretation of the data is made more complicated by the shape of the bond, but for comparative purposes, this disadvantage is largely outweighed by the simplicity of the test.

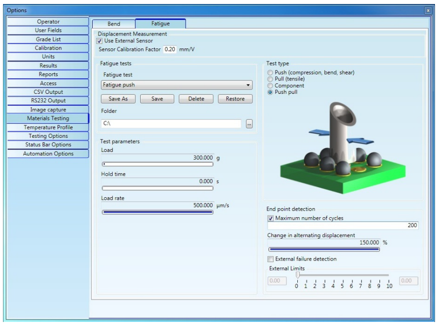
Nordson DAGE

THE METHOD

At high plastic strains, fatigue lifetime can be from just tens to low thousands of cycles and large changes in displacement are observed as the solder deforms.

Bi-directional shear fatigue is performed using either an S250 (250g) or S5KG (5Kg) cartridge. The cartridge senses the substrate surface and using the precise Z servo of the 4000*Plus* micro materials test system is able to set shear heights down to less than 1μm. A direct drive XY stage is used to slowly oscillate the sample beneath the tool with Paragon™ test software providing control of peak load, ramp rates and hold time at peak load.

As with all small scale testing, displacements are very small and Paragon™ takes into account tool deflection. If higher precision is required, the external interface on the 4000*Plus* can be used to input measurements from an external transducer.



All measurement parameters can be saved to a Test Group

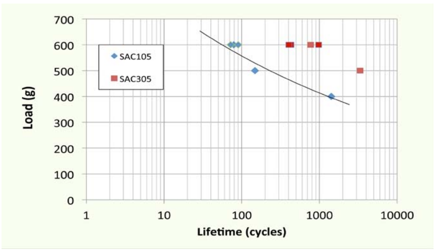
THE RESULT

Cycling can be completed to failure of the bond, or the test can be stopped and dye penetration or a static shear test can be used to evaluate the degree of crack propagation.

Dye penetration provides direct observation of the crack size, shape and location.

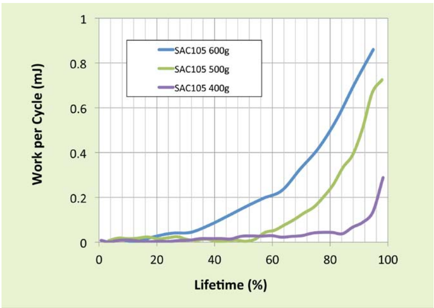
At any given set of conditions, fatigue lifetimes vary considerably and any data analysis must take into account the statistical nature of this process, usually testing multiple samples for each test load.

In general, fatigue data is plotted as load or strain against the log of the number of cycles to failure.



Fatigue life for two lead free solders

Load-displacement data is collected for each cycle and the area enclosed by the plot used to calculate the energy lost in plastic deformation. Some models use this data to predict fatigue life under more complex loading conditions.



Work per cycle determined from the load vs. displacement plot for three different test loads

In addition, as the crack grows the bond becomes more compliant and this change is measured by the slope of the load-displacement plot.

For more information, please contact your Nordson DAGE regional office or speak with your Nordson DAGE representative, all of which are listed on www.nordsondage.com.

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