# Process and Reliability Investigation of Sn-Bi Assembly for BGA Components

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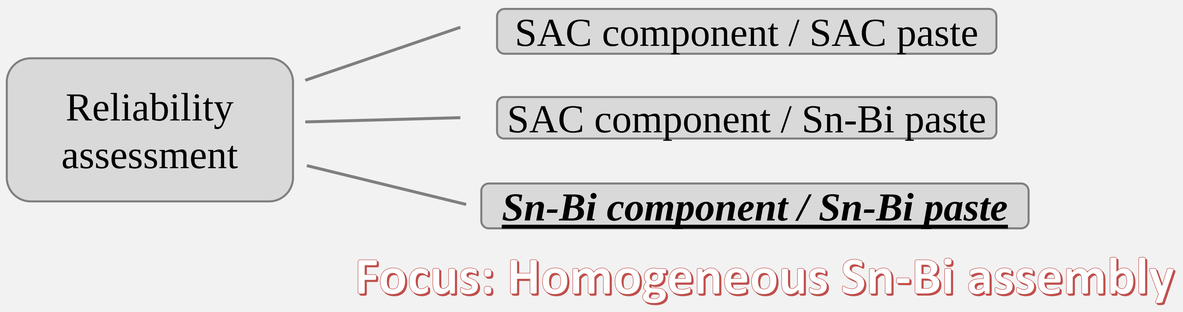
## Background

- Lead-free solders are widely used in microelectronic fields due to the toxicity of Sn-Pb solder. With the miniaturization of electronic packaging, higher demands are required for the reliability of solder joints.
- The low melting eutectic Sn-Bi solder alloy is a possible alternate. Low temperature soldering can not only save the energy for heating, but also can increase the reliability of joints by minimizing warpage during processing.
- Currently most studies focused on homogeneous SAC assembly or SAC component/Sn-Bi paste hybrid assembly, yet there's no study exploring reliability of homogenous Sn-Bi board assembly




## Objectives

- Assembling Sn-Bi solder on bare components and evaluating the assembling quality.
- Processing three types of board assemblies: pure Sn-Bi assembly, Sn-Bi/SAC305 hybrid assembly and pure SAC305 assembly.
- Performing thermal cycling test on boards and investigating the reliability of different types of assembly.

## Sample preparation

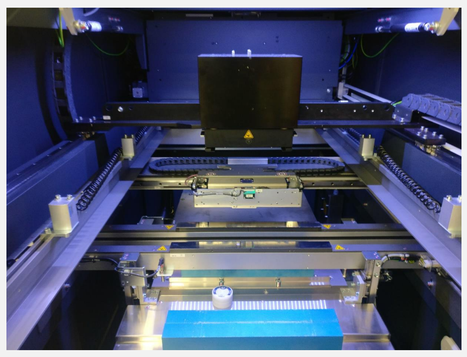


Fig. 1. Stencil printing and ball attaching device for assembly

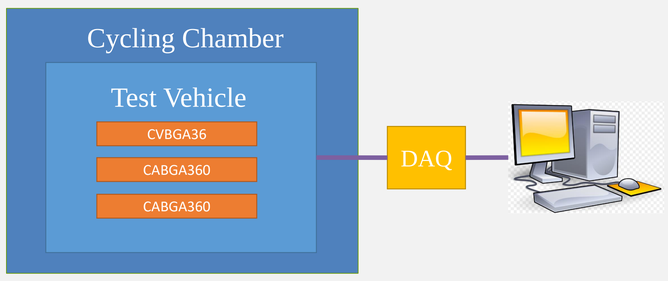



Fig. 2. Event monitoring setup

- Thermal cycling conditions: -40°C to 125°C, ramp rate:5°C/min, dwell time:20 min
- Test components: CVBGA432 (pitch: 0.4 mm, ball diameter: 0.25 mm); CABGA360 and CABGA36 (pitch:0.8 mm, ball diameter: 0.45 mm)

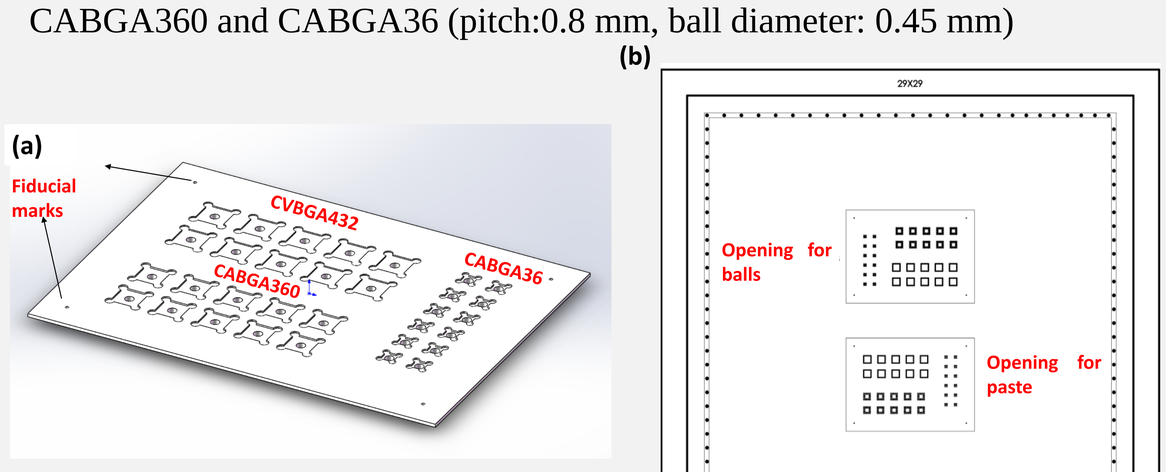



Fig. 3. Setup for stencil printing and ball attaching, (a) structure of chip holding jig, (b) stencil with both paste and ball opening

- To assemble solder balls on bare components, two methods are employed, one way is to apply paste first and then placing balls manually, the other way is to using stencil printing to apply paste on components multiple times

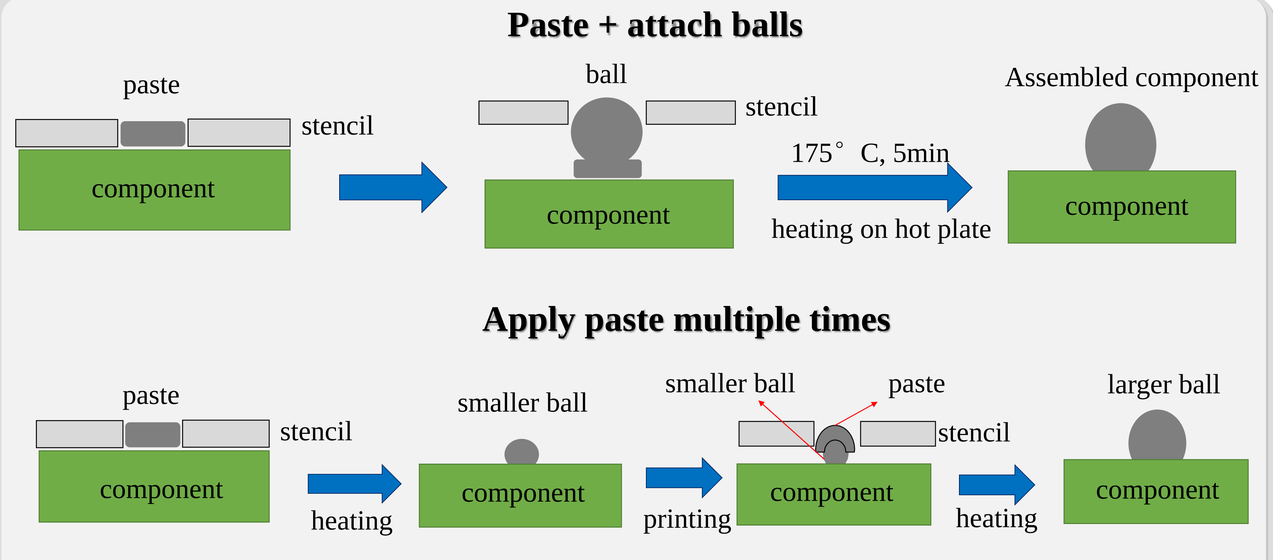



Fig. 4. Two methods to make component assembly

- Applying paste multiple times is suitable for components with small pitches, for CVBGA432, paste should be printed 3 times to make balls having comparable volume to SAC305 components

## Assembly assessment and event monitoring

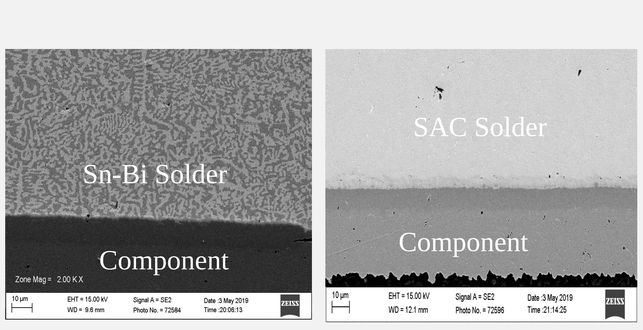



Fig. 5. Cross section view of the interfaces at assembled components

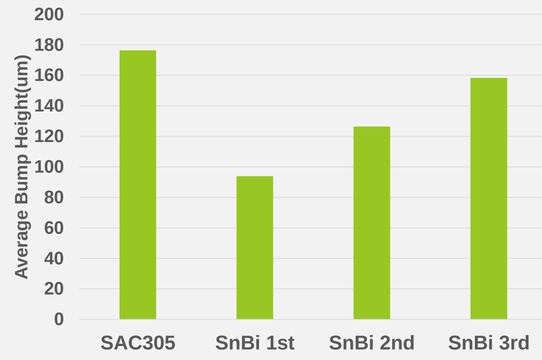



Fig. 6. Relationship of bump height and times of printing paste on CVBGA432

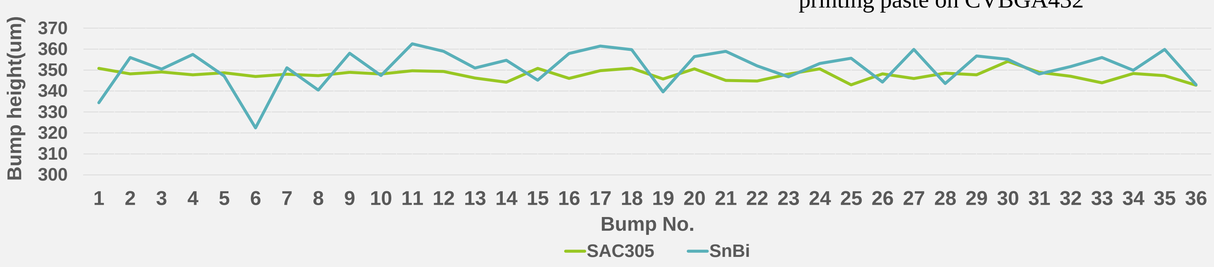
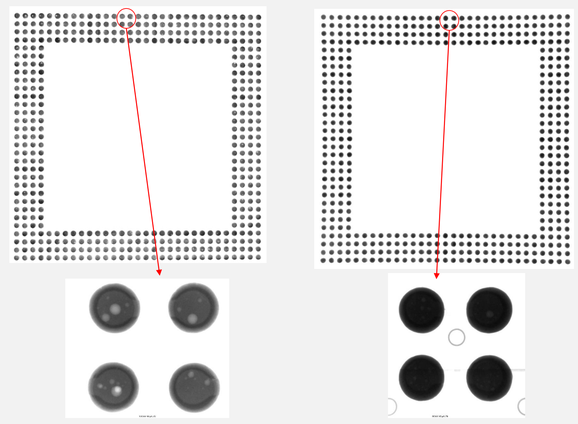
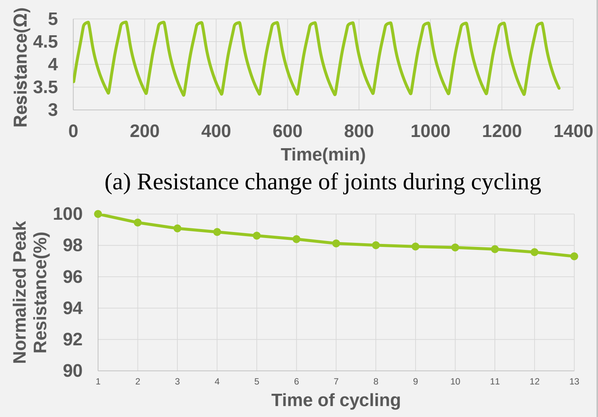


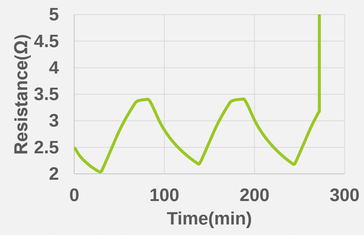

Fig. 7. Comparison of bump height of SAC305 and Sn-Bi on CABGA36






(a) Resistance change of joints during cycling

(b) Normalized peak resistance change of joints during cycling




(c) Failed joint resistance change

- Based on the x-ray image of reflowed components, Sn-Bi components exhibit better quality of board assembly
- Except for defects during manufacturing, most joints remain same resistance during cycling

## Future work

- Studying the fatigue life of Sn-Bi solder joints comparing to SAC305 interconnections by thermal cycling test of both BGA and QFN test vehicles
- SEM analysis for microstructures for reflowed assemblies and cycled interconnections
- Generate Weibull charts as well as constitutive equations for Sn-Bi solder