

GR&R Test on Sn-Bi Measurement

1. Overview

Regarding Sn-Bi measurement, some technical instructions have already been shown in the application brief No.17, 18 and 21. This application brief introduces the comparisons of the measurement repeatability and reproducibility by our existing instruments, the latest SFT9300, the standard SFT3000S and the highest resolution SEA5000. In order to do this, GR&R test on Sn-Bi measurement by each machine was done.

2. Measuring conditions

The measuring conditions are shown in the table below.

	SFT9300	SFT3000S	SEA5000
Collimator Size	Φ0.1mm	Φ0.1mm	Φ0.1mm
Primary Filter	OFF	ON	OFF
Numerical Filter	ON	ON	OFF
X-ray Tube Voltage (kV)	50	45	50
X-ray Tube Current (μA)	1500	1000	1000
Preset Measuring Time (sec)	100	100	100
Calculation	Thin Film Fundamental Parameter Method		
Reference Material	Sn-Bi : 7.8μm、 Bi : 2.8%		

3. Experiments

An ordinary lead frame sample was prepared for this test. 3 operators participated in this test. Each operator gauged Sn-Bi thickness and Bi% on different 10 points one after another. This sequence was repeated 3 times.

4. Results

%R&R and some other parameters are shown in the table below. The detail worksheets of this test are attached on the following pages.

	Sn-Bi thickness			Bi%		
	%Repeatability	%Reproducibility	%GRR	%Repeatability	%Reproducibility	%GRR
SFT9300	1.34	0.93	1.63	17.86	7.29	19.29
SFT3000S	3.54	1.39	3.80	50.02	19.39	53.64
SEA5000	3.61	1.10	3.78	23.70	8.60	25.22

According to these results, %Repeatability should be reduced on these gauges in order to realize lower %GRR. If longer measurement time and bigger collimator size is applied, %Repeatability will be improved..

GRR Worksheet

Machine: SFT9300

Sn-Bi thickness (μm)

Upper spec: $15\mu\text{m}$

Lower spec: $5\mu\text{m}$

Sample	Operator A			Operator B			Operator C		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
1	10.00	10.00	10.00	9.96	9.95	10.00	10.04	10.01	10.03
2	9.64	9.68	9.70	9.67	9.68	9.70	9.67	9.67	9.73
3	9.61	9.60	9.61	9.56	9.57	9.60	9.59	9.60	9.59
4	9.60	9.63	9.65	9.63	9.63	9.65	9.63	9.65	9.70
5	9.58	9.58	9.57	9.60	9.63	9.62	9.59	9.58	9.61
6	9.67	9.68	9.71	9.61	9.62	9.63	9.65	9.63	9.64
7	9.68	9.65	9.67	9.64	9.68	9.65	9.66	9.70	9.64
8	9.64	9.66	9.66	9.65	9.62	9.65	9.62	9.65	9.67
9	9.61	9.67	9.69	9.61	9.66	9.66	9.63	9.60	9.64
10	9.66	9.65	9.69	9.66	9.66	9.70	9.66	9.62	9.69

Bi composition (%)

Upper spec: 4%

Lower spec: 1%

Sample	Operator A			Operator B			Operator C		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
1	1.29	1.08	1.26	1.31	1.22	1.28	1.32	1.19	1.11
2	1.06	1.11	1.30	1.29	1.23	1.22	1.22	1.34	1.37
3	1.25	1.27	1.32	1.26	1.11	1.17	1.24	1.06	1.24
4	1.13	1.20	1.09	1.23	1.31	1.34	1.27	1.34	1.12
5	1.23	1.24	1.26	1.35	1.17	1.26	1.17	1.20	1.18
6	1.20	1.22	1.09	1.27	1.33	1.24	1.14	1.29	1.24
7	1.11	1.40	1.19	1.29	1.16	1.36	1.13	1.18	1.30
8	1.21	1.06	1.28	1.34	1.27	1.31	1.35	1.25	1.14
9	1.25	1.15	1.26	1.27	1.09	1.35	1.11	1.20	1.34
10	1.15	1.39	1.26	1.13	1.27	1.02	1.28	1.23	1.24

Machine: SFT3000S

Sn-Bi thickness (μm)

Upper spec: 15 μm

Lower spec: 5 μm

Sample	Operator A			Operator B			Operator C		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
1	10.45	10.44	10.66	10.60	10.56	10.59	10.59	10.61	10.48
2	10.10	10.16	10.12	10.23	10.07	10.12	10.10	10.08	10.06
3	9.85	9.87	9.96	9.88	9.97	9.97	9.91	9.82	9.92
4	9.83	9.82	9.97	9.86	9.86	9.97	9.81	9.97	9.83
5	9.98	9.88	9.91	9.99	10.07	10.03	9.96	10.08	10.06
6	9.98	9.95	9.90	9.97	9.82	10.01	10.04	10.07	9.99
7	10.06	9.98	9.95	10.00	10.01	9.99	9.96	9.91	9.98
8	9.99	10.07	10.00	9.97	10.03	9.97	9.96	10.02	10.07
9	10.04	10.02	9.99	9.97	9.88	9.95	10.04	9.86	10.00
10	9.93	9.94	9.96	9.97	9.95	10.00	9.99	9.89	9.96

Bi composition (%)

Upper spec: 4%

Lower spec: 1%

Sample	Operator A			Operator B			Operator C		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
1	1.22	1.52	1.59	1.29	1.27	0.71	1.49	1.38	1.73
2	1.42	1.04	1.49	1.37	1.25	1.57	1.06	1.49	0.94
3	1.25	1.27	1.49	0.95	1.01	1.15	1.21	1.58	1.32
4	1.62	1.74	1.40	0.89	1.33	1.76	1.13	1.50	1.44
5	1.25	1.52	1.43	1.15	0.74	1.29	1.62	1.06	1.36
6	1.53	1.17	1.21	0.87	1.69	1.36	1.29	1.36	1.08
7	1.07	1.22	1.63	1.46	1.15	1.58	1.24	1.43	1.23
8	1.39	1.15	1.62	1.54	0.85	1.28	1.35	1.37	0.79
9	0.86	1.21	1.09	1.55	1.20	1.35	1.55	1.14	1.34
10	1.22	0.83	1.01	1.24	0.85	1.22	1.23	0.96	1.78

Machine: SEA5000

Sn-Bi thickness (μm)

Upper spec: $15\mu\text{m}$

Lower spec: $5\mu\text{m}$

Sample	Operator A			Operator B			Operator C		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
1	10.11	10.12	10.11	10.24	10.20	10.04	10.13	10.11	10.03
2	9.88	9.82	9.68	9.85	9.72	9.80	9.83	9.78	9.81
3	9.68	9.70	9.61	9.72	9.70	9.65	9.70	9.60	9.65
4	9.65	9.72	9.60	9.61	9.59	9.55	9.71	9.68	9.62
5	9.61	9.58	9.64	9.69	9.56	9.67	9.56	9.54	9.53
6	9.73	9.66	9.54	9.62	9.66	9.55	9.67	9.63	9.49
7	9.80	9.69	9.66	9.74	9.68	9.58	9.64	9.69	9.64
8	9.72	9.78	9.66	9.78	9.68	9.76	9.75	9.72	9.63
9	9.81	9.74	9.61	9.75	9.70	9.63	9.73	9.68	9.67
10	9.65	9.68	9.64	9.66	9.64	9.61	9.63	9.63	9.61

Bi composition (%)

Upper spec: 4%

Lower spec: 1%

Sample	Operator A			Operator B			Operator C		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
1	1.28	1.45	1.31	1.23	1.34	1.45	1.43	1.36	1.40
2	1.37	1.50	1.31	1.38	1.52	1.56	1.48	1.30	1.26
3	1.64	1.18	1.31	1.37	1.50	1.34	1.45	1.49	1.33
4	1.46	1.28	1.57	1.40	1.35	1.23	1.52	1.39	1.53
5	1.36	1.35	1.33	1.38	1.37	1.42	1.33	1.62	1.21
6	1.33	1.27	1.29	1.50	1.34	1.52	1.46	1.51	1.40
7	1.20	1.19	1.43	1.53	1.60	1.23	1.33	1.42	1.42
8	1.32	1.35	1.47	1.34	1.63	1.57	1.34	1.21	1.39
9	1.26	1.29	1.51	1.33	1.31	1.43	1.40	1.48	1.35
10	1.14	1.42	1.61	1.24	1.26	1.46	1.47	1.30	1.38