METHOD 2035

ULTRASONIC INSPECTION OF TAB BONDS

1. Purpose. The purpose of this method is to detect unbonded and insufficiently bonded sites in TAB (Tape automated bonding) devices in the open package condition, through the measurement of bond area by means of Scanning Laser Acoustic Microscope (SLAM) techniques. It establishes methods and criteria for ultrasonic inspection of these TAB semiconductor devices.

NOTES:

1. For various metallurgical constitutions, absolute strengths expressed as pull strengths per unit area of bond differ. A scalar equivalency must be established for each alloy and process, to relate bond area to anticipated bond strength.

2. The term TAB bond in this document refers to one of the multiplicity of bonds, inner lead (ILB) or outer lead (OLB) formed by a tape automated bonding (TAB) process. In the case of ILB, it refers to that area of the device defined by the intersection of the beam lead, the semiconductor bonding pad area, and the contact outline of the thermode or fixture performing the bond, in the horizontal plane, and refers to all interfaces within that area between the semiconductor die surface and the beam lead. In the case of OLB, it refers to that area of the device defined by the intersection of the beam lead, the substrate bonding pad area, and contact outline of thermode or fixture performing the bond, in the horizontal plane, and refers to all interfaces within that area between the substrate surface and the beam lead.

3. The terms ultrasonic inspection and SLAM as used in this document refer to the process and instrument performing high frequency ultrasonic inspection and produce grey-scale images of the internal features of devices by means of scanning laser acoustic microscopy, and by which bond area measurement may be performed.

2. Apparatus. The apparatus and materials for this evaluation shall include:

a. Ultrasonic imaging equipment of the scanning laser acoustic microscope type, of frequency and resolution sufficient to penetrate the bond area and render an image which discloses the size and shape of the bond area with a linear dimensional allowance no greater than 20 percent of a bond dimension. Frequency is dictated by consideration of the wavelength of sound in the materials and the limit of resolution. Whereas lower frequencies have been used for inspection of larger scale device types, the present size of TAB sites requires frequencies of from one hundred to several hundred megahertz.

b. A visual output/storage device. A method of producing, displaying, and storing a scale image of adequate grey-scale range (minimum of 64 levels) shall be used. Such device may include a grey-scale printer/plotter, or preferably CRT display with an image digitizer capable of rendering images in digital code for bulk media storage and retrieval, and algorithmic processing and evaluation. The images so stored shall be suitable for manual, or preferably, automated analysis. The output devices shall be capable of producing and storing the images to a spatial and grey-scale resolution at least equal to the resolution of their acquisition by the ultrasonic imaging equipment. The output/storage device must be capable of presenting, storing, and retrieving image label information.

3. Procedure. The equipment used shall be adjusted as necessary to obtain satisfactory images of good contrast to achieve maximum image detail within the sensitivity requirements of the bond type being examined. The appropriate operator methodology will be used to insure adequate positioning and insonification (irradiation by ultrasound) of the device for purposes of producing its image. Additional protocols will be followed as required. The normal intrinsic strength of the bond metallurgy shall be known and established, and the metallurgy of the devices to be tested should be qualified as in agreement with that strength.

3.1 Calibration of the instrument. When specified, at least one device of the type and construction to be tested shall be available to set up the ultrasonic inspection equipment and peripherals. The device may be a scape non-operational device with TAB bonded leads which will be used to identify device landmarks and ensure the equipment is properly functional.

3.2 Labeling and identifying. The devices tested and the image records made of them shall be labeled in a standard format to include the following information:

a. Device manufacturer's name or code identification number.

b. Device type or part number.

c. Production lot number and/or inspection date code lot number.

d. Ultrasonic image view number and date; to include description or code for the region or bond number (s) viewed.

e. Device serial/cross reference number if applicable.

f. Ultrasonic operator identification.

3.3 Serialized devices. When device serialization is required, each device shall be readily identifiable by a serial number, and this serial number must be included in a form readable in the stored image. In the event of a skipped piece in the serialization, a blank space representing the skipped piece, and labeled with its serial number should appear in the storage medium. In the event of a large contiguous range of skipped pieces, a similar blank space advising of the range of pieces skipped should appear in the storage medium in place of the large physical space of the many skips.

3.4 Data back-up. When required, data back-up shall be specified from a choice of multiple floppy disk, multiple track data tape, or a video format tape, or other options having sufficient volume, resolution, speed, and reliability to suit the requirements for storage and labeling.

3.5 Mounting. The devices shall be mounted for ultrasonic inspection in a fixture which insures correct positioning in all dimensions, and adequately safeguards the potentially fragile bonds from mechanical contact with any substance other than the coupling fluid. Positioning thereafter must continue in a fashion which continues the above condition, and furthermore exposes each inspected bond area to the correct acoustic environment and portion of the instrumental field.

3.6 Angle of insonification. The angle of insonification must be specified by prior analysis, and if the mounting fixture is goniometrically agile it must be set to the correct angle by adjustment or selection.

3.7 Conditions of operation. Adjustments, selections, options, and settings used in the performance of the ultrasonic inspection must be recorded if they are of a nature critical to the proper operation of equipment; not to be recorded are those casual adjustments which are done as an obvious matter of course, and the performance of which are guided by such rules as trimming for maximum, minimum, or optimum, and which are not controlled by calibrated interfaces.

3.8 Operating personnel. Operating personnel shall have a basic familiarity of the nature of sound and the use of ultrasonic instruments in the inspection of devices. They shall be specifically trained and certified in the operation of the ultrasound and peripheral equipment used so that defects revealed by the method can be validly interpreted and compared with applicable standards.

3.9 Reports of inspection. For class S devices, or when specified for other device classes, the manufacturer shall furnish inspection reports with each shipment of devices. The report shall describe the results from the ultrasonic inspection, and list the purchase order number, or equivalent identification, the part number, the date code, the quantity inspected, the quantity rejected, and the date of the test. For each rejected device, the part number, the serial number when applicable, and the cause for rejection shall be listed.

3.10 Acoustic micrograph and report retention. When specified, the manufacturer shall retain a set of the ultrasonic images and a copy of the inspection report, for the period specified.

3.11 Examination and acceptance criteria. Once the manufacturer has established the total bond area to be sought, based upon studies of the device to be bonded, and the inclusion of a prudent excess margin, then the following shall be considered the minimum bond area percentage:

a. In the case of solder bonds of lead-tin alloys a bond area percentage of 75 percent of the total bond area shall be considered minimum.

b. In the case of gold-tin eutectic and gold-gold thermocompression, a bond area percentage of 50 percent of the total bond area shall be considered minimum, except in the case of lead misalignment; when lead misalignment is a contributing factor a bond area percentage of 75 percent shall be considered minimum.

In the examination of devices, the following aspects shall be considered unacceptable bonding, and devices which exhibit any of the following defects shall be rejected:

a. A bond having a total bond area less than the minimum bond area. The failure may be caused by any reason, including lateral or longitudinal misalignment.

b. A bond meeting the minimum bond area, but with this area being discontinuous so that no single bonded area meets or exceeds the minimum bond area.

4. Summary. The following details shall be specified in the applicable acquisition document:

a. Number of views to be taken by SLAM inspection of each piece or bonding site, in accordance with 3.10, if other than one view.

b. Markings of devices, or labeling of images, if other than in accordance with 3.2, or special markings of devices to indicate that they have been ultrasonically imaged, if required.

c. Defects to be sought in the devices, and criteria for acceptance or rejection, if other than in 3.11.

d. Image and report retention when applicable (see 3.10).

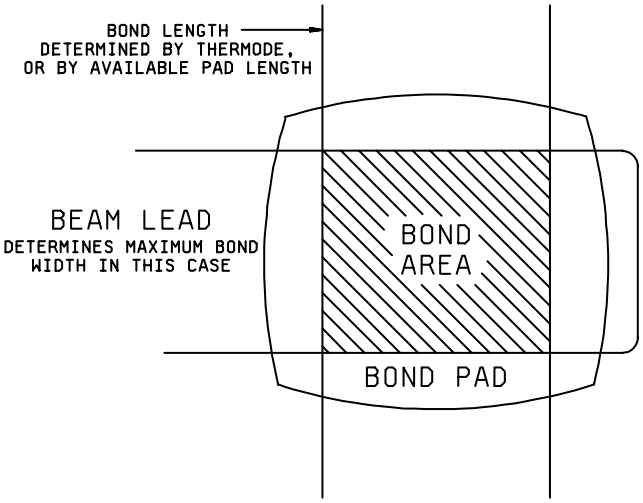

FIGURE 2035-1. Bond area.

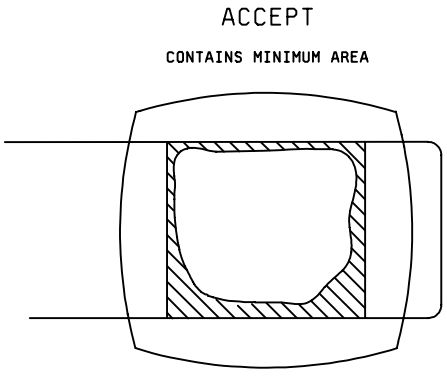

FIGURE 2035-2. Acceptable bond area.

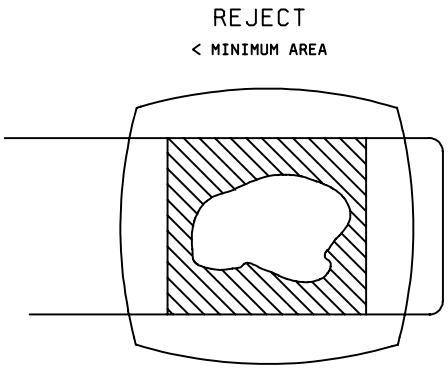

FIGURE 2035-3. Rejectable bond area.

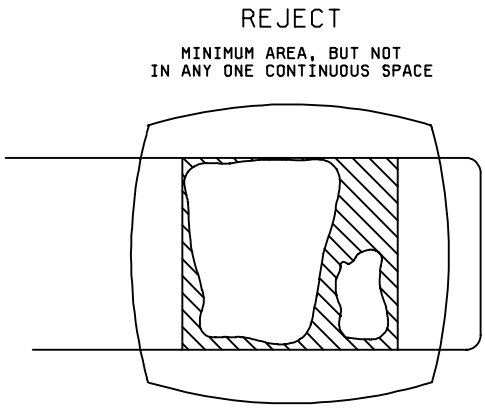

FIGURE 2035-4. Rejectable discontinuous bond area.

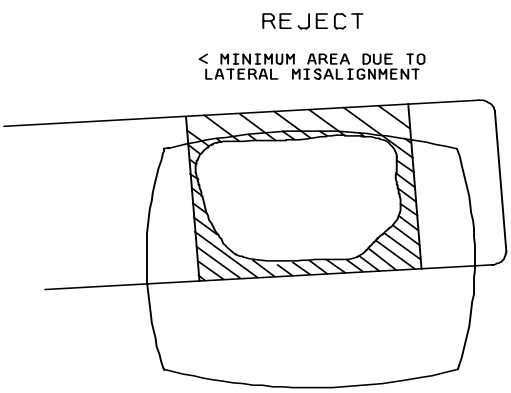

FIGURE 2035-5. Lateral misaligned bond area.

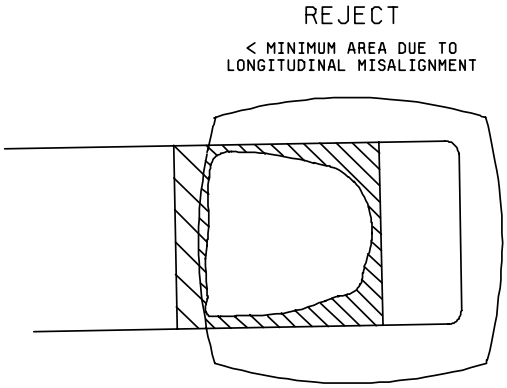

FIGURE 2035-6. Longitudinal misaligned bond area.

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