Technology Focus

SMIC's Solder Products Conform to Industry Calls

In 1996, Senju Metal Industry Co., Ltd. (SMIC) commenced full-fledged marketing of M705 Eco Solder, a standard material for lead-free solder, and has since led the industry. During the introduction period of lead-free solders, governments and industry groups spearheaded the standardization efforts with the idea of minimizing the risks of patent acquisition and maintaining high product quality, and SMIC's M705 became the standard material.

Now, after more than 10 years, the concept of lead-free solder mounting is widely known, and the selection of materials and methods that depend on the purpose of application is being pursued rather that the use of standard materials.

SMIC develops new materials and methods to address this trend, meeting a wide variety of needs from different fields (Fig.1).

SMIC Audits Nonuse

Currently in the mounting industry, one of the major topics is the nonuse of conflict tin (Sn) minerals.

Photo: Scenes from refinery audit

In July 2010, Section 1502 (Conflict Minerals Provision) of Dodd-Frank Wall Street Reform and Consumer Protection Act or the Dodd-Frank Act was signed into law by U.S. President Barack Obama. Although this Act does not prohibit the use of conflict minerals, most major corporations have declared nonuse or being conflict-free. While only corporations directly listed on the stock market in the United States are obligated to submit reports to the U.S. Securities and Exchange Commission (SEC), any member of the supply chain is responsible for an accurate investigation and reporting to downstream customers (Fig. 2). Thus, the Act applies equally to all American and other foreign corporations. At present, members of the supply chain make investigation and reports of the country of origin of the minerals. However, having only the nonuse certificate cannot be considered a valid and sufficient investigation process. For its part, SMIC has audited all refineries of its suppliers and verified that no conflict minerals are used. Very few corporations ensure traceability through audit.

It is well-known that the Dodd-Frank Act is an extremely strict law, and it is highly likely that stringent penalties will be applied if incorrect descriptions are found in the investigation report. Furthermore, as it is difficult to trade conflict minerals through the proper channels, they are often traded at lower prices than the market rate. Therefore, it is risky to use cheap materials without checking. Analytical techniques that can identify the area of origin of the materials are being established with a view to improve the accuracy of investigation. The use of solder materials and plating electrode materials clearly indicating the country of origin will lead to business risks reduction.

It is expected that the investigation on plating electrode materials will cover a wider range and the identification of their country of origin will be more difficult than solder materials. Although peo-

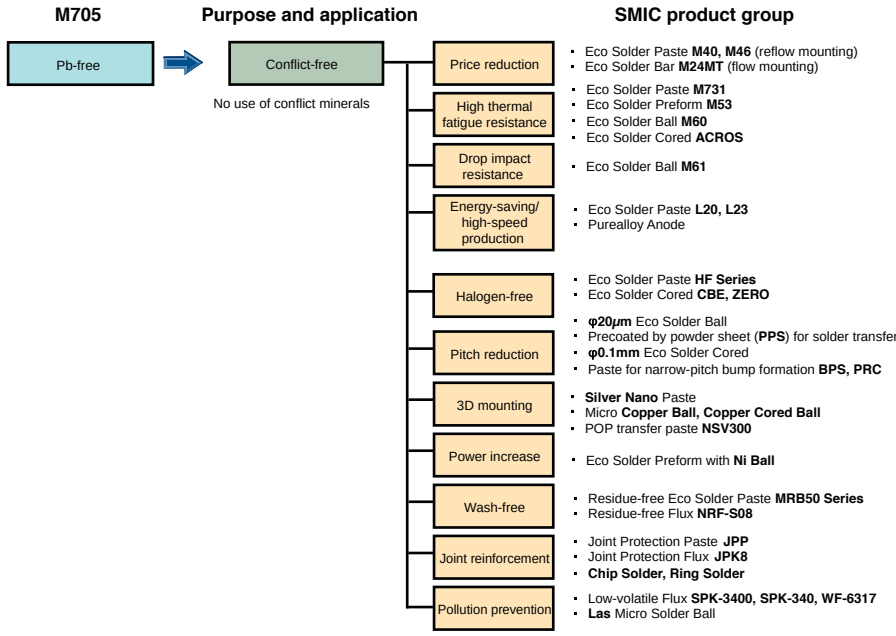


Fig. 1: SMIC's portfolio of solder-related materials based on purpose and application

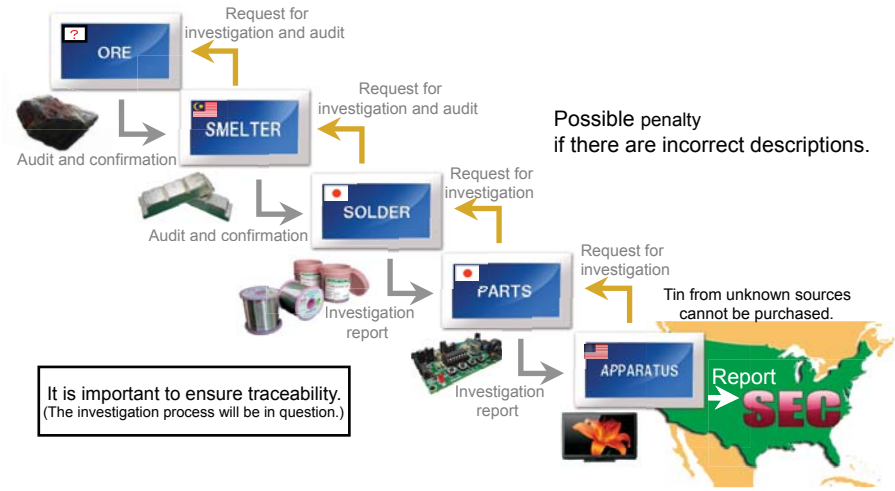
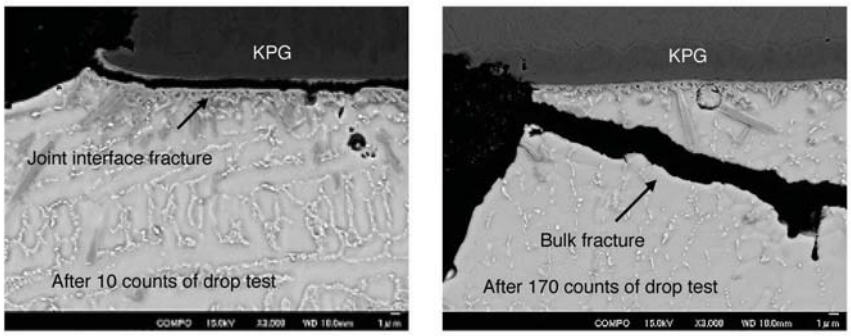


Fig. 2: While only the corporations listed on the U.S. stock market are obligated to submit reports to the SEC, any supply chain is responsible for the accurate investigation report to customers.



M705 (normal fracture mode) M61

Fig. 3: Solder ball M61 with improved drop impact resistance

ple regard conflict minerals as gold, tantalum, tungsten, and tin, which is used for soldering, the tin plating film carries a great impact and falls on a blind spot. Tin electrode materials, which SMIC manufactures using tin materials verified through audit, are safe on this point.

Low-Silver, Silver-Free Solder

SMIC's M40 low-silver (Ag) solder paste, which has been employed in TV receivers of Panasonic Corp. for more than a year, makes it possible to reduce costs and improves the thermal fatigue resistance under similar mounting conditions compared with the conventional 3 percent silver product (M705).

The rise in the price of raw materials and cost reduction strategies of manufacturers are further heating up, leading to demands for low-price solder materials. Among the cost reduction measures being implemented is the reduction in use of expensive silver. If Ag content is simply reduced to less than 3 percent, the melting point (liquidus temperature) rises. As a result, the mounting temperature must be raised, while the serious problem of reduced thermal fatigue resistance occurs. SMIC has successfully improved the thermal fatigue resistance property while suppressing the increase in melting point by solving trace amounts of bismuth (Bi) and indium in tin and adding a trace amount of antimony instead of reducing silver to 1 percent.

Moreover, SMIC recommends M46 solder paste with 0.3 percent Ag if the customer wishes to use halogen-free, low-silver solder paste with even lower price.

Although M46 has an approximately 4ºC higher melting point than M40, the melting point has been suppressed to a low level compared with that of the equivalent products of other manufacturers by adding trace amounts of bismuth and indium. While the mounting temperature needs to be increased a little, it is very attractive for products with a sufficient room for thermal resistance.

Sn-Bi type solder pastes L23 and L20, which have lower melting points than the Sn-Ag-Cu type solders, are drawing attention as low-price next-generation solder materials. They are materials with low melting points that can save energy and reduce costs, thus meeting both environmental consideration and dramatic cost reduction in combination with material costs. Although there are issues specific to Sn-Bi type solders, such as brittleness, these solder pastes deliver sufficient practical properties depending on the application and are already being introduced into practical use. As the issues can be solved by developing them into joint protection pastes containing thermosetting resin, these materials are expanding in terms of purpose and application.

Solder Material, Chip Solder for Handhelds

Demands for mobile devices represented by smartphones and tablet computers are increasingly growing. Weight, thickness, length, and size reduction is further demanded for mobile devices, and at the same time, drop impact resistance is required. To achieve reduction in weight, thickness, length, and size, a three-dimensional (3D) bump connection is popularly used with minute solder balls. The diffusion in the bump connection block formed on the interface between the semiconductor chip and the solder ball, which has grown due to large thermal history, breaks due to drop impact.

SMIC has developed M61 low-silver solder ball featuring an excellent drop impact resistance (Fig. 3). M61 solder ball suppresses fine smoothing and excessive growth of the interface diffusion layer by adding trace amounts of nickel and copper (Cu), improving the drop impact resistance to twice that of the conventional product. In addition, the strength of M61 has been reinforced in a manner in which the fracture occurs in bulk, which could not be considered possible conventionally,

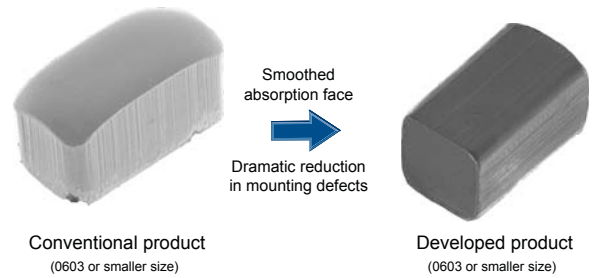


Fig. 4: Micro chip solder with smoothed absorption face

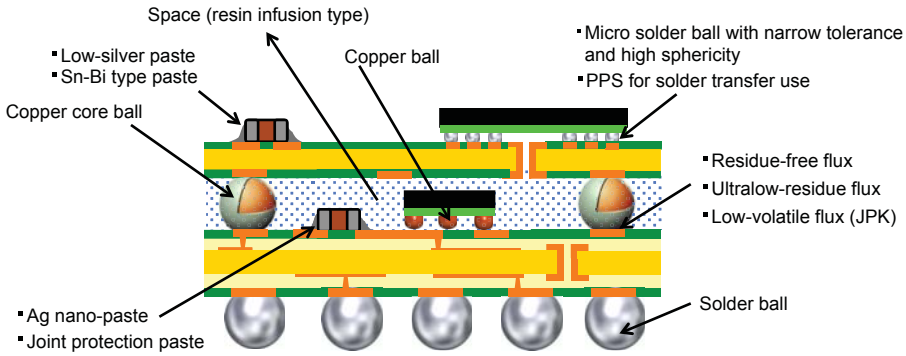


Fig. 5: SMIC products used for leading-edge 3D mounting with embedded components

instead of the diffusion layer regardless of the PKG surface treatment material.

A reduction in weight, thickness, length, and size equals to a reduction in solder materials as well. It can be said that the mechanical strength of joint is proportional to the amount of solder. Thus, the deterioration in strength becomes a matter of concern in sections where mechanical strength is required. SMIC has developed a chip solder that allows the automatic loading and simultaneous melting of solder chips in such sections where insufficient solder amount can be expected. The chip solder has taping specifications to allow automatic loading. While 0603 size or smaller chips conventionally have absorption defects with an R formed on the absorption face due to the processing method, the newly developed chip solder has reduced momentary stops due to absorption failure in processes, thanks to the high-precision machining of smoothed absorption face (Fig. 4).

Innovative Ag Nano-Paste

Ag nano-paste, which achieves ohmic contact, allows low-temperature sintering and no re-melting even at high temperatures. It is a next-generation junction material that can be used in various applications to create new values.

When the particle size is reduced to the nano level, the number of atoms exposed on the surface increases and the surface energy becomes higher, increasing particle activity to enable junction between particles or sintering even at low temperatures. It appeals as a mechanism similar to that of ceramics that can be applied for junction materials. Among the applications that utilize its characteristics to the maximum include 3D mounting with embedded components, die bonding materials, solar cell electrodes, and circuit formation on glass or polyethylene (PET) films. SMIC develops Ag nano-paste products that are suited to various applications to achieve optimal and best supply methods including printability and coating properties, armed with its long experience in organic synthesis technology and a prominent rheology theory.

Supports Narrow-Pitch, 3D Mounting

Semiconductor mounting is a leading-edge mounting technology that enables further reduction in weight, thickness, length, and size as well as improvement in performance. Many SMIC products are used in narrow-pitch mounting and 3D mounting, which are being adopted to achieve weight, thickness, length, and size reduction (Fig. 5).

Whereas the image of alloy products is predominant for SMIC, the company also develops various flux products that are essential to paste and semiconductor mounting. There is a rich lineup of products from which materials can be selected according to the purpose or application.

Micro solder balls are necessary in narrow-pitch mounting. SMIC manufactures solder balls with narrow tolerance and high sphericity through the membrane emulsification technique using its proprietary Shirasu porous glass, achieving a uniform bump formation, in combination with its newly developed MB-T100 flux that adjusts the balls into spheres again during re-melting after circuit board mounting.

At present, SMIC is preparing for a mass-production system for the smallest ϕ20μm solder balls.

In addition, demands for further speedup in transmission in concurrence with the advances in semiconductor mounting are emerging. There are also moves to adopt copper balls with small resistance value for bumps. SMIC has developed copper balls with narrow tolerance and high sphericity using its solder ball manufacture know-how, offering products in various forms.

It is not easy for 3D mounting with embedded components to ensure a high-precision space for embedding semiconductors or components. SMIC has developed copper core balls with various types of plating over copper balls. By using copper core balls between circuit boards, a solder on the surface layer enables electrical connection between the boards and the core copper balls, which do not melt at the soldering temperatures, thus easily ensuring certain space with high precision. Various copper core ball products are offered from ϕ80μm.

Risks of wafer contamination during flux cleaning or reflow process in semiconductor mounting, which may lead to a problem of quality, are present. SMIC offers a lineup of various flux materials to match the methods of avoiding these risks. They are, for example, the WF-6317 low-volatile bump formation/water-wash flux, JPK8 low-volatile/wash-free flux, and NRF-S08 low-residue/wash-free flux. The WF-6317 flux, more than 95 percent of which becomes residue that can be washed off easily with water, can be selected when the user does not wish to contaminate the furnace with flux due to its evaporation during reflow process, while the NRF-S08 flux, which can eliminate the cleaning process with residue of 1 percent or less, can be selected when the user does not wish to cause contamination during the cleaning process. It is also possible to select the JPK8 flux, which requires no cleaning because the residue of 95 percent or more forms thermosetting resin. SMIC meets a wide variety of demands from different fields by offering a lineup of flux products to match even more detailed applications.

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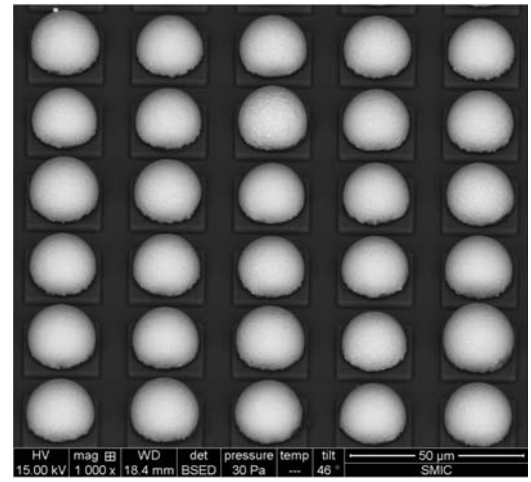
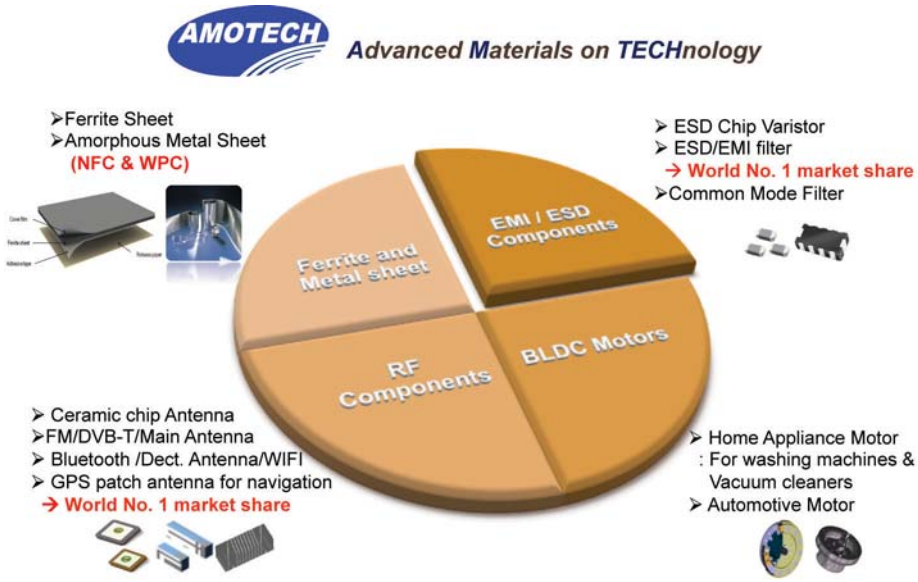


Fig. 6: 30μm-pitch bumps formed with PPS



Amotech has grown to become a leader in important product fields

As the company rides high on the booming sales of ceramic EMI and EMC filters to Samsung and LG, the company has zoomed past its neighboring Japanese rivals to become the largest producer of ESD chip varistor and ESD/EMI filters as well as the world leader in ceramic chip antenna market.

Among the company's other products include amorphous metal sheets, common mode filters, Bluetooth antennas, Global Positioning System (GPS) patch antennas, and brushless DC motors. This broad portfolio of products allows the company to serve a wide range of application markets from FPD TVs to mobile phones to smart phones to washing machines.

Reversing the Downturn

Yet, 2010 and 2011 were among the most challenging years for the company as its chip varistor and EMI/EMC filter businesses, which are the major sources of revenue streams, were dealt with the slowdown in sales and price deteriorations. To make up for the setbacks, Amotech has diversified its product lineup into three- and six-axis magnetic sensors, like accelerometers, light-emitting diode (LED) tube and lighting, and amorphous cores.

Looking into 2012 and beyond, Amotech expects its business would get back on track, as its investments into new business lines like hi-tech materials will start to pay off. Also, its existing chip varistor business is expected to perform better in terms of profitability, as the company starts to sell more lucrative and feature-rich varistors that also double as diodes in 2012.

As the dual-featured varistors will sell for eight times as high as normal counterparts, the company expects it can significantly improve profitability.

In 2011, Amotech shipped 100 million to 200 million dual-featured varistors, replacing normal diodes, and in 2012, shipments would be between 500 million to 1 billion units.

Another money-spinner would be amorphous cores and amorphous-based laminated block cores. The amorphous cores are widely used in inverters, or DC/DC and AC/DC converters for alternative energy systems, like solar cells and wind power generation systems, not only to cut back on heat losses, but also to suppress sudden surge of electric spikes.

They are also used in current transformer systems for smart TVs, as ultra-thin form factors that fit into an 8mm-thick smart TV. The company also expects sales of its Near Field Communication (NFC) antenna would greatly contribute to revenues for fiscal 2012. ❑

SMIC's Solder Products Conform…

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The development of precoated by powder sheet (PPS) for solder transfer, which has enabled to achieve the ideal 25µm-pitch mounting, supports the leading-edge technology for narrow-pitch mounting. This PPS for solder transfer use is expanding its application range, and SMIC hopes to nurture it to be the cutting-edge material of the company (Fig. 6).

High Thermal Resistance Properties

SMIC puts its efforts into developments in fields, such as automotive applications and notebook PCs, where thermal fatigue resistance is required.

Flux cored solders are often used for automotive component mounting. When flux residue cracks due to thermal fatigue and voltage is applied while moisture condensation remains on the crack, migration can easily occur, leading to short-circuit failure.

SMIC has solved this problem by developing ACROS, a flux cored solder that does not cause cracks or breaks even after extreme thermal fatigue.

As solder balls are beginning to be more popular in automotive applications, demands for high thermal fatigue resistance solder balls are growing. SMIC has developed M60 solder ball with excellent thermal fatigue resistance. Whereas the conventional M705 loses the Ag_3Sn network that ensures the strength and causes deterioration in strength when thermal stress loads are applied, the new M60 does not lose the Ag_3Sn network even when thermal stress loads are applied, thanks to the study of optimal Ag level and the addition of trace amounts of nickel and cobalt. M60 solder ball has improved its thermal fatigue resistance by approximately 20 percent compared to the conventional product. ❑