ARMY RESEARCH LABORATORY

A New Technique for Wirebonding Using Indium Spheres

by Kimberley A. Olver

ARL-TR-5240 **July 2010**

NOTICES

Disclaimers

Army Research Laboratory
Adelphi, MD 20783-1197

ARL-TR-5240 **July 2010**

A New Technique for Wirebonding Using Indium Spheres

Kimberley A. Olver
Sensors and Electron Devices Directorate, ARL

REPORT DOCUMENTATION PAGE		*Form Approved* *OMB No. 0704-0188*

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED (From - To)
July 2010	Final	

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
A New Technique for Wirebonding Using Indium Spheres	
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
Kimberley A. Olver	
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
U.S. Army Research Laboratory ATTN: RDRL-SEE-I 2800 Powder Mill Road Adelphi, MD 20783-1197	ARL-TR-5240
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

A new technique has been developed for wirebonding mercury cadmium telluride (MCT) devices using indium spheres. Indium powder with a mesh size of 170/200 is made up of indium spheres. These spheres are used as solder between the gold pad on the MCT device and the gold ball of the wirebond. This novel technique eliminates damage that typically occurs to the MCT material under gold wirebonding pads due to force and ultrasonic power needed in wirebonding.

15. SUBJECT TERMS

Wirebonding indium, Mercury Cadmium Telluride, MCT

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
					Kimberley A. Olver
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER (*Include area code*)
Unclassified	Unclassified	Unclassified	UU	14	(301) 394-2048

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18

Contents

List of Figures

Acknowledgments

The author would like to thank Dr. Wendy Sarney of the Electro-optic (EO) Materials and Devices branch for helping with the scanning electron microscope (SEM) image of the indium spheres.

INTENTIONALLY LEFT BLANK.

1. Introduction

A novel technique for gold wirebonding of delicate mercury cadmium telluride (MCT) devices has been developed. Gold ball wirebonding to MCT devices is challenging. The act of applying force and ultrasonic power to MCT very easily creates damage under the device bond pads, damage that sometimes goes unnoticed until testing the device's integrity at a later date. Indium spheres placed between the gold wirebond ball and the gold bonding pad on the MCT material allows one to use less force and ultrasonic power to attach the wire and acts as a soft solder in the process. In this study, an indium powder of a mesh size of 170/200 is used as a cushion between the free air gold ball and the device pad being wirebonded. Indium powder is made up of small (70–90 microns diameter) indium spheres (figures 1 and 2). The properties of indium make it a good choice in this technique. Indium is malleable and thermally and electrically conductive, and has a low oxide formation level. These qualities make it an ideal cold-welding material.

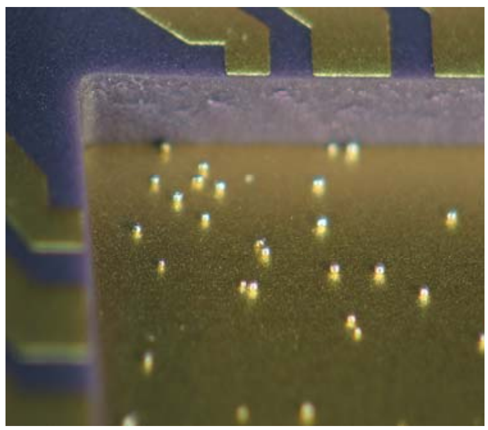

Figure 1. Indium spheres placed on the device package.

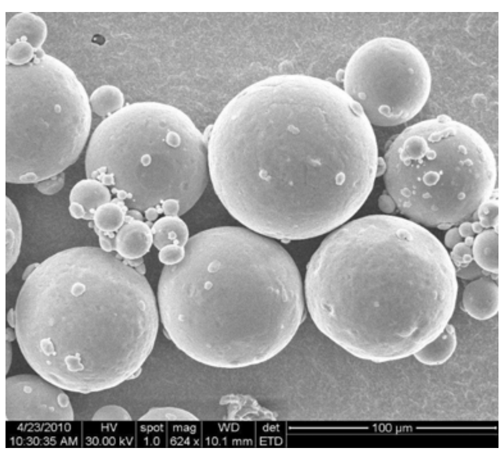

Figure 2. A scanning electron microscope (SEM) image of indium spheres.

2. Procedure and Results

For this technique, the equipment used was a Marpet Enterprise, Inc. (MEI), 1204B Hybrid Ball Wirebonder (*1*) threaded with Kulicke & Soffa AW14 0.7-mil gold wire. The ceramic capillary tool make and size was a Gaiser Tool Company #1513-12-375 GM-20D (*2*). The indium spheres were purchased from Indium Corporation of America and the mesh size of the indium (powder) was 170/200 (*3*).

Conventional ultrasonic ball wirebonding (*4*) consists of several steps: welding the wire to the contact pad on the device (known as the first bond); forming the wire loop as the capillary is moved to the second bond position; creating the second bond (also called the crescent or stitch bond), which connects the wire to the device package; and firing the electric flame off (EFO), which forms the next ball at the bottom of the capillary tool. This new technique follows the traditional steps of ball wirebonding with the addition of placing an indium sphere in between the gold wirebond ball and the device bond pad on the first bond.

Indium spheres were placed onto the package such that they were in close proximity to the devices being bonded (figure 3). The ultrasonic power and the firing time on the transducer unit of the wirebonder were turned to near zero for the first bond. Normal settings for power and time (based on the individual wire bonder equipment) were used for the second bond. At the first bond position the capillary is brought over to an indium sphere, the capillary is lowered just to the point that the gold ball on the end of the capillary makes contact with the indium (figure 4). Pressure is not applied to the indium; instead, static electricity holds the indium sphere to the gold ball. The capillary is then brought up slightly and the indium ball is positioned directly over the pad that will be accepting the first bond (figure 5). The capillary is brought down to the bond pad and slight pressure is applied. The indium flattens, adhering to the metal bond pad, and the gold ball adheres to the indium on the pad (figure 6). The capillary then rises to the loop height position, and the wire is brought over to the second bond position. The second bond is formed, the wire disconnects, the EFO fires, and the cycle is complete (figure 7). Figure 8 shows the completed wirebonds. When the indium sphere wirebonding has been completed, the unused indium spheres are simply put back into the container by a gentle tapping on the back of the package over the container.

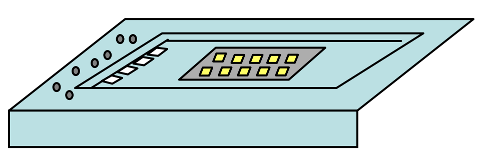

Figure 3. Indium balls placed on the package in close proximity to the devices being wirebonded.

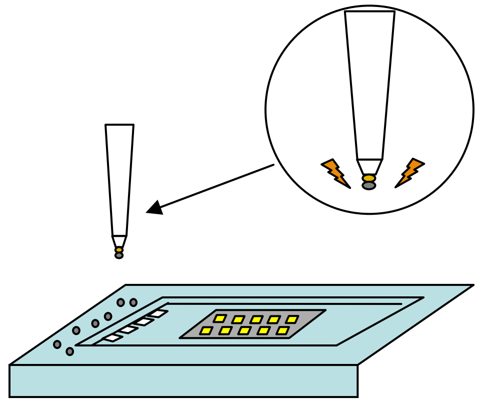

Figure 4. Indium ball statically held onto the gold ball at the end of the capillary.

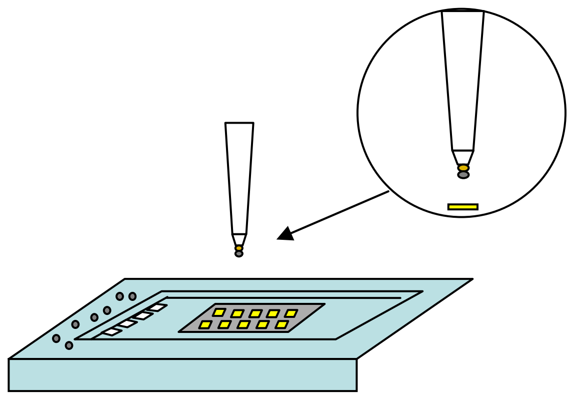

Figure 5. Capillary brought over to the device bonding area.

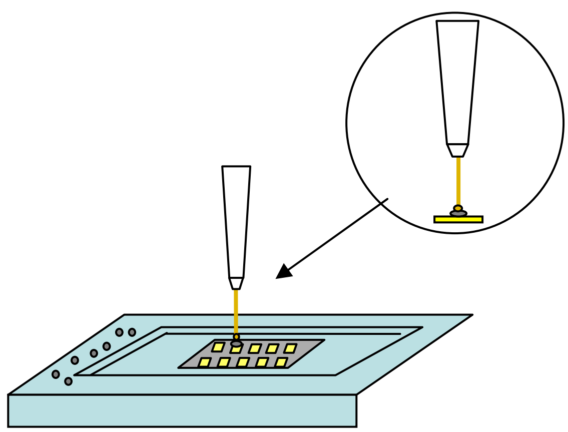

Figure 6. Indium makes contact with the device pad and the first bond is completed.

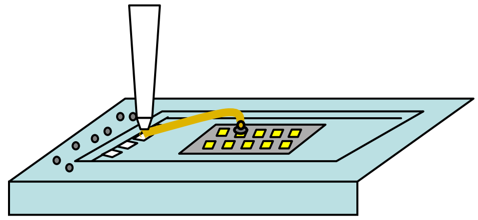

Figure 7. Capillary is brought over to the package bonding pad and the second bond is completed.

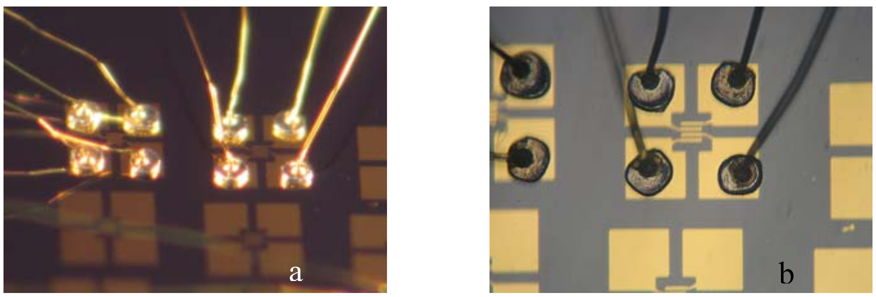

Figure 8. Completed indium sphere wirebonds on an MCT device.

4. Conclusion

This new technique of wirebonding works very well for wirebonding the delicate MCT material devices. It reduces or eliminates the damage caused by traditional wirebonding processes by allowing one to perform wirebonding without using the ultrasonic power and force that damages the device material. This method has also been used successfully for wirebonding devices when there has been an issue with metallization liftoff of the bond pads.

There is one limitation to this technique, This technique is not suitable for wirebonding devices that will experience an operating temperature of 157 °C or higher—the melting temperature of indium.

5. References

1. *MEI 1204B Hybrid Ball Bonder Operations Manual*, Marpet Enterprises, Inc., Danvers, MA 01923.

2. Gaiser Tool Company Semiconductor and Hybrid Microelectronics Wirebonding Tools Catalog, Gaiser Tool Company, Ventura, CA 93003. www.gaisertool.com (accessed March, 2010).

3. Indium Corporation of America, Utica, NY 13502. www.indium.com (accessed March 2010).

4. Harman, G. *Wirebonding in Microelectronics Materials, Processes, Reliability, and Yield*, 2nd ed., McGraw-Hill, 1997.

NO. OF COPIES	ORGANIZATION
1 ELEC	ADMNSTR DEFNS TECHL INFO CTR ATTN DTIC OCP 8725 JOHN J KINGMAN RD STE 0944 FT BELVOIR VA 22060-6218
1 CD	OFC OF THE SECY OF DEFNS ATTN ODDRE (R&AT) THE PENTAGON WASHINGTON DC 20301-3080
1	US ARMY RSRCH DEV AND ENGRG CMND ARMAMENT RSRCH DEV & ENGRG CTR ARMAMENT ENGRG & TECHNLGY CTR ATTN AMSRD AAR AEF T J MATTS BLDG 305 ABERDEEN PROVING GROUND MD 21005-5001
1	PM TIMS, PROFILER (MMS-P) AN/TMQ-52 ATTN B GRIFFIES BUILDING 563 FT MONMOUTH NJ 07703
1	US ARMY INFO SYS ENGRG CMND ATTN AMSEL IE TD A RIVERA FT HUACHUCA AZ 85613-5300
1	COMMANDER US ARMY RDECOM ATTN AMSRD AMR W C MCCORKLE 5400 FOWLER RD REDSTONE ARSENAL AL 35898-5000
1	US GOVERNMENT PRINT OFF DEPOSITORY RECEIVING SECTION ATTN MAIL STOP IDAD J TATE 732 NORTH CAPITOL ST NW WASHINGTON DC 20402
1	US ARMY RSRCH LAB ATTN RDRL CIM G T LANDFRIED BLDG 4600 ABERDEEN PROVING GROUND MD 21005-5066
11	US ARMY RSRCH LAB ATTN IMNE ALC HRR MAIL & RECORDS MGMT ATTN RDRL CIM L TECHL LIB ATTN RDRL CIM P TECHL PUB ATTN RDRL SEE G WOOD ATTN RDRL SEE I D BEEKMAN ATTN RDRL SEE I J LITTLE ATTN RDRL SEE I K OLVER ATTN RDRL SEE I P UPPAL ATTN RDRL SEE I P WIJEWARNASURIYA ATTN RDRL SEE I W SARNEY ATTN RDRL SEE P GILLESPIE ADELPHI MD 20783-1197

TOTAL: 19 (1 ELEC, 1 CD, 17 HCS)