Evolveing Bump Chip Carrier

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The Bump Chip Carrier, which was developed as a small pin type, miniature, and lightweight CSP, is not only extremely small due to its characteristic structure, but also has excellent secondary mounting capacity. This article introduces its features, properties, and our approach to the development of new products.

Introduction

The recent popularization of mobile phones has been remarkable. Some of the most recent models are composite types in which functions other than calling and e-mail have been added. There are also miniature, lightweight types and specialized types that have limited functions. In this context, the demand for mounted packages has increased as well, with miniaturization, weight reduction, and high mounting reliability that can endure any type of environment, etc. becoming important issues to be resolved.

The bump chip carrier (hereafter referred to as BCC) described in this article was developed as a small pin type, miniature, and lightweight CSP. Mass production started at the Kyushu Plant of FUJITSU INTEGRATED MICROTECHNOLOGY in 1998. Its major application was initially in mobile phones and then shifted to digital household appliances including digital cameras and digital video cameras. More recently, it has also been adopted for vehicle-mounting purposes—its applications vary widely. It has been nearly eight years since the start of mass production; cumulative production is approximately 1 billion pieces, and various types from 10 pin to 116 pin are currently produced.

Fig.1 presents the mass production history.

This article describes the kind of package that BCC is and examines its advantageous features, providing some specific examples. It also introduces our approach to the development of a new BCC that addresses recent and new demands, sales expansion, etc.

Product Features

Package

BCC is a package that is lead-free. It is extremely small in terms of mounting area, volume, and weight compared to conventional lead-type packages. The main feature is that it has a terminal block (bump) instead of an external lead. This is a resin terminal with metal plating on the surface; it is connected to the chip electrically with wire. The package forms can be classified into two types: the standard type with the terminal around the chip and the ++ type whose chip-mounting block forms a ground terminal.

Figure 1 History from Mass Production Launch

Cumulative production quantity (k pieces)

Year

1998 1999 2000 2001 2002 2003 2004 2005

0 200 400 600 800 1000 1200

* The value for year 2005 is a predicted value.
Fig.2 presents a cross-section structure of BCC.

What makes it most different from other packages in production is that the lead frame is completely removed by etching. The previously described characteristic package structure is obtained by this process. This structure is simple and close to the limit as a package structure containing “chip,” “resin,” and “terminal”; the copper material that forms the substrate is removed by etching at the end, leaving only the plating in the terminal block. Since an appropriate standoff is formed on the four-layer plating at the terminal block, it excels in handling and treatment during mounting. Due to individualization by package dicing similar to BGA and the adoption of a lead frame provided with half etching and plating on the same mask, it is possible to realize various package designs (package external size and terminal size) flexibly.

At present, mass production has been implemented from 10 pin to 116 pin at maximum, and package thickness ranges from 0.8mm at mass production start to thin-type 0.6mm and 0.5mm.

Fig.3 presents product examples.

Test

We carry out testing on the complete package dicing form, which is mounted on the dicing tape. This minimizes the loss of condition change even when the package size is different, and an environment in which measurements can be taken efficiently is ensured.

Specifications

BCC has excellent features such as single package reliability, secondary mounting reliability, thermal resistance, electric features, etc.

Single package reliability

It is reflow-resistant, and the ++ type has been confirmed to meet the requirements of JEDEC LEVEL 1 with the package size of 9mm×9mm or smaller.

Thermal resistance

Even when a chip with large power consumption is mounted,
the ++ type excels in heat release from the ground terminal thanks to its package structure suggesting that ground terminal largely contributes to the realization of outstanding heat resistance. It is assumed that this is because the heat generated by the mounted chip is efficiently released outside the package in the heat release path of chip → diamond touch paste → ground terminal → solder paste → mounting substrate. Furthermore, it has been confirmed that it exhibits the highest heat release effect and delivers excellent heat resistance when a thermal via is established on the mounting substrate.

**Fig.4** presents a cross-section diagram of the ++ type mounted on a substrate with a thermal via.

### Electric features

Unlike conventional lead-type packages and interposer-type packages, its design does not contain inner leads or running wire patterns. This simple structure for connecting the chip and terminal with wire allows the simple analogy of 1nH inductance per 1mm wire length. The LCR simulation value is one to several nH and the S para-simulation value is approximately 6 to 8GHz, making it a package suitable for radio frequency. It is also expected that 50Ω impedance may be maintained using a coplanar structure for the inner pattern (**Fig.5**).

### Secondary mounting reliability

It is considered important for semiconductor post-processing manufacturers to provide information on mounting simplicity at the customer plant and reliability after mounting in addition to providing packages that satisfy customer requirement specifications.

BCC was utilized in mobile phones when it was first mass-produced, and there were various questions from customers regarding its secondary mounting reliability. Thus, we have been preparing an environment for data acquisition since the early stages, and are now capable of conducting dropping tests, bending tests (repeated bending tests, threshold bending tests), temperature cycling tests, etc. According to the evaluation results obtained thus far, it has been confirmed that BCC particularly excels in secondary mounting reliability compared to other packages.

The next section describes secondary mounting reliability and provides some specific examples.

### Secondary mounting reliability

#### Excellent mounting flexibility

Simulating our customer mounting environments, we conduct mounting experiments, etc. by mounting the package successively using a mounting system. It has been found that the terminal, which is a feature of BCC, forms a well-shaped fillet around the terminal when mounted on the substrate and that it prevents the formation of solder bridges by successive mounting. It also has the advantage that the solder’s self-alignment effect (the phenomenon in which it returns to the correct position at reflow heating) when the mounting position is slightly shifted simplifies mounting. As examples, a fillet block appearance photograph (**Photo 1**), its block cross-section photograph (**Photo 2**), and X-ray photographs after mounting (**Photos 3 and 4**) are presented.

Some customers may wish to see the fillet when mounted on the substrate. This is easily achievable by extending the foot pattern on the mounting substrate (outward in this case). As examples, a fillet block appearance photograph (**Photo 5**) and its block cross-section photograph (**Photo 6**) are presented. As is evident, a favorable side fillet is formed.

#### High reliability on mechanical strength

We implement strength tests related to bending, distortion, and dropping impact with assumption of mechanical load on...
the package after substrate mounting. As a result, it has been found that the reliability of BCC on mechanical strength is high after mounting, and that it is more effective against substrate distortion after mounting as the external package size is smaller. Mechanical strength is further improved by connecting the ground terminal as in the ++ type. For example, the ++ 5mm×5mm type has been confirmed to successfully withstand bending over 10mm and dropping of 180 times under our evaluation conditions.

Fig.6 illustrates the relationship between mechanical strength and package size.

High reliability on temperature cycles

Assuming the load of thermal cycles on the package mounted on the substrate, we conduct an environmental test to expose the package alternately to high and low temperatures (temperature cycling test). In general, the mounting form is divided primarily into double-sided mounting and single-sided mounting.

Fig.7 presents the evaluation results from a product mounting BCC32++ (package size 5mm×5mm) as an example of a Weibull plot on double-sided mounting products. Though the conditions are strict for double-sided mounting products, they clear 2,000 cycles before generating an initial defect under our test conditions (−25 to 125°C), indicating that sufficient performance is delivered. A similar evaluation was implemented on single-sided mounting products, and they have been confirmed to have an over 3,000-cycle performance. The mode of destruction in temperature cycling is solder cohesion failure.

Fig.8 presents an example of stress simulation analysis on the solder block under temperature cycling.

Approach to a new BCC

Nearly eight years have passed since the mass production of BBC commenced. New packages are being developed and mass-produced by our competitors that are light weight, thin, and small-sized. We have worked on the development of new BCCs in order to provide various services while also continuing to provide our conventional high-quality products. Some have already been completed and mass production has commenced—this section introduces some examples of such an approach.

Specific examples include the development of fine-pitch terminals, ultrathin 0.35mm thickness packages, MCP (multichip packages), etc. In fine-pitch development, 0.4mm pitch has been developed and mass-produced while 0.5mm was the standard. It is also possible to realize further miniaturization. Development has achieved an external size of 7mm×7mm for a product of 0.35mm package thickness—this will support the demand for thickness reduction in memory cards and module.
parts. Furthermore, development for both parallel mounting and stack mounting has already been completed for MCP development, and the parallel mounting type is being applied to mass-production. While the technique to mount multiple chips is already conventional, it is expected that FUJITSU can lead in terms of cost performance by realizing it in CSP. In terms of stack mounting, two-layer stack mounting has been completed, and a check on the prototype level has been completed for the three-layer type. It is also possible to develop it into a SiP in which chip parts, etc. can be combined. In this way, we will realize development into higher functions in the future. In addition to these products, we shall continue to develop other forms.

**Future development**

It is the market trend to offer various different packages pursuing light weight, thinness, and small-size features. More recently, the provision of CSP with a focus on secondary mounting and the utilization of chip features has been growing more important. We consider BCC to be one of the small-size CSPs that can satisfy such demands.

We will continue to offer new BCCs with more added value by incorporating new functions into their already excellent features.