Fine Pitch Bumping Formation Application
- PPS & Micro ball -

Sep.08.2011
Senju Metal Industry
R&D center
Kaichi Tsuruta
Role of Senju Micro Soldering Material

Support for The Development of High Density Packaging Technology
Trend of Semiconductor Packaging

Demand for The Development of Micro Soldering Technology
Fine Pitch Trend and Micro Soldering Methods

Y2005: 120um Pitch
Y2010: 100um Pitch
Y2015: 80um Pitch
Y20XX: 60um Pitch

Micro Solder Ball Mounting

Solder Paste Printing

The Current Method

Senju PPS Method

PPS: Pre-coated by Powder Sheets

写真提供: 長瀬産業株式会社様
Micro-Solder Precoat Technology by Precoat by Powder Sheet (PPS)
Micro solder bump by PPS

25um Pitch

35um Pitch

Sample by NAGASE & CO., LTD
Peripheral PCB

Micro solder bump for Peripheral PCB by PPS

Sample by Hitachi chemical
Comparison of Micro-Solder Bump Technologies

<table>
<thead>
<tr>
<th>Solder Paste (Screen Print)</th>
<th>Variation of Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Printability for fine pitch patterns</td>
</tr>
<tr>
<td></td>
<td>Voids</td>
</tr>
<tr>
<td>Ball mount</td>
<td>Expensive mounting tool</td>
</tr>
<tr>
<td></td>
<td>Accuracy of mounting</td>
</tr>
<tr>
<td>Plating</td>
<td>Limitation of metal compositions</td>
</tr>
</tbody>
</table>

Those issues may be resolved by **PPS**

**PPS** = Precoat by Powder Sheet
Features of PPS method

1. Applicable to fine pitch (25 µm Pitch)
2. Solder bump height is usually apx.4-6 µm with 1st PPS and apx.10 µm height with 2nd PPS for a wafer with 40 µm pitch.
3. Small variation of Bump Height
   \[ \sigma < 1 \] for a wafer with 40 µm pitch
4. No need of solder mask or alignment tools
5. Applicable for a variety of solder alloy composition
Structure of PPS sheet

Base sheet (PET)

Adhesive layer
5um~10um

Solder Powder

Powder size: 5～10um
Powder size and alloy composition are selective for each application
# Solder Bump by PPS

<table>
<thead>
<tr>
<th></th>
<th>After UBM</th>
<th>After Solder bump</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Surface × 500 (Bird’s eye view)</td>
<td>Surface × 500 (Bird’s eye view)</td>
</tr>
<tr>
<td><strong>25um Pitch</strong></td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
<tr>
<td><strong>35um Pitch</strong></td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
</tr>
</tbody>
</table>

Sample by NAGASE & CO., LTD
1. Contact PPS sheet with work then press with heat

PPS transfer temperature should be lower than the melting point of solder alloy.
2. Removing PPS sheet
3. Flux+Reflow, Cleaning

Reflow temperature is higher than the melting point of solder alloy.
PPS bonder φ 320mm Max

Upper heat plate

Lower heat plate
Cross section of PPS bump
Void inspection by X ray viewer

Test Board

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCB size</td>
<td>30 × 30 × 0.8 mm</td>
</tr>
<tr>
<td># of Electrodes</td>
<td>60 × 60 = 3600 pads</td>
</tr>
<tr>
<td>Pitch</td>
<td>200 μm</td>
</tr>
<tr>
<td>Diameter of each pad</td>
<td>120 μm</td>
</tr>
</tbody>
</table>

Less voids
Mechanism of PPS method

- PET
- Adhesive layer
- Solder powder
- PPS sheet
- Solder bump
- IMC
- Electrode, pad

$F_{ts} < F_{imc}$

Selective transfer, Selective solder bump
Senju Micro Ball Technology
The Success Factor for Micro Soldering

Micro Solder Ball

50um

30um

DELTALUX MB-T100
Flux for Micro Soldering

SNR-850MB

CX-430 /for Clean Room
Reflow Oven for Micro Soldering
## Work Size

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>wafer</td>
<td>8 inch</td>
</tr>
<tr>
<td>Pitch</td>
<td>85 um</td>
</tr>
<tr>
<td># of Bumps</td>
<td>3200K</td>
</tr>
</tbody>
</table>

## Soldering Materials and Equipment

<table>
<thead>
<tr>
<th>Material/Equipment</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solder Ball</td>
<td>M705-50um</td>
</tr>
<tr>
<td>Flux</td>
<td>MB-T100</td>
</tr>
<tr>
<td>Reflow Oven</td>
<td>SNR-850MB</td>
</tr>
</tbody>
</table>

85um Pitch/50um Ball Bumping
## Advantage of Micro Solder Ball Bumping

<table>
<thead>
<tr>
<th></th>
<th>Paste</th>
<th>Micro Ball</th>
<th>Plating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Void</td>
<td>○</td>
<td>○</td>
<td>△</td>
</tr>
<tr>
<td>Coplanarity</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Repair</td>
<td>×</td>
<td>○</td>
<td>×</td>
</tr>
<tr>
<td>Pitch size</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Solder composition variation</td>
<td>○</td>
<td>○</td>
<td>×</td>
</tr>
<tr>
<td>For Environment</td>
<td>○</td>
<td>○</td>
<td>△</td>
</tr>
<tr>
<td>Operation cost</td>
<td>©</td>
<td>○</td>
<td>△</td>
</tr>
</tbody>
</table>
The diameter range of Senju solder products is from 40um to 1mm. Senju can supply various size of ball answering the needs of customer.

Senju standard Micro Ball tolerances is +/-3um.
Control Cpk, Cir Trend & SPC. at RFC, DRB, MRB System Completely

* LAS M705 70um

**Individual Measurement of AVG(Dia)**

- AVG(Dia) Mean: 0.070169
- LCL: 0.069694
- UCL: 0.070645

**Individual Measurement of Sigma(Dia)**

- Tau: 0.0004
- Avg: 0.000248
- UCL: 0.000374
- LCL: 0.000123

**Individual Measurement of CpK(Dia)**

- Avg: 3.88
- UCL: 5.73
- LCL: 2.04
<table>
<thead>
<tr>
<th>Year</th>
<th>Micro Ball Manufacturing (HVM Method)</th>
<th>Micro Ball Technology (Special Method)</th>
<th>Micro Solder Alloy</th>
<th>New Micro Soldering Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>45um</td>
<td>20um</td>
<td>SAC</td>
<td>Cu,Ni core Ball</td>
</tr>
<tr>
<td>2012</td>
<td>40um</td>
<td>Under 20um</td>
<td>SAC,SC</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>Under 30um</td>
<td>Under 20um</td>
<td>Low Temp.Bi,In,Zn</td>
<td></td>
</tr>
</tbody>
</table>

Aug. 2011
Micro Ball Recyclable PBF Package

CSR, EHS & EICC Green Program

LABOR
Workers Treated with Respect and Dignity
- Freely Chosen Employment
- Child Labor Avoidance
- Working Hours
- Wages and Benefits

ENVIRONMENT
Global Environmental Stewardship
- Permits & Reporting
- Pollution Prevention
- Hazardous Substances
- Wastewater
- Solid Waste
- Air Emissions
- Product Content

HEALTH AND SAFETY
Evaluate & Control Exposure to Hazards
- Occupational Safety
- Emergency Preparedness
- Occupational Injury & Illness
- Dormitory & Canteen
- Industial Hygiene

ETHICS
Uphold the Highest Standards
- Business Integrity
- No improper Advantage
- Disclosure of Information
- Intellectual Property
- Fair Competition
- Protection of Identity
- Community Engagement

SMIC
Senju Metal Industry Co., Ltd.

MANAGEMENT SYSTEM

NEW
Halogen-Free / Lead-Free Soldering Products

Our complete technical expertise and customer support deliver a cutting-edge ECO Soldering Solution™

ECO SOLDER
Lead-Free by SMIC

SMIC confidential
The alpha particle discharged from solder is an incidence in the memory cell. It ionizes and electron-hole pair is generated. The hole is pulled to the substrate side and the electron is pulled to the memory cell side. It is information 0 as for the state that the electron is filled in the memory cell part, the electron is information 1 in the memory cell part as for empty. The malfunction of information 1→0 occurs.
Senju LAS Materials

- **LAS Solder Paste**
  For fine pitch bumping for substrate, wafer

- **LAS Solder Ball**
  For super fine pitch & stable volume bumping on substrate, wafer

- **LAS Super Fine Solder Powder**
  For flexible wiring, bumping, research material for future
Senju LAS Material

Senju Low Alpha Grade

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Senju LAS Micro Ball Standard
Diameter and Tolerance : 40-110um ±3um
Alpha count : 0.02cph/cm^2 or less
Solder Composition : M705(SAC305), M200(SnCu), SnPb
Senju can provide low alpha solder material. We have many experiences of low alpha product manufacturing (Solder Ball, Solder Paste, Solder Powder, etc...). Raw materials may be sourced internally or externally to best meet customer’s preferred low alpha limitations.

◆ **LACS-4000M(SUMIKA)**
  - Sample area: 900～1000cm^2
  - Counting time: 72～99hour
  - Counting gas: PR-10(Ar90%+CH₄10%)

◆ **Model 1950(Alpha Sciences)**
  - Sample area: 900～1000cm^2
  - Counting time: 72～100hour
  - Counting gas: PR-10(Ar90%+CH₄10%)
**Senju Low Alpha Control Ability**

**Reference : LAS (Low Alpha Solder) Material**

![Graph showing LAS material]

Ex. 0.005 cph/cm² grade of SAC Solder

Senju Product Standard
G1 : < 0.02 cph/cm²  
G2 : < 0.01 cph/cm²  
G3 : < 0.005 cph/cm²  
G4 : < 0.002 cph/cm²

**Reference : HAS (High Alpha Solder) Material**

![Graph showing HAS material]

Ex. HAS SAC Solder

Alpha count reveal  
→ about 7~12 cph/cm²

『Senju Product Standard』
G1 : < 0.02 cph/cm²  
G2 : < 0.01 cph/cm²  
G3 : < 0.005 cph/cm²  
G4 : < 0.002 cph/cm²
The Senju-LAS product is blended and inspected by itself.

RM incoming

Selected RM group

Multi Vendor

LAS RM

(With alpha count CofC)

Rare Sn, Pb or alloy (Sn/Pb, SA, SAC etc)

Ag, Cu Pure metal

Alloy casting

Melting blending

Inspection

Alpha count inspection

OK

Solder Sheet

Composition inspection

OK

LAS product manufacturing

Sphere, powder, others
SMIC has the Policy Securing Capacity at the HVM Factory
Micro Ball Shall be Shipped from Tochigi or Miyazaki

Iwate Plant
(HVM Plant for BGA/CSP Sphere)

Tochigi Plant (R & D)
(Initial Sphere Build & Mother Plant)

Senju Giken, Miyazaki
(HVM Plant for Micro Sphere

Micro Sphere & Powder Mfg and Develop’t Established on 2006/12/01
If you have any question for our products, please feel free contact us. Thank you.

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Senju Metal Industry Co., LTD.