Advanced Solutions Suit Semiconductor Chip Packaging

Senju Metal Industry Co., Ltd. (SMIC) has been making effective proposals of various solutions leveraging on extensive lineup of products on the back of its outstanding capabilities to develop materials.

One of these products is the semiconductor packaging solution. SMIC deploys a comprehensive solution, encompassing its original solder pastes, solder balls, solder preforms, fluxes for semiconductors, factory automation (FA) equipment for semiconductor mounting, and furthermore, Injection Molded Solder (IMS) equipment, which forms bumps by injecting melted solder while applying pressure. With this comprehensive lineup of solutions, SMIC provides customers with new value proposition.

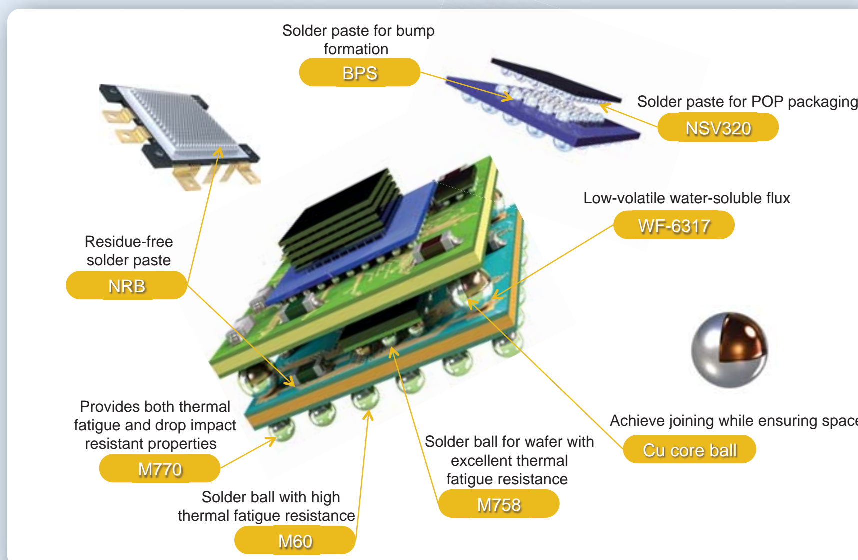

Fig. 1: Overview of SMIC's soldering solutions for semiconductor chip

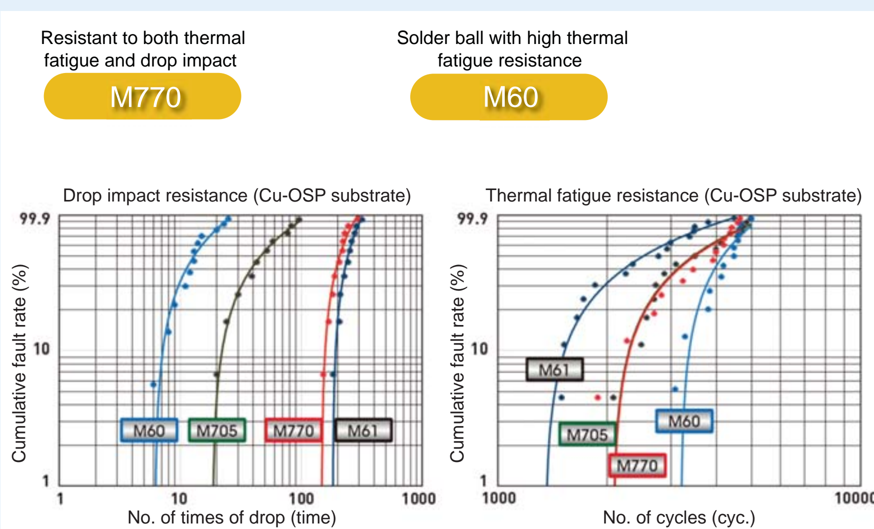

Fig. 2: Thermal fatigue and drop impact resistance test results on Cu-OSP substrate

M770 Offers Thermal Fatigue Resistance, Drop Impact Resistance

Downsizing of mobile devices is essential. Finer and narrower pitches are required for the part of mobile devices joined by solder balls. At the same time, the soldered part is also required to have drop impact resistance. Furthermore, as mobile devices come to provide higher reliability and better functionalities with higher-density packaging, the demand for thermal fatigue resistance is also soaring.

Measures for providing solder connections with thermal fatigue resistance and with drop impact resistance are contradictory with each other. In general, it has been considered that it is difficult to achieve solder connections that have both these properties. SMIC has developed M770 solder ball, which satisfies these two requirements, and solved the problem.

With an increasing amount of silver (Ag), the amount of compound deposit with tin (Sn) increases, solder connections become hard and mechanical strength increases. On the contrary, with a decreasing amount of Ag, solder junctions become less hard and mechanical strength decreases. By using this property of solder, SMIC studies the optimum amount of Ag and minute amount of additives. As a result, the company has succeeded in achieving both thermal fatigue resistance effect and drop impact resistance effect.

M758 Ideal for Bump Formation on Wafers

Electric and electronic devices are increasingly becoming to feature better functionalities in smaller dimensions. By contrast, chip sizes have been increasing in order to provide many functions to a single semiconductor chip.

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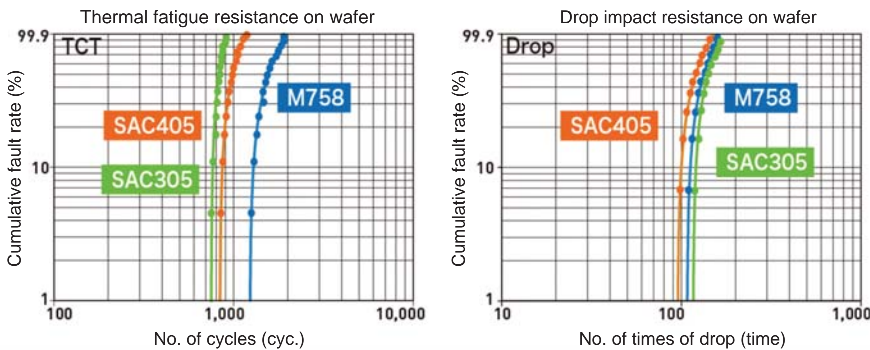

Fig. 3: Thermal fatigue and drop impact resistance test results on wafer

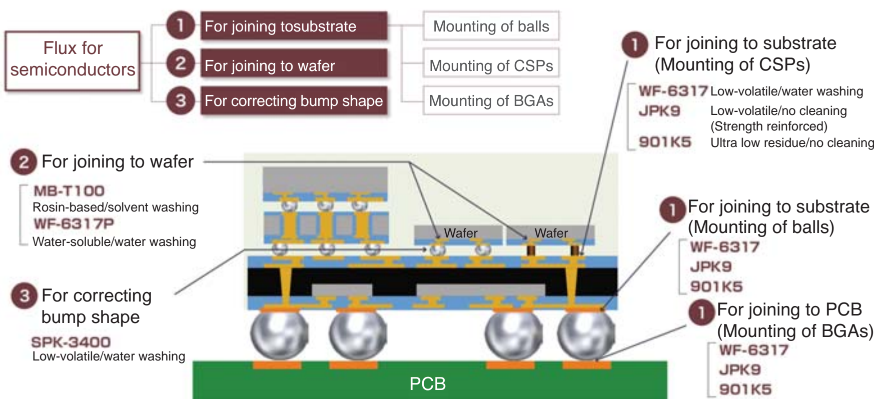

Fig. 4: Application areas of WF-6317 low-volatile flux

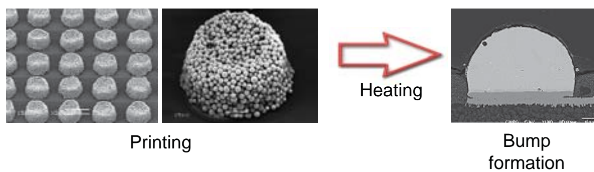

Fig. 5: Formation of 120μm-pitch bumps with fewer voids

In semiconductor packaging, wherein wafer chips as inorganic materials with small coefficients of thermal expansion and substrates as organic materials with large coefficients of thermal expansion are connected using solder balls, the difference in absolute values of the coefficient of thermal expansion has been becoming increasingly bigger. As a result, the stress on connecting boundary surfaces becomes large loads leading to the deterioration of joining reliability.

SMIC has reformed connecting boundary surfaces so that they provide excellent thermal fatigue resistance even when connecting large chips, and developed M758 solder ball, which is optimal for the formation of bumps on wafers.

In developing M758, SMIC performed precipitation hardening of tin, silver and copper (SnAgCu)-based solder and added bismuth (Bi) to hardening solid solution. Thus, the company has enhanced the strength of bulk, and at the same time controlled boundary surface reaction at the connecting interface through the addition of minute amount of nickel (Ni). Thus, M758 acquired robust connecting strength, making it an optimal product for the formation of bumps on large wafer chips, which are subject to big differences in coefficient of thermal expansion. M758 also demonstrates good wettability to packages with copper plating.

M60 Optimal for Thermal Fatigue-Resistant Applications

M60 solder ball is optimal for applications that place importance on thermal fatigue resistance, in which the stress of solder bulk is buffered through the softening of the material.

SMIC has reduced the stress of M60 by making the bulk softer through Ag content reduction. In addition, through the addition of Ni and other elements, the company has successfully improved the fracture mode through the reforming effect on the connecting interface. The improvement has been made without eliminating intermetallic compound network, which maintains the bulk strength even after the application of thermal stress load. M60 exhibits good thermal fatigue resistance even when it undergoes various surface treatments.

Cu Core Ball Ensures Space in 3D Packaging

Three-dimensional (3D) packaging of semiconductor packages is essential for making electric and electronic devices smaller. In 3D packaging, multiple substrates are electrically connected in the vertical direction, while space is ensured using the shape of solder balls. However, solder balls are pressed flat by the substrates' own weight and make contact with neighboring solder balls, causing electrical short circuits depending on the weight of substrates and pitch sizes.

SMIC has developed a copper (Cu) core ball, which enables electrical and mechanical connecting using nickel, and solder plating. The company used a Cu ball that does not melt in the melt region

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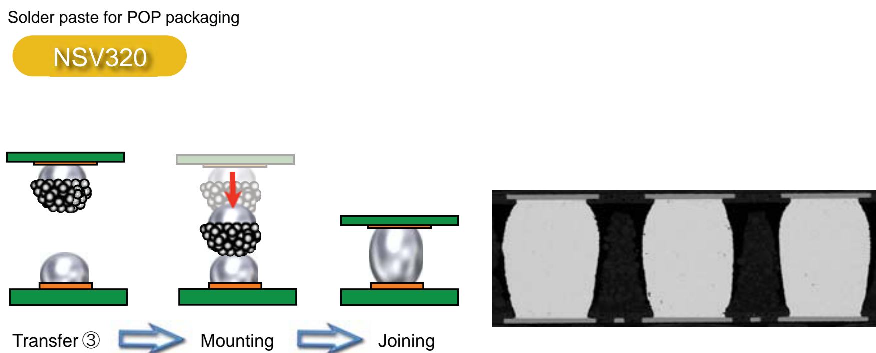

Fig. 6: Featuring excellent solder transfer property, NSV320 prevents incomplete soldering.

Fig. 7: NRB70 achieves residue-free even in nitrogen atmosphere.

of solder, as core and solved the problem. Recently, Cu pillar and solder plating have come to be increasingly used in fine-pitch packaging. Using Cu core balls enables fine-pitch packaging free from electrical short circuits without the need for solder plating after packaging.

WF-6317 Flux for Semiconductor Packaging

Flux is absolutely necessary in order to perform soldering using solder balls.

SMIC has developed WF6317 water-soluble flux, which is highly active and heat resistant, thereby contributing to semiconductor packaging. WF-6317 is a low-volatile flux, and flux residue can be removed by cleaning with water. Cleaning with warm water at 40°C achieves no flux residue. As it is a low-volatile flux, it inhibits flux contamination of reflow ovens.

BPS Solder Paste for Bump Formation

There are cases where bumps are formed using solder paste depending on the product form or manufacturing facilities. SMIC's BPS solder paste for bump formation, which employs the company's original viscoelasticity control technology, demonstrates good printability, enabling the formation of 120µm-pitch bumps.

In addition, the company has also developed a flux for fine powder, which exhibits good wettability even when using fine-powder alloy with an average particle diameter of 4µm, with which reoxidation in the reflow process is concerned. It forms bumps with fewer voids.

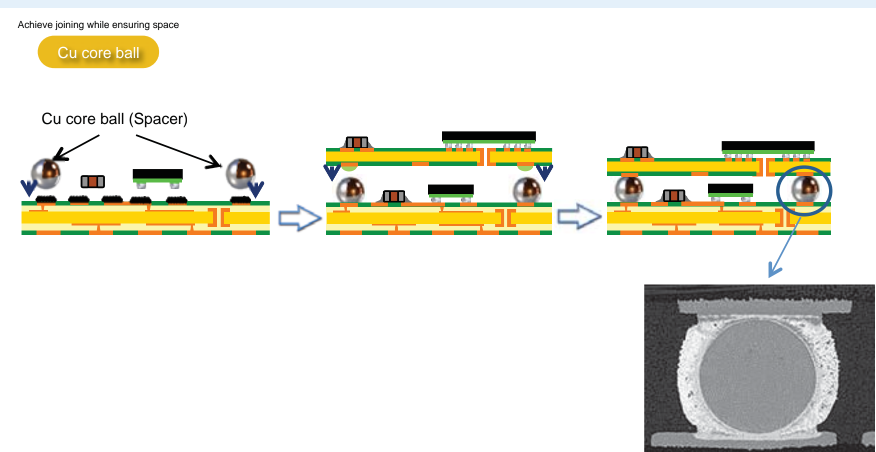

Fig. 8: Cu core ball ensures space in 3D packaging.

NSV320 Solder Paste for POP Packaging

When soldering chip-scale packages (CSPs) on a substrate, package-on-package (POP) packaging to connect solder balls and solder balls is generally used. However, it is difficult to achieve secure soldering through packaging using solder balls only. Connecting through flux and solder paste becomes necessary.

SMIC has developed NSV320 flux, which can transfer sufficient amount of solder to solder balls, by employing the company' original viscoelasticity control technology, thereby suppressing incomplete soldering caused by the insufficiency in solder amount.

Residue-Free, No-Clean NRB Series

In semiconductor packaging, there are cases where flux residue and contamination during cleaning impact the reliability of the injection of underfill. Residue-free and no-clean solder pastes are required.

SMIC has developed NRB non-rosin flux by employing advanced organic synthesis technology, realizing a residue-free and no-clean flux. NRB70 for surface mounting achieves residue-free even in nitrogen gas atmosphere ovens.

NRB60 for semiconductors achieves void-free soldering, in addition to residue-free and no-clean in die bonding mounting in the company's SVR-625GT vacuum oven, which enables the control of the degree of vacuum.

About This Article:

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SMIC Set to Boost Solder Products for ICs in China

As microfabrication of semiconductors become in demand for smartphones, solders need to address strength and heat cycle issues. SMIC's solder products meet these challenges.

Tomohide Hasegawa, President, Senju Metal (Shanghai) Co., Ltd.

As Senju Metal Industry Co., Ltd. (SMIC) strives to increase the market solder products for semiconductors in China, it has brought to the market M770 Eco Solder Ball for semiconductor packages.

SMIC's sales activities in the Chinese market are being overseen by Senju Metal (Shanghai) Co., Ltd. in East China, Beijing Senju Electronic Materials Co., Ltd. in North China, and Senju Metal (Hong Kong) Ltd. in South China. SMIC also has production bases in Shanghai, Beijing and Huizhou.

In particular, the Huizhou Plant produces flux cored solder wires and solder paste (powder), in addition to solder bars and fluxes for the local market. SMIC considers the Huizhou Plant as a comprehensive plant, which can accommodate various market requirements.

Demand Rises for Higher Strength

With the trend toward microfabrication of semiconductors and the growing demand for smartphones, the need for solders with higher strength has been increasing.

Hasegawa says, "Microfabrication of semiconductors for smartphones has been advancing. The reduction of line widths with finer pitches leads to less amount of solder. As a result, the strength and heat cycle of solders become challenges. Our company offers products that meet these challenges."

As products for semiconductors, SMIC offers solder products that have unique characteristics, including M770 Eco Solder Ball for semiconductor packages, Precoated by Powder Sheets (PPS) transfer solder sheet based on a new concept, fluxes with ultralow residue for three-dimensional (3D) bump connection, and copper core solder balls coated with solder material. With solder balls, the company has been advancing the practical application of $\phi 20\mu m$ balls in response to the demand for narrower pitches.

Favorably Received at Semicon

Tomohide Hasegawa, President, Senju Metal (Shanghai) Co., Ltd., says, "The Chinese government has announced investments to develop the country's semiconductor industry. Our company has also been endeavoring to bolster the semiconductor field. We plan to design and produce semiconductors for smartphones in China. We took part in Semicon China 2015 held in Shanghai, China in March. We invited technical advisers from Japan and held consultations for individual customers of semiconductor products."

Hasegawa says, "At Semicon China, we highlighted M770, which has achieved both drop impact resistance and thermal fatigue resistance, as a solder ball product for mobile devices. Our company delivers M770 to Chinese local smartphone manufacturers, and sales have been increasing." ❑

SMIC has been stepping up solder products in the semiconductor field targeting the Chinese market.