High Density Interconnect using Transient Liquid Bonding Technology for High Speed Microelectronic Packages

Kuo-Chuan Liu and Michael G. Lee
Fujitsu Laboratories of America
1240 E. Arques Ave., #345, Sunnyvale, CA 94085

Arising needs on high speed microelectronic packages and dense interconnects has forced innovative packaging technologies to be developed. A concept to combine extremely high density thin film circuits with organic laminated package put a strong need on a high density interconnect process to join these two parts. This concept is to introduce an “interposer-like” organic thin film circuit that can provide a dense routing of 5-micron line/space and 20-micron via size on an organic build-up package. In order to join these two parts, a reliable and high yield interconnect technology is needed. In this paper, a reliable interconnect technology using transient liquid bonding is introduced.

Transient liquid bonding is using a low-temperature metal that will be melted during bonding process and form intermetallic compound to join two metals. Applying this technology to microelectronic package is to sequentially electroplate a metal post, such as Cu, and the low-melting point metal, such as Sn, as illustrated in Figure 1. By selecting adequate bonding sheet and thermal profile, a permanent bonding can be formed, as shown in Figure 2.

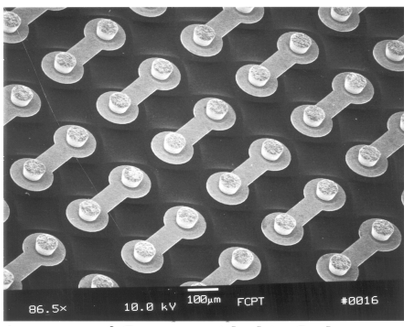

Figure 1 An array of Cu post with thin Sn layer electroplated on flexible substrate

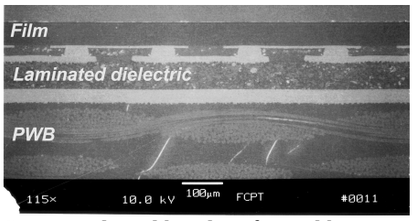

Figure 2 Transient liquid bonding formed between a flexible substrate and a rigid organic substrate.

Prototypes in daisy chains layout in serpentine format with the bonding pitch less than 200 micron with a bonding post diameter as small as 50 micron have been fabricated. These samples having over 5k bonding pads with zero defect were passed reliability tests, including high temperature storage, pressure cooker test, thermal cycling, and HAST. Silicon dies in a size of 10mm x 10 mm were also attached on top of the prototype with underfill and subjected to thermal cycle test. There were no broken joints due to the stress caused by the silicon die.

Through this effort, we successfully developed a high density interconnection technology to bond a flexible thin film circuit and a rigid organic package with high yield and good reliability.

Reference:

1. Kuo-Chuan Liu and Michael G. Lee, “Method for Joining and an Ultra-High Density Interconnect”, U.S. Patent Application Number 20020129894, September, 2002.
2. Kuo-Chuan Liu and Michael G. Lee, “Method for Joining Conductive Structures and an Electrical Conductive Article”, U.S. Patent Application Number 20030019568, January, 2003.
3. H.H. Jiang, M. Mark, A.W. Chan, K.C Liu, “Structure and Method for Forming Z-laminated Multilayered Packaging Substrate”, U.S. Patent Application Number 20020119396, August, 2002.