**INTRODUCTION**

1. Material properties of SAC are needed to support modeling
   - Elastic, time-independent, time-dependent plastic (creep)
2. Why actual solder joints?
   - Bulk solder and solder joints have different microstructures
3. State-of-the-art
   - There are many published data for bulk solder
   - However, data for actual solder joints are not available yet
4. Elastic and time-independent plastic properties of SAC105, SAC305, and SAC405 were measured in this work
5. Methodology
   - Combining compressive, drop test, DIC and FEM modeling

**TEST VEHICLE**

- The test vehicle: CABGA
- Packages were cross-sectioned & polished using 320-1200 grit silicon carbide papers
- Cross-sectioned surfaces exhibit random speckle pattern for DIC
- No further treatment is needed

**EXPERIMENTS**

- Drop weight technique was used to create compressive force on the BGA
- Images of solder joints were taken before and after each drop using microscope
- Plastic displacement & strain in the BGA were evaluated using DIC

**FEM MODELING**

- Analysis: Transient
- Method: “G-Input”
- Elasto-plastic model: Multi-linear kinematic hardening (TB,KINH) for the solder joints

**ITERATION PROCESS**

- Ramberg-Osgood Equation
  \[ \varepsilon = \frac{\varepsilon_0}{E} \left( \frac{\varepsilon}{\varepsilon_0} \right)^n \]
- Curve fitting \((G, Y_{\text{plus}})\)
  \[ Y_{\text{plus}} = m \left( \frac{\varepsilon}{\varepsilon_0} \right)^n \]
- \((m, g_0)\) were obtained by fitting the experimental data
- \((n, \alpha)\) were extracted from \((m, g_0)\) by using a developed iteration process

**RESULTS & DISCUSSIONS**

- Constitutive equations for SAC105, SAC305, and SAC405 solder joints were successfully developed
- The results in this work are in good agreement with literature
- Contour plots from DIC and drop modeling match very well

**CONCLUSIONS**

- A novel methodology was developed for the characterization of elasto-plastic behavior of SAC solder alloys
- The Ramberg-Osgood model is able to describe the elasto-plastic behavior of the solder alloys
- The coefficients of the model were successfully extracted with high accuracy
- The model was recommended to be used for drop test modeling of electronic packaging

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