

## Technical Development of Copper-Core Solder Ball for Flip Chip Interconnection

### 1. General Description

Nippon Steel Micrometals (NMC), a subsidiary to NSC, produces and supplies solder microballs as one of flip chip bonding items for semiconductors. In this connection, NMC has recently developed processes for manufacturing very small copper-core lead-free solder balls having a high bonding reliability and a good expectancy of needs in future. The sizes of the copper-core balls treatable in the processes are 100 to 150  $\mu\text{m}$  in diameter. In the processes, copper cores are surface-treated, are then electroplated with solder components to a thickness of 25  $\mu\text{m}$ , and are finally formed into lead-free copper-core solder balls of 150 to 200  $\mu\text{m}$  in diameter. The process flow and the evaluation and uses of the balls are described in the following sections.

### 2. Manufacturing Processes

Fig. 1 shows a process flow.

### 3. Evaluation

Fig. 2 shows a photo of cross-sections of finished balls, Table 1 lists available solder balls, and Table 2 specifies the shear strength of a copper-core ball.

### 4. Uses

There is a method utilizing solder bumps formed on mounting side of chips in flip chip bonding methods for the semiconductor chip and so on. Furthermore, as a method for forming solder bumps on chips, there is a method that uses solder balls. In the method, solder balls are placed on electrodes of mounting side of chips, and melted to form solder bumps.

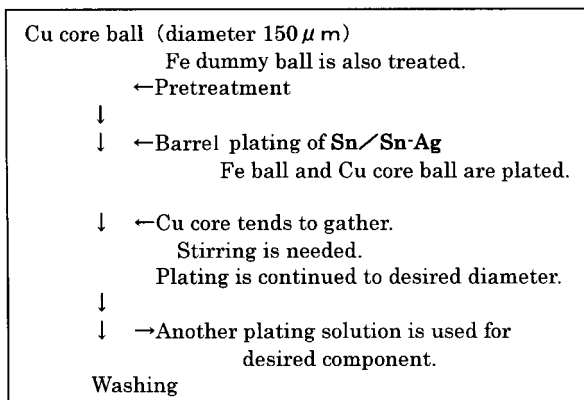


Fig. 1 Process for preparing Cu core solder ball

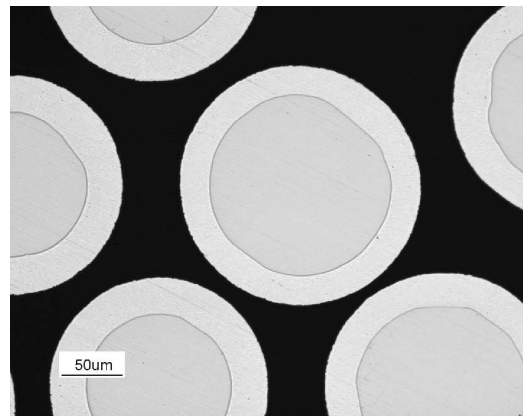


Fig. 2 Cross section of Cu core solder ball plated SnAg

Table 1 Core diameter and solder component of Cu core solder ball

Cu core ( $\mu\text{m}$ )	Sn	Sn-Cu	Sn-Ag	Sn-Ag-Cu
150			3.5Ag	
100			3.5Ag	

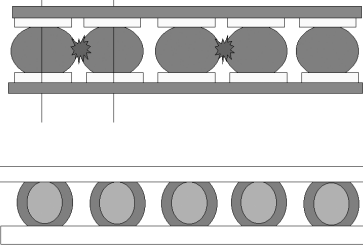
:Test sample can be supplied soon :Test sample can be supplied in one month

Table 2 Shear strength of Cu core solder ball. Diameter of UBM is 300  $\mu\text{m}$ .

	Shear strength	Standard deviation
Cu core solder ball	279.3 gf	16.9

A variation of the flip chip bonding method uses copper-core balls coated with a layer of solder. In this variation, when flip chips with copper-core solder balls are bonded to electronic parts, the surface solder layer is melted, but the copper core remains unmelted. As a result, the copper ball lies as a spacer between the semiconductor chip and the circuit board, maintaining a constant distance between them that constitutes an electronic part. Fig. 3 schematically illustrates this formation. Briefly, the copper-core solder ball is expected to assure reliability (1) as a spacer as described above, and (2) as a part having a property of low degradation at high temperatures, though this is not described herein.

The solder plating is available to meet various plating thickness requirements.



**Fig. 3** The sketch of chip on board. Solder ball can not hold fixed spaces shown by the upper sketch. Cu core solder ball can holds fixed spaces shown by the lower sketch.

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