C. Radial Alignment of Photonic Packages with Sequential Laser Spot Welds

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Introduction

Commercial fiber optic packages typically are spot welded with a laser that delivers 2 or 3 equal energy beams to the work piece synchronously through the use of separate optical fibers. By positioning identical focused laser beams at equidistant positions around the part perimeter and through synchronous pulsing of each fiber, multiple welds are made simultaneously. Since the welds are on opposite sides of the part, post weld shift is thought to be minimized. It is believed that shrinkage strains from each weld are cancelled out via the synchronous weld approach and fiber alignment prior to welding is maintained.

Technical Approach

This investigation was prompted by the need to actively align a TO type diode laser to an optical fiber. The use of a cylindrical radially aligned package has inherent design advantages for assembly with laser welding and was chosen for this study. Ferrules were attached to 125μm optical fibers that enabled measurement of the post weld shift while exploring process variables including spot weld location, restraint load, and their effect on post weld shift direction and magnitude. Measurements of post weld shift were made initially with Eddy Current Sensors and later with a CCD camera.

Results/Discussion

It was found that the ferrule moved consistently down after each laser pulse even for welds that are not restrained. For the welds that were restrained, it was observed that post weld shift magnitude is significantly decreased due to the load, as is the variation in magnitude. It was found that through the application of an axial restraining force on radially aligned ferrules, post weld shift was reduced to less than 2 μm.

Shrinkage due to welding was roughly approximated by considering linear thermal expansion due to the weld heating. The transverse shrinkage was calculated with shrinkage of the surrounding heat affected metal and shrinkage of the weld. From the analytical methods which are independent of stress, estimates of post weld shift were determined which were reasonably consistent with the measured values of post weld shift.

These results for asynchronous laser pulses plainly indicate that active alignment can be employed in the same manner it is employed using two or more synchronous pulses. If the post weld shift is the same for each weld, then welds that are made asynchronously and sequentially should have the same resultant post weld shift as welds that are made synchronously.

Conclusions

Application of a restraint force on the ferrule during welding reduces both the magnitude and variance of post weld shift. Post weld shift magnitude is independent of the location and number of prior tack welds. Post weld shift direction is relatively consistent and predictable when welds have a minimum degree of restraint. Based on the results in this investigation an alignment method using asynchronous laser

spotwelds appears to be a simple and practical approach to the task of photonic alignment with laser welding.

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