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IN REPLY
REFER TO DSCC-VAC (Mr. Barone/DSN 850-0510 / (614)692-0510)

MEMORANDUM FOR VSS (Mr. Art Hudson)

SUBJECT: Dated Engineering Practices (EP) Study on Test Method 1018, RGA for small volume packages - Project Number: 5961- 2352

Findings and recommendations Engineering Practices (EP) Study, dated 30 July 2001, and attachments are enclosed.

It is requested that your office take the necessary electronic action to reflect completion of this project.

Enclosure

TOM HESS
Chief
Active Devices Team

ENGINEERING PRACTICES STUDY

TITLE: Problems in the Standardization on RGA For Small Volume Packages

30 July 2001

STUDY PROJECT (SEE ATTACHMENT 1)

FINAL REPORT

Study Conducted by JC-13.1 task group

Prepared by

Alan Barone

I. OBJECTIVE: The objective of this study is to improve test method 1018 to cover small volume packages.

II. BACKGROUND: A JEDEC task group was formed to study this issue due to lack of criteria to measure RGA in small volume packages. These initiatives include an effort to establish RGA test criteria for small volume packages, less than .01 cc. Numerous experiments have been performed to isolate material outgassing effects and establish a baseline with the RGA test labs. Additionally, since most of these products are sealed using tooling that yields an internal partial pressure of approximately 0.5 ATM., a method delineating the adjustment to the existing 5000 ppm, 1.0 ATM. criteria were drafted. A correlation effort was initiated to determine the extent of variability in the test results. The test labs that have tooling capability to test these small packages were asked if they could test 0.001 cc volume of encapsulated gas. They stated that they have internal calibration techniques that would support these measurements however the accuracy and repeatability would not be as good as in the larger packages; a 500 to 1000 ppm error was possible for the 0.002 cc UB surface mount package.

Prior to releasing the new test method devices from seal lots were sent to both certified labs to establish correlation of their results and repeatability with-in the labs. The physics of the effects of moisture in a device of this size was discussed at length in Task Group. The general consensus is as follows:

1) In small volume cavities very little moisture is needed to show as a very high water content reading, parts per million (ppm).

2) Moisture is readily absorbed and dis-absorbed from package materials, especially the encapsulated metal surfaces.

3) The presence of Hydrogen has skewed results between labs in large volume packages and hydrogen is present in these small packages due to the manufacturing processes used. It is imperative the RGA test set up incorporates the effects of Hydrogen.

4) The Surface to Volume ratio of these package types is very high compared to most packages used in the semiconductor industry. This radically enhances the effect of disabsorbed gases.

5) The RGA test is performed in a vacuum at 100C. Isolation of the constituent gases of the package cavity from those that are outgassed from package material during the test is not guaranteed.

6) Materials used in the package have plated surfaces. Hydrogen is a by-product of the plating process and as a result imbedded in the materials. Hydrogen is also used as a forming gas in the required Au Si die attach process.
7) When the partial pressure adjustment is applied to the measurement it will typically reduce the reported moisture about 50% for these package types.

For 8 months industry has diligently worked with the EIA G12 Task to bring this issue to a mutually acceptable conclusion. Experiments were designed to isolate the effects of the materials and processes noted above. Additionally, manufacturers have subjected all numerous production lots to RGA testing (which is currently not a requirement of the specification) in an attempt to establish baseline data. To optimize the testing numerous consultations were conducted with the test labs and other experts in the field. This resulted in numerous experiments which attempted to isolate and control the major contributors to the moisture reported in the package as well as evaluate the correlation between the different accredited RGA labs and the repeatability of any one lab's results.

III. RESULTS:. The results are at best inconclusive (see summary of test results):

Appendix:

Ser#	Test lab	Test Date	Prbk	moisture	hydrogen	nitrogen	oxygen	argon
LDC: 9914								
4466	Pernicka	7/1/00	no	4899ppm	6120ppm	843,000	138,378	6743ppm
4553	Pernicka	7/1/00	no	5285ppm	86ppm	930,996	60,687	2786ppm
4438	pernicka	7/1/00	no	40,333ppm	29,869ppm	922,414	3357ppm	68ppm
4446	pernicka	7/1/00	no	19,629ppm	28,617ppm	948,953	1293ppm	57ppm
4377	pernicka	6/7/00	yes	20,529ppm	15,552ppm	959,885	2171ppm	116ppm
4373	pernicka	6/7/00	yes	21,817ppm	17,045ppm	949,887	8649ppm	443ppm
4382	pernicka	6/7/00	yes	40,797ppm	48,113ppm	898,322	7346ppm	100ppm
4394	pernicka	6/7/00	yes	26,025ppm	23,063ppm	940,532	8006ppm	435ppm
?? 1	AAL	7/12/00	yes	550 ppm	82,000ppm	+910,000	ND	ND
?? 2	AAL	7/12/00	Yes	540 ppm	85,000ppm	+910,000	ND	ND
?? 3	AAL	7/12/00	Yes	530 ppm	92,000ppm	+900,000	ND	ND
?? 4	AAL	7/12/00	Yes	570 ppm	78,000ppm	+920,000	ND	ND
?? 5	AAL	7/12/00	Yes	290 ppm	107,000	890,000	ND	ND
?? 6	AAL	7/12/00	Yes	330 ppm	90,100	900,000	ND	ND
?? 7	AAL	7/12/00	Yes	390 ppm	101,000	890,000	ND	ND
?? 8	AAL	7/12/00	yes	900 ppm	131,000	860,000	ND	ND
A-experiment	*Hdr & lid*	*Vac.bake*	*24h*	*@ 200C*				
1	*pernicka*	*9/7/00*	*yes*	*8544ppm*	*6246ppm*	*978,572*	*4379ppm*	*191ppm*
2	*pernicka*	*9/7/00*	*Yes*	*8190ppm*	*8758ppm*	*976,323*	*4341ppm*	*214ppm*
3	*pernicka*	*9/7/00*	*Yes*	*8880ppm*	*7197ppm*	*978,281*	*3627ppm*	*182ppm*
11	AAL	*9/15/00*	*Yes*	*2620ppm*	*ND*	*+990,000*	*ND*	*ND*
12	AAL	*9/15/00*	*Yes*	*2740ppm*	*ND*	*+990,000*	*ND*	*ND*
13	AAL	*9/15/00*	*Yes*	*2550ppm*	*ND*	*+990,000*	*ND*	*ND*
20	*pernicka*	*10/2/00*	*yes*	*9161ppm*	*8271ppm*	*977,931*	*2786ppm*	*167ppm*
21	*pernicka*	*10/2/00*	*Yes*	*9381ppm*	*6699ppm*	*979,444*	*2784ppm*	*151ppm*
22	*pernicka*	*10/2/00*	*Yes*	*14,636ppm*	*9103ppm*	*970,859*	*3587ppm*	*193ppm*
A1	*pernicka*	*12/8/00*	*yes*	*35,124ppm*	*6929 ppm*	*952,561*	*3617 ppm*	*149 ppm*
B-experiment	*Lid only*	*Vac.bake*	*24h*	*@ 200C*				
4	*pernicka*	*9/7/00*	*Yes*	*7023ppm*	*4878ppm*	*981,043*	*4521ppm*	*207ppm*
5	*pernicka*	*9/7/00*	*Yes*	*8876ppm*	*12,199ppm*	*971,588*	*4665ppm*	*187ppm*
6	*pernicka*	*9/7/00*	*Yes*	*9580ppm*	*6209ppm*	*975,680*	*4652ppm*	*185ppm*
14	AAL	*9/15/00*	*Yes*	*2880ppm*	*ND*	*+990,000*	*ND*	*ND*
15	AAL	*9/15/00*	*Yes*	*2620ppm*	*ND*	*+990,000*	*ND*	*ND*
16	AAL	*9/15/00*	*Yes*	*2570ppm*	*ND*	*+990,000*	*ND*	*ND*
23	*pernicka*	*10/2/00*	*yes*	*11,567ppm*	*8941ppm*	*974,418*	*3373ppm*	*186ppm*
24	*pernicka*	*10/2/00*	*Yes*	*12,030ppm*	*8445ppm*	*973,991*	*3129ppm*	*155ppm*
25	*pernicka*	*10/2/00*	*Yes*	*11,513ppm*	*9112ppm*	*974,492*	*3056ppm*	*149ppm*
B2	*pernicka*	*12/8/00*	*yes*	*21,831ppm*	*8107 ppm*	*965,058*	*2895 ppm*	*136 ppm*
C-experiment	*Control*	*NO vac*						
7	*Pernicka*	*9/7/00*	*Yes*	*8553ppm*	*7818ppm*	*977,227*	*4060ppm*	*186ppm*
8	*Pernicka*	*9/7/00*	*Yes*	*11,677ppm*	*18,021ppm*	*963,331*	*3835ppm*	*153ppm*
9	*Pernicka*	*9/7/00*	*Yes*	*10,493ppm*	*13,497ppm*	*969,232*	*3987ppm*	*181ppm*
10	*Pernicka*	*9/7/00*	*Yes*	*7020ppm*	*13,545ppm*	*972,634*	*4001ppm*	*182ppm*
17	AAL	*9/15/00*	*Yes*	*2540ppm*	*ND*	*+990,000*	*ND*	*ND*
18	AAL	*9/15/00*	*Yes*	*2520ppm*	*ND*	*+990,000*	*ND*	*ND*
19	AAL	*9/15/00*	*Yes*	*2520ppm*	*ND*	*+990,000*	*ND*	*ND*
26	*pernicka*	*10/2/00*	*yes*	*10,371ppm*	*8719ppm*	*976,305*	*3027ppm*	*174ppm*
27	*pernicka*	*10/2/00*	*Yes*	*11,620ppm*	*8534ppm*	*975,181*	*2894ppm*	*158ppm*
28	*pernicka*	*10/2/00*	*Yes*	*11,661ppm*	*8758ppm*	*974,427*	*3147ppm*	*132ppm*
D-xperiment	*Lid only*	*Hi.Vac.bak*		*@ Pernicka*				
A	*pernicka*	*11/15/00*	*Yes*	*22,509ppm*	*46,432ppm*	*921,827*	*2379ppm*	*11ppm*
B	*pernicka*	*11/15/00*	*Yes*	*50,571ppm*	*5144ppm*	*934,132*	*2638ppm*	*38ppm*
C	*pernicka*	*11/15/00*	*yes*	*19,417ppm*	*61,672ppm*	*909,375*	*2082ppm*	*23ppm*
D	*pernicka*	*12/8/00*	*Yes*	*24,873ppm*	*84,639ppm*	*878,685*	*2818 ppm*	*4 ppm*
E	*pernicka*	*12/8/00*	*Yes*	*119,320ppm*	*4463 ppm*	*861,411*	*2680 ppm*	*1 ppm*
F	*pernicka*	*12/8/00*	*Yes*	*39,217ppm*	*79,993 ppm*	*860,753*	*3529 ppm*	*0 ppm*

- data collected on production lots show moisture levels all over the place, from as low as 7,000ppm (deemed "acceptable") to +50,000 ppm.

- the two labs exercised (Pernicka and Atlantic Analytical) do not correlate, neither on moisture nor on any other reportable gas.

- neither one of the two labs show a level of repeatability acceptable against the 10,000 limit.

preconditioning the devices under high vacuum does not generate an improvement in the reported results; on the contrary. Attempts to isolate the variables are inconclusive.

- Both labs were made aware of each others results, however, both labs stand behind their data and claim no calibration or procedural problem, nor any equipment limitation exists.

The task group reviewed the whole body of data generated since January 2000. The task group acknowledges reaching practical limitations in applying the RGA methodology to very low volume packages like the UB packages remains an unresolved problem. Manufacturers of similarly small cavity devices face the same problems.

IV. CONCLUSION: In order to circumvent this problem our joint proposal is as follows:

1. Do not attempt to perform RGA testing directly on small cavity packages, less than 0.01 cc (UB Packages) until the government correlation and calibration activities are complete and accepted. Use special "monitor" packages (herein-called Surrogate Monitors) to evaluate the process baseline.

2. Surrogate Monitors are to be procured from the same manufacturer and be manufactured in the same technology as the production headers, using the same materials, plating, processing and technology. For example, the UB packages: Kyocera header, multilayer cofired ceramic technology; SemiAlloys lid, Alloy 52, nickel underplate, gold plate.

3. The device manufacturer shall use the same preconditioning on Surrogate Monitors and production product, i.e.vacuum bake time & temperature, storage conditions, die attach materials and process, etc.

4. Surrogate Monitors shall be sealed at the same time and using the same process as the production parts.

5. To optimize the effect of preconditioning the transit time from the oven to the seal furnace shall be controlled and minimal.

6. A typical process would include:
- batch high-vacuum bake headers and lids
- store baked material in dry nitrogen
- 2nd vacuum bake overnight (min. 12 hrs) just prior to seal
- Minimize the post-2nd bake exposure to atmosphere
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7. Surrogate Monitor packages will be under baseline documentation control. Full traceability from procurement to utilization shall be maintained.

8. Surrogate Monitors will be subject to RGA testing i.a.w. method 1018 of MIL-STD-750; a production lot will be validated by the performance of its monitors.

9. Initially the Surrogate Monitors will be used at the beginning of the seal operation and at 2 hrs intervals. A minimum of 6 monitors must be processed for each seal lot (a "seal lot" may consist of multiple production lots if they go through sealing without interruptions (other than the scheduled breaks) and have identical traceability of headers and lids).

10. It is expected that it will take approximately 6 months for a manufacturer to collect enough lots and data to establish a baseline. Later modifications of the preconditioning process will be evaluated against this baseline.

It is well known and established that preseal bake and storage conditions of packaging materials will severely impact the levels of moisture detected in almost any package type. The use of the Surrogate Monitors without a controlled and disciplined manufacturing line is of questionable value. The proposed test is not, nor is it intended to be a direct measurement of the UB packaged product internal moisture. However, it is quantifiable indicator that the process and controls used are consistent. This is a significant improvement over the existing situation in which there is a requirement for control of internal moisture and no accurate and repeatable method of measurement.

V. RECOMMENDATIONS: The device manufacturer will submit to DSCC the results from a minimum of 3 "seal" lots to establish the effectiveness of the process baseline. Additional testing will be retained and available to DSCC upon request.

This surrogate monitor approach must be incorporated into method 1018 in the next specification action.