Volume 3, Issue 7, pp. 36-37, 2019.
International Journal of Scientific Engineering and Science
ISSN (Online): 2456-7361

# Electronic Interposer for Wirebonding Improvement on Semiconductor Electronic Device

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***Abstract**— The miniaturization of integrated circuit (IC) becomes the common direction for semiconductor electronic industries, converting the electronic devices to get smaller in size yet with increased number of functional components. Aligned with this common goal is to continuously improve the manufacturing and assembly side of semiconductor devices as well to be able to adapt to the fast changing requirement of technological breakthrough. Through integrating an interposer in the current design of substrate-based electronic product, the assembly limitations and capability can be significantly improved, thus devices with tight clearance requirement or devices with gross assembly rejection related to tight clearances can be provided with reliable alternative solution and process improvement.*

***Keywords—** Interposer; wirebonding; electronics; semiconductor; wire sweep; package design.*

## I. Introduction

Tight clearances inside an integrated circuit (IC) is a trade-off by increasing the size of functional circuit or known in IC assembly as silicon die with reference to the required dimension of an electronic product. Moreover, the clearance is a critical factor during IC assembly since the distance/spaces between each individual parts is used to anticipate the variation or deviation produced by the individual process step during IC assembly mostly contributed by the equipment and material tolerances.

A cross-sectional view of the package construction in Fig. 1 highlights a critical location in the device layout where tight clearance is identified. The identified assembly rejection manifested during wirebonding process wherein the wiring from the top die (or Die 2) and bond fingers connection become electrically shorted.

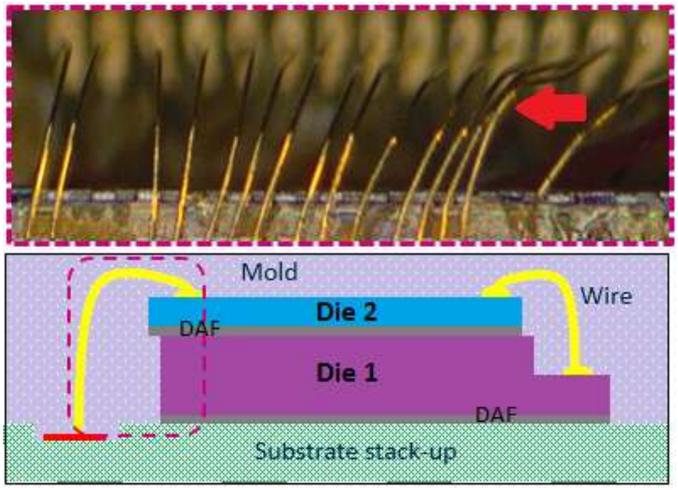

Fig. 1. Actual captured photo of shorting of wires.

Careful analysis of the problem leads to isolate that the occurrence of the wire shorting is evident only on circumstances that the placement of the top die (Die 2) is offset near to the bond finger location, as illustrated in Fig. 1. Succeeding evaluation clearly identified two assembly challenges related to this device: (1) first is the wirebonding integrity for smaller/tight clearances, (2) placement deviation during die attach process.

## II. Package Design Solution and Improvement

An alternative solution of redesigning the package layout and integrating an electronic interposer material is presented in this material to improve the packaging strategy of IC technology and provide reliable options for miniaturization requirement.

### *A. Packaging Design*

A 3D view of the improved package design is shown in Fig. 2, clearly illustrating the position of the individual components inside the package.

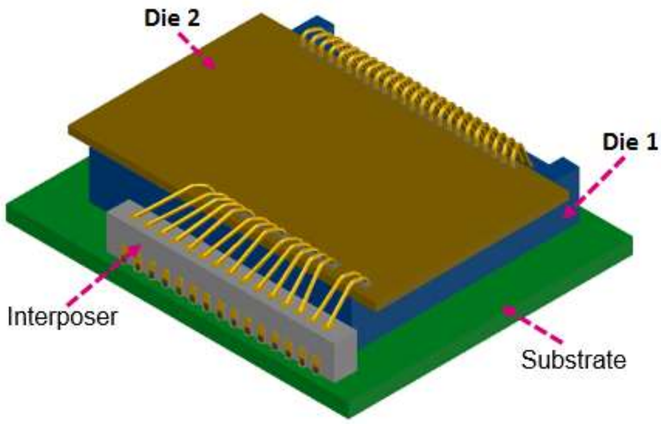

Fig. 2. 3D view of a substrate-based electronic device with interposer design.

The interposer is incorporated in the bond finger part elevating the connection of the leads upto the height of the top die. The bottom part of the interposer is electrically connected to the bond fingers while the topside portion of the interposer is designed to have bondable pads for the wiring and connection of the top die. The number of die stack-up could be more than two however the height of the interposer should be adjusted as well.

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### B. Electronic Interposer Design

The interposer is the extension of the electrical layering of the substrate when it is attached to the bond fingers. The innermost connection or the through via hole will be filled with a conductive material for electrical connection. However, if a non-conductive fill or material is used for the filling, the copper boundary as shown on Fig. 3 should still be connected to bottom connection of the interposer.

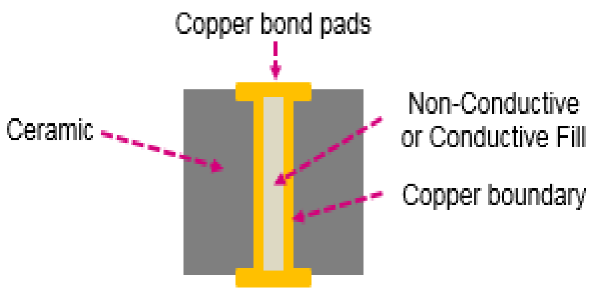


Fig. 3. Interposer design and composition.

The topside portion or the bond pad of the interposer is designed to be bondable for the wiring material. The cheapest candidate for the bond pad of the interposer is a copper material with the exposed portion can be coated with flash of golds for good intermetallic response between the wiring materials.

The copper connection in Fig. 3 is extended to the bottom conductive part of the interposer which during assembly will be attached to the bond finger or to the electrical layering of the substrate. A conductive paste can be used to attach the electrical layers of interposer to the substrate in this process.

A ceramic or polymer material could be used to isolate the conductive part of the interposer to the neighbouring electrical components. In addition, this provide stability also for the interposer to avoid sagging or breaking during the assembly.

## III. METHOD OF APPLICATION AND DISCUSSION

### A. Assembly Process Flow for Interposer Attach

In integrating this technology to the actual assembly flow of substrate-based devices, an interposer attach process is required on the assembly process flow shown on Fig. 4.

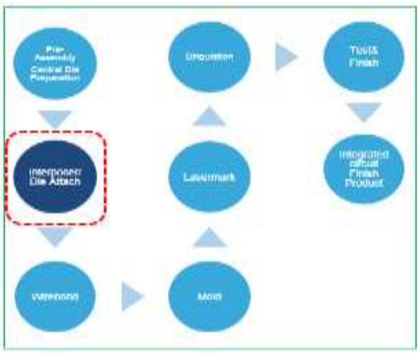

Fig. 4. Assembly process slow.

In this process, an interposer bonder machine could be used as equipment to attach the interposer to the electrical layering of the substrate. The process starts by dispensing the conductive paste on top of the bond fingers in Fig. 5a then a bonder will attach the interposer on top of the conductive paste shown in Fig. 5b.

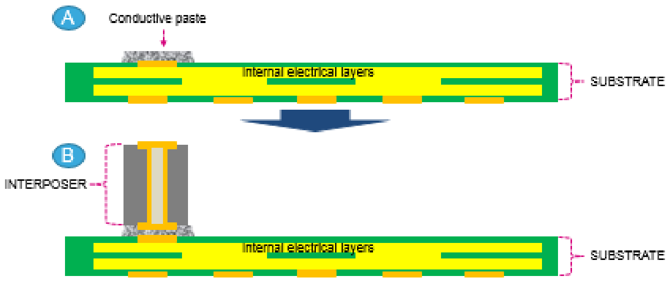


Fig. 5. Interposer attach process.

### B. Wirebonding Process for Interposer

On normal and standard process of wirebonding, a certain clearance is provided between bond fingers and die so that a good arching formation for the wire can be achieved, as shown in Fig. 6a. A closer distance between the die and bond fingers affects the consistency of the wirebonding process.

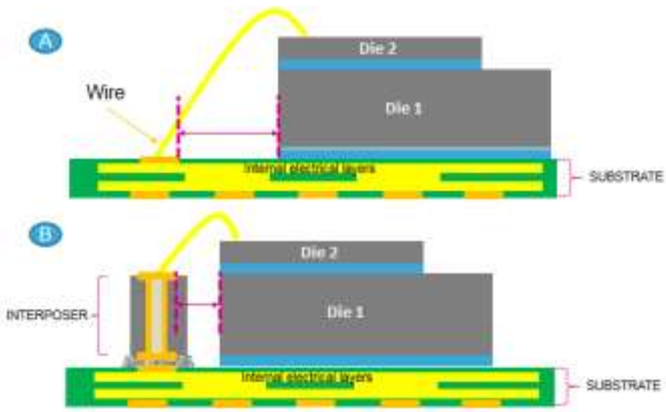


Fig. 6. Comparison of device for with and without interposer design.

With the integration of the electronic interposer design, the bonding pad for wirebond will be elevated. By increasing the height of the bond pad, the needed wire arching is reduced as well, eventually enabling a closer distance of wiring. Moreover, a shorter length of wire results to better structural stability for the wire making it more resistant to deformation or displacement during plastic encapsulation.

## IV. SUMMARY

The integration of electronic interposer in the current design of substrate-based product could benefit and address the current limitations of semiconductor electronic device assembly and could further improve its manufacturability and reliability performance. The improved design offers potential solution for the miniaturization of substrate-based product improving the current capability to process packages with tight clearance requirement.