

Destructive Wire Bond Shear Testing and its Purpose

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IN OUR LAST ARTICLE “DESTRUCTIVE Wire Bond Testing for Development and Production” was discussed. In this piece we will discuss the use and purpose of one element of the destructive wire bond testing, and that is, specifically the wire bond shear test. In the next article, the wire bond pull test will be discussed in greater depth. The reason that the shear test is being discussed first is that it is our view that it is the first step in a thoughtful wire bond process development plan. The process of wire bonding a wire to a substrate is simply the joining of two metals through force and vibration. The best way to determine the strength and integrity of that weld, is by shearing the weld with a blade to evaluate not only the force required to shear the joint (shear strength), but also to determine the total amount of the intended weld area that is actually welded (nugget size) as a percent of the intended weld area. The wire bond shear test is not a replacement or substitute for the pull testing, but rather a completely different test, with a different purpose and intent, typically used to develop the wire bond process. Shear testing is the often the forgotten or unknown method of testing wire bonds. Perhaps because it has been conspicuously missing from mil STD883 it has gone largely unknown as a testing tool in the new product development process design cycle.

In the product development cycle, the development of the process used to manufacture or produce the new product is an iterative and hopefully a collaborative approach in the new product design phase. In the case of the wire bond process development, once the metal systems and the geometry have been determined, the work of developing a robust repeatable wire bond process must be completed. We always begin the wire bond development cycle with the shear testing. Whether it is a gold, aluminum, copper, wedge, or ball bond, the foundation of any good wire bonded interconnect is the weld between the wire bond foot and the substrate to which it is bonded. In fact, the fundamental characteristic of any welded joint is that the weld should always be stronger than the materials being

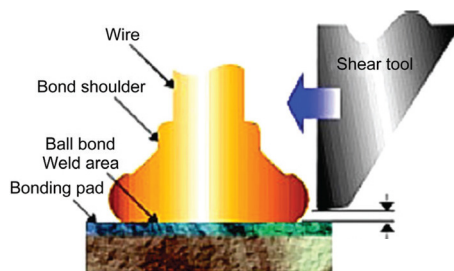
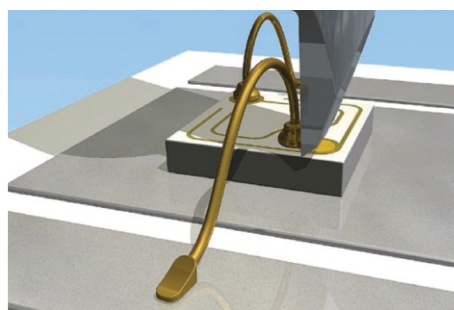


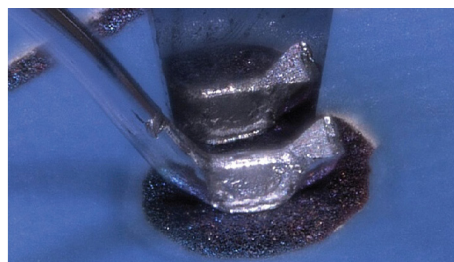
Figure 1

SHEAR NUGGET	
Rank	Nugget Size % of total
1	0 - 25
2	25 - 50
3	50 - 75
4	75 - 100

Figure 2



Ball Bond Shear



Aluminum Wedge Bond Shear

joined by that weld. This is the reason that a wire bond lift during destructive pull testing is considered a rejectable condition in all cases at SMART.

The destructive wire bond shear test is the tool used to quantitatively and qualitatively measure the integrity of the welded joint of the wire bond. A sharp flat blade is placed parallel to bond foot on the bond pad and raised to a height above the pad approximately equal to 10% of the wire diameter (see figure 1). The force required to shear completely through the welded joint of the bond foot is recorded. The remnant of the welded joint remaining on the bond pad can also be quantified as a percentage of the weld area. We simply rank them on a scale of one through four (see figure 2). All bond wire should be supplied with a certification that includes the tensile strength of the wire. The wire tensile strength along with the shear area can be used to calculate the theoretical shear strength of the joint to ensure that the measured values are within reason. Through the application of tools like a thoughtful, well-designed DOE, the bond parameters can be optimized to produce welded joints that consistently have high shear values and seventy-five to one hundred percent weld nuggets.

The wire bond shear test is one of many tools that we use to develop, measure, qualify, and maintain the integrity of the welded joint in the wire bonded interconnect system. During the process development phase, it is used extensively to develop the wire bond process for long term sustainable manufacturability of a bonded assembly. After release into production, it is also good practice to periodically use the shear test as a tool in the overall SPC plan to insure the process has not drifted out of control and the incoming material is still stable (see figure 3). It is also one of the many tools we use in the diagnostic journey of failure analysis. There are many high-quality multifunction bond testers on the market today. The bond tester that we employ at SMART is the Nordson DAGE 4000Plus multifunction shear and pull tester.

WIRE BOND TESTING

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MIL-STD-883 is a collection of test methods, the “go-to standard” for many companies and industries. So, it is interesting that the test method for destructive wire bond shear testing is absent from this widely used standard. That is likely the reason that it often gets overlooked in the wire bond process development cycle. At the IMAPS New England 46th Symposium & Expo, Thomas Green delivered a paper on wire bond inspection criteria in which he discussed the efforts currently underway to update the standard. Hopefully it will one day include a section on shear testing. But for now, if one is involved in the design and development of a microelectronics assembly interconnects that includes wire bonding, then shear testing should not be overlooked, in fact it should be considered the foundation of the process design.

For more information visit our website at www.spiritelectronics.com.

William Boyce is the Engineering Manager at SMART Microsystems. Mr. Boyce earned a Bachelor of Science in Engineering degree from the University of Rhode Island and has served in the field for over 20 years as a mechanical design engineer, process engineer, team leader, engineering Manager, and Global Engineering Director. In addition to his current role at SMART, he has held positions at General Dynamics, Texas Instruments, Sensata Technologies and TT Electronics. Mr. Boyce has also been a member of the IMAPS New England Chapter for over 15 years as a session chair. He is EIT certified, a Six Sigma Green Belt, and an industry recognized expert in AI wire bonding.

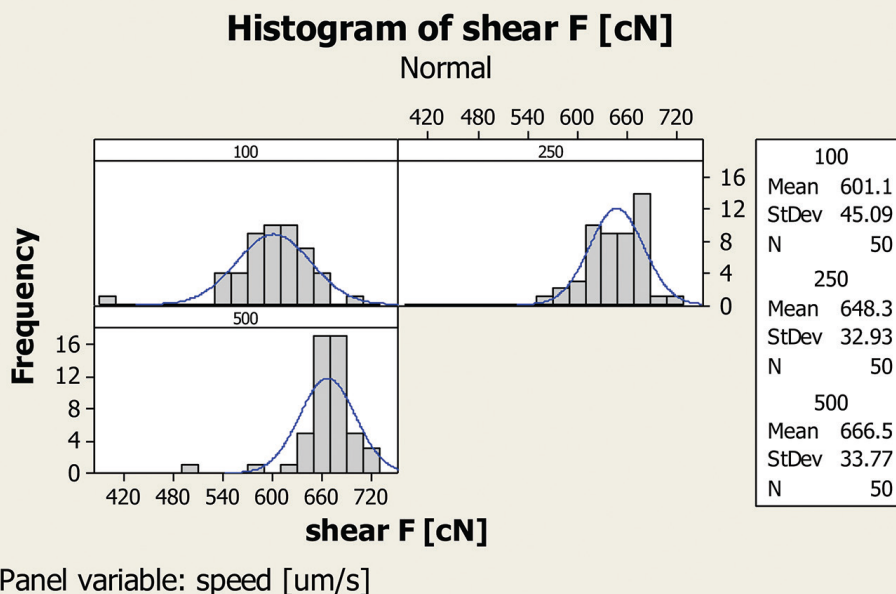


Figure 3



ISO9001: 2015
AS9100: 2016

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