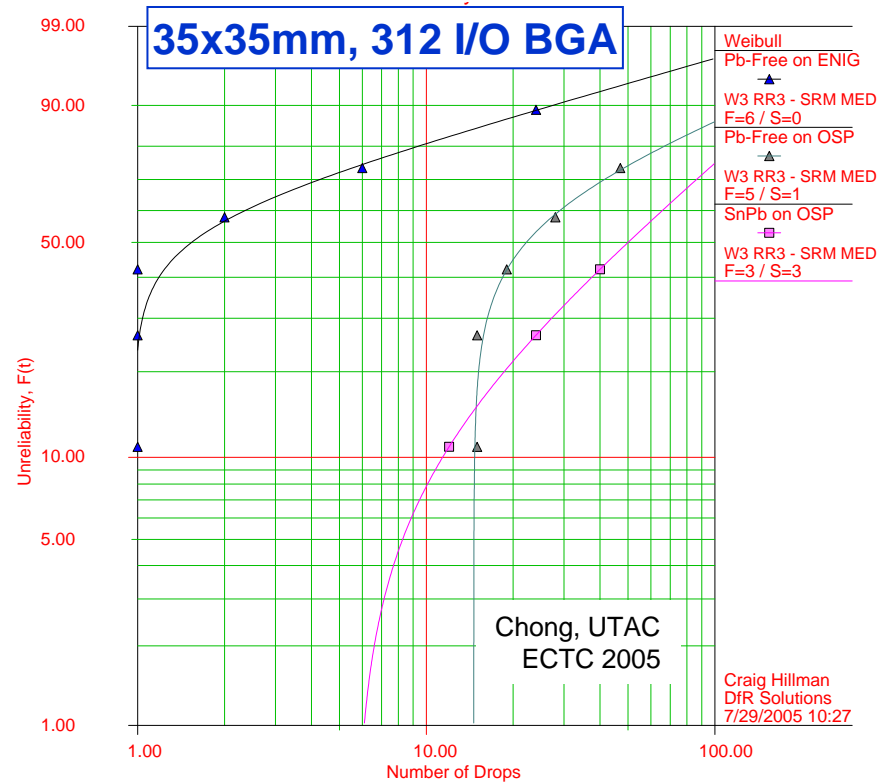


# Mechanical Shock

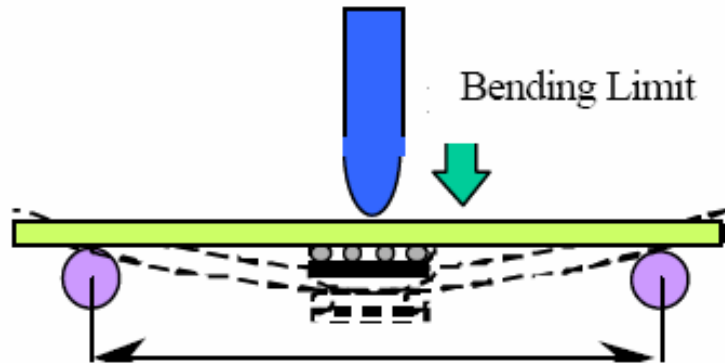
- Few results in literature
  - No indications of elevated failure rates from mobile products
- Initial findings
  - SAC displays slightly less robust behavior than SnPb
  - Plating can be a greater driver
    - SnNi vs. SnCu intermetallics
    - Crossover into board failure



$\beta_1=0.3122, \eta_1=1.8307, \gamma_1=0.9725, \rho=0.8835$   
 $\beta_2=0.4379, \eta_2=17.5982, \gamma_2=14.6125, \rho=0.9316$   
 $\beta_3=0.9213, \eta_3=66.0929, \gamma_3=5.6500, \rho=1.0000$

PQFP (28x28mm, 208 I/O)	Failures	
Pb-Free on ENIG	2/6	44/50, 45/50
Pb-Free on OSP	2/6	16/50, 29/50
SnPb on OSP	0/6	--

# Mechanical Loading (Lower Strain Rates)



35x35mm, 388 I/O BGA; 0.76 mm/min			
Paste	Solder Ball	Average Fracture Load (N)	Std Dev (N)
SnPb	SnPb	692	93
Sn4.0Ag0.5Cu	SnPb	656	102
	Sn4.0Ag0.5Cu	935	190

Roubaud, HP  
APEX 2001

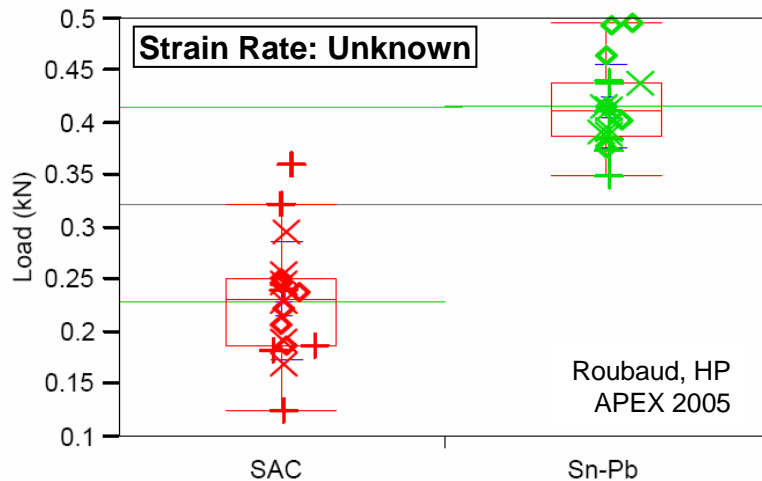


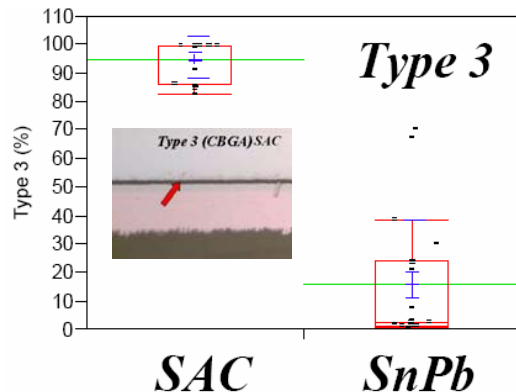
Table 4. Board displacements until solder joint open failure as a function of joint material combination.

Solder ball	SnPb	SnAgCu	SnAgCu
Solder paste	SnPb	SnAgCu	SnPb
Avg.	0.808	0.740	0.783
Max.	0.898	0.854	0.960
Min.	0.669	0.617	0.630

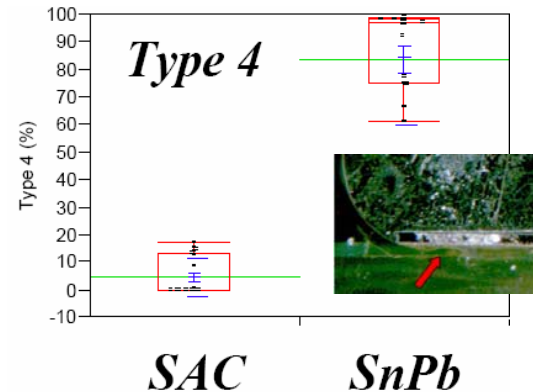
Speed: 5mm/min ( or 2.5mm/min)

# Mechanical Loading (Discrepancies)

- Printed board behavior (bond pad pullout)
  - More robust board experiences less damage during Pb-free reflow?
  - Better materials provide better copper/epoxy adhesion?



Roubaud, HP  
APEX 2005



- Different strain rates
  - Low: Bulk; Moderate: Bond Pad; High: Intermetallic
- Solution?
  - Companies have decreased allowable strain values during manufacturing and assembly from 1000 to 750 or 500 microstrain