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knowles

Coating Adhesion Testing

By Tom Monaghan

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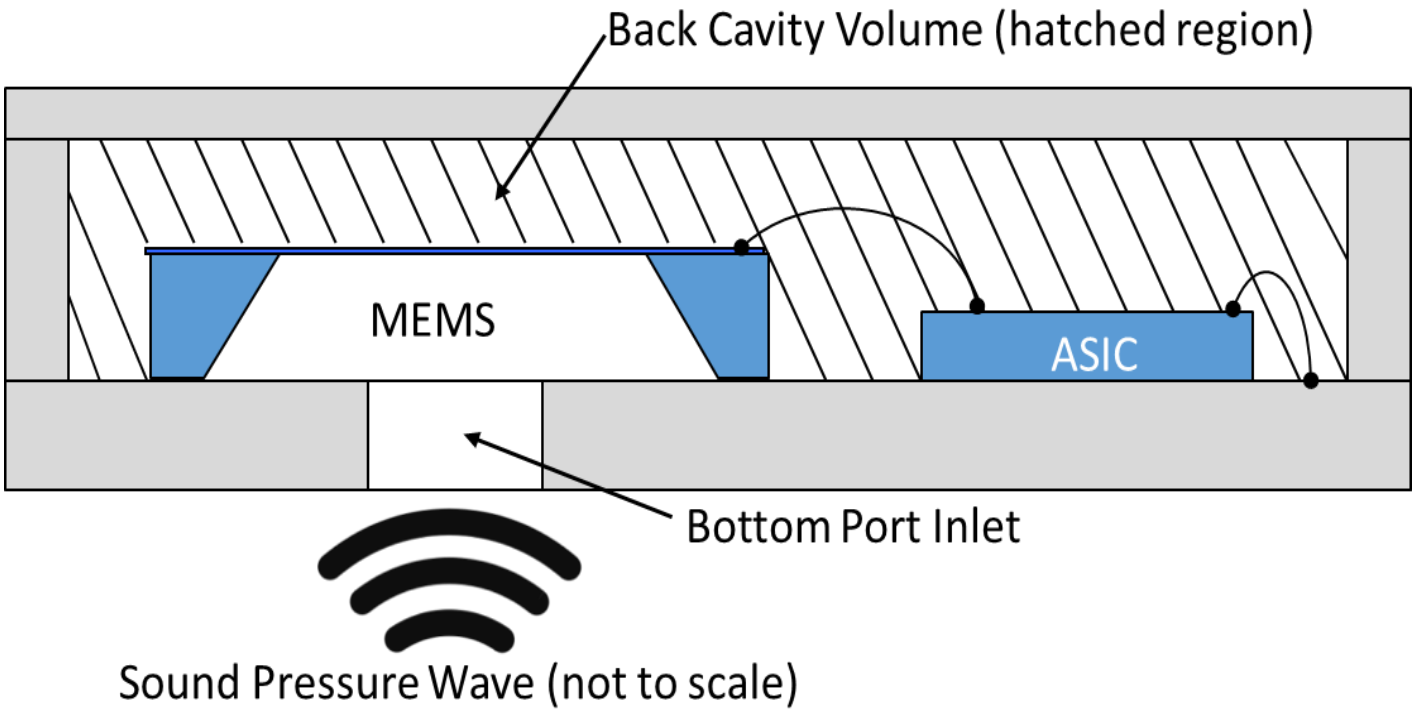
Background

- **Knowles has been producing Sisonic MEMS microphones for several years now**
- **These microphone assemblies use a metal can to protect the electronics, act as an RF shield and establish either the front volume (typically with the hole in the can) or the back volume for the microphone**
- **Recently, the marketing group has requested a reduction in radiated RF of the microphone – Knowles is investigating coatings to support this application**
- **Part of the requirement for this new configuration is to quantify the level of adhesion between the coating and the can**

Background – MEMS Microphone

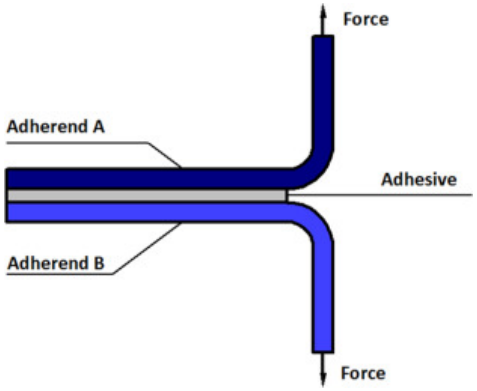


Background – Product Sample

Background – Can Description

Current Test Methods: Peel Testing

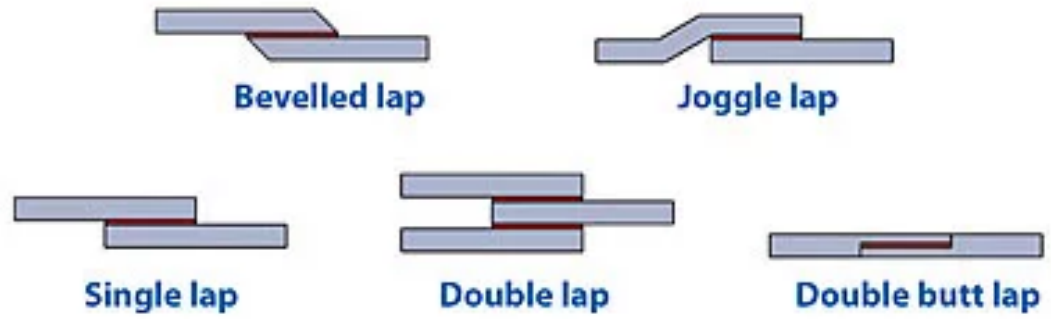
- **Probably, the most widely used peel test for thin-gauge metal adherends is the T-peel test (ASTM D1876)**



- **In this test, the entire load applied is transmitted to the bond**
- **This test requires a flat geometry and a leader length of the film that can then be clamped to the tester and pulled at a 90 degree or 180 degree angle**
- **The geometry and the size of the can would not allow the technique to be use for the Knowles cans**

Current Test Methods: Shear Testing

- **This test requires space on at least two sides of the test piece to be unattached in order to fit a stylus or attach clamp adjacent to the test piece – the tester then pushes the stylus or pulls the clamps and measures the force**
- **This is commonly used for die shear and wire bond ball shear (JEDEC JESD22-B116)**
- **This cannot be used for a geometry where there is no room for a stylus or clamps to contact the coating**



Current Test Methods: Die Pull

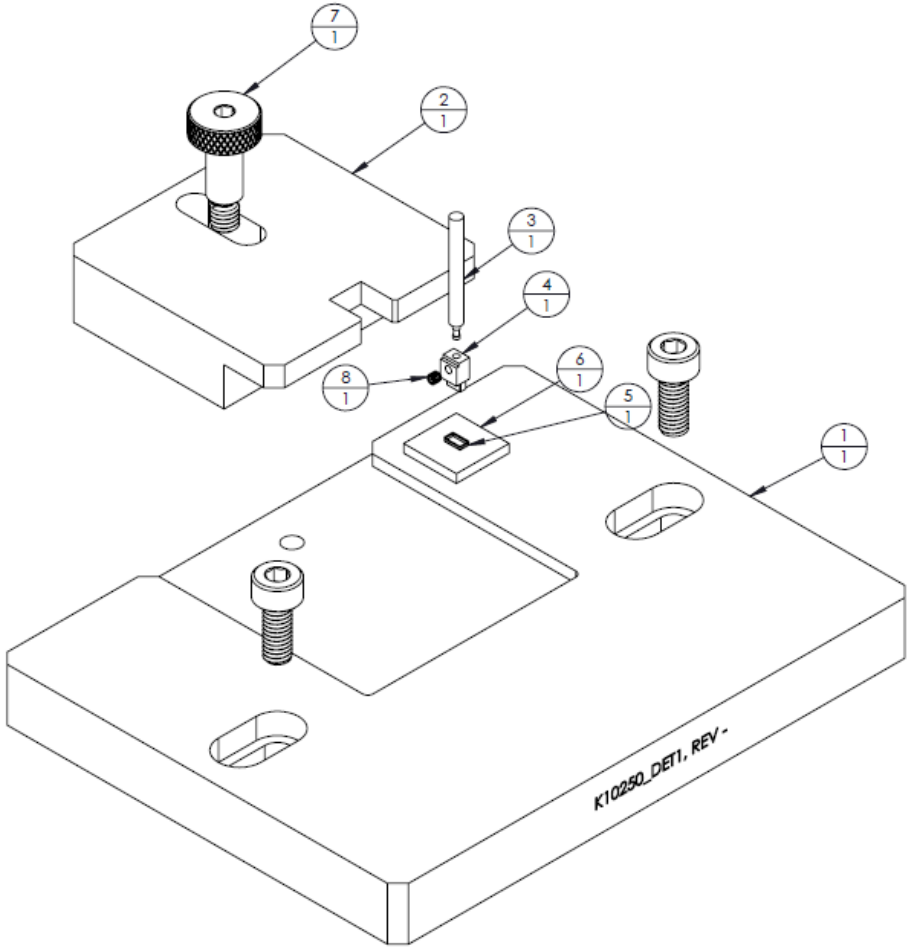
- **Finally, there is MIL-STD-883K Test Method 2031.1 Flip Chip Pull Off Test**
- **This test is designed to measure the adhesion between a Si chip and the substrate it is attached to (solder balls, epoxy, Ag-glass, etc)**
- **The test requires 75% coverage of the surface area of the chip**
- **This test is designed for use with a rigid material set (Si, Solder or cured epoxy) – this would not work with a low modulus material like the one Knowles uses for coating the inside of the can**

New Test Method Description

- **Design a test fixture and jigs for use in this testing**
- **Test and determine what materials are best suited for use with the materials that must be tested**
- **Mount the can to a metal base using solder – this insures that this interface will not fail first**
- **Glue a test jig to the plastic using a two part epoxy material and cure it**
- **Attach a metal shaft to the test jig using a set screw**
- **Insert the metal shaft into a chuck which is attached to the base of the force gage**
- **Slide a can separation clamp over the metal base**
- **Raise the force gage until the weakest interface fails, record the peak force**

New Test Method Description – Mark-10 Manual Test Stand

New Test Method - Tooling



ITEM NO.	QTY.	DESCRIPTION
1	1	CAN SEPARATION, FIXTURE, BASE
2	1	CAN SEPARATION, CLAMP
3	1	CAN SEPARATION, TEST PIN
4	1	CAN DEFLECTION, TEST TIP
5	1	LID, METAL CAN
6	1	CAN SEPARATION, PCB
7	1	92957A210_METRIC THUMB-GRIP 18-8 SS SHOULDER SCREW.SLDPRT
8	1	92311A050_18-8 SS CUP POINT SET SCREW.SLDPRT
9	2	91292A116_TYPE 18-8 SS SOCKET HEAD CAP SCREW.SLDPRT

Test Materials: Material Selection

- **FR4 was selected for item #6 (the can separation material) due to its availability and low cost**
- **Several different adhesives (cyanoacrylate, epoxy and silicone) were tested - all of these materials proved to have lower adhesion than the actual test piece**
- **One material that happened to be readily available was a solderable metal plate that measured about 10mm x 10mm x 0.125mm**
- **This combination produced a robust joint that consistently was the strongest interface in the test**
- **To secure the test jig to the coating, an appropriate glue must be identified**
- **Cyanoacrylates, epoxies and silicones were tried - the best performer was a 3M material, DP-190**

Figure 3 Test jig and test lids mounted to cans

Test Materials: Base with solder dots and test specimens

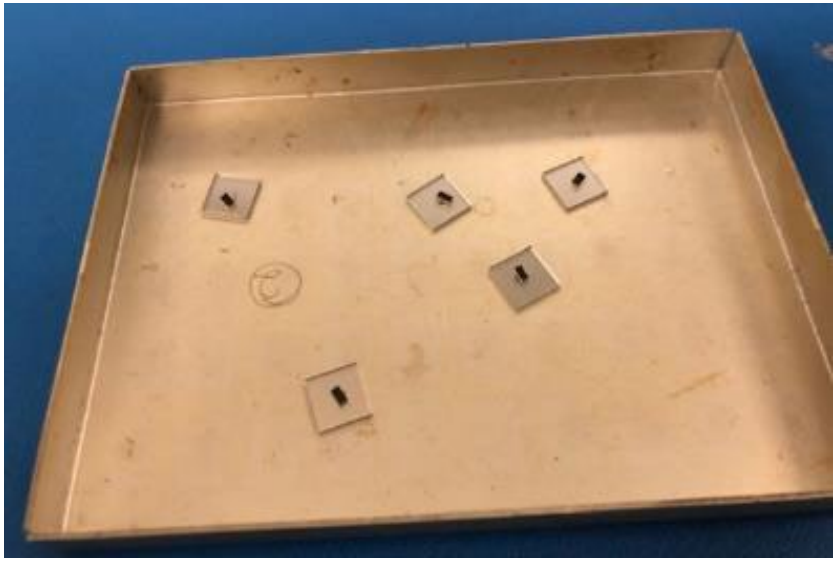


Figure 3 Test jig and test lids mounted to cans

Test Materials: Test Jig glued into Test Specimen after curing

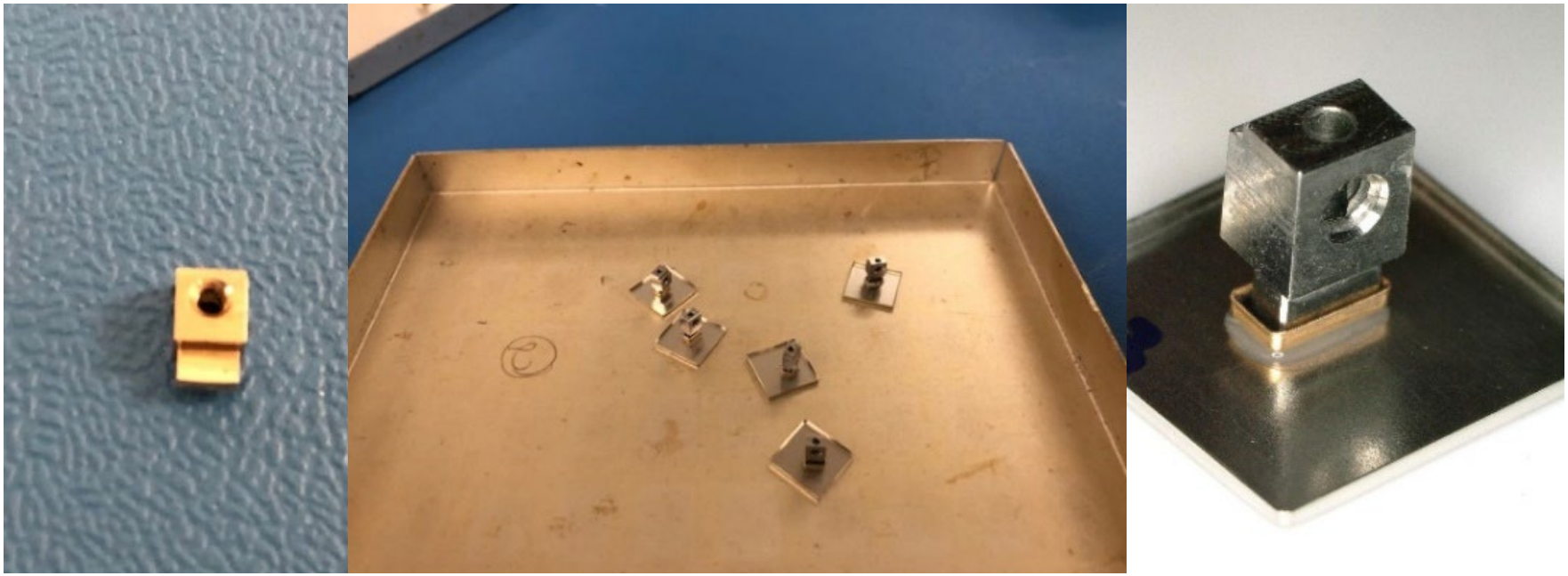
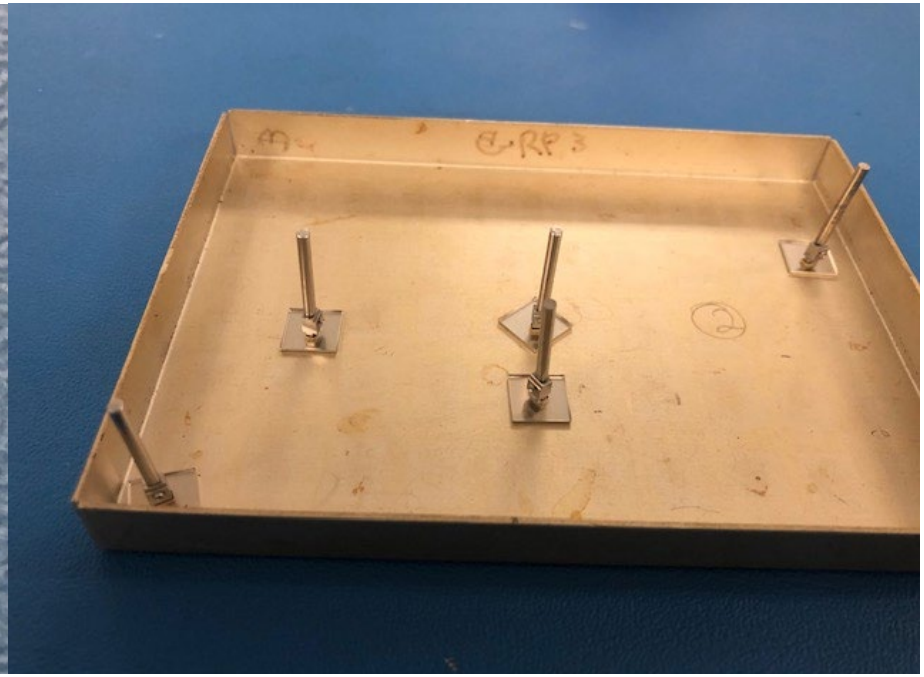


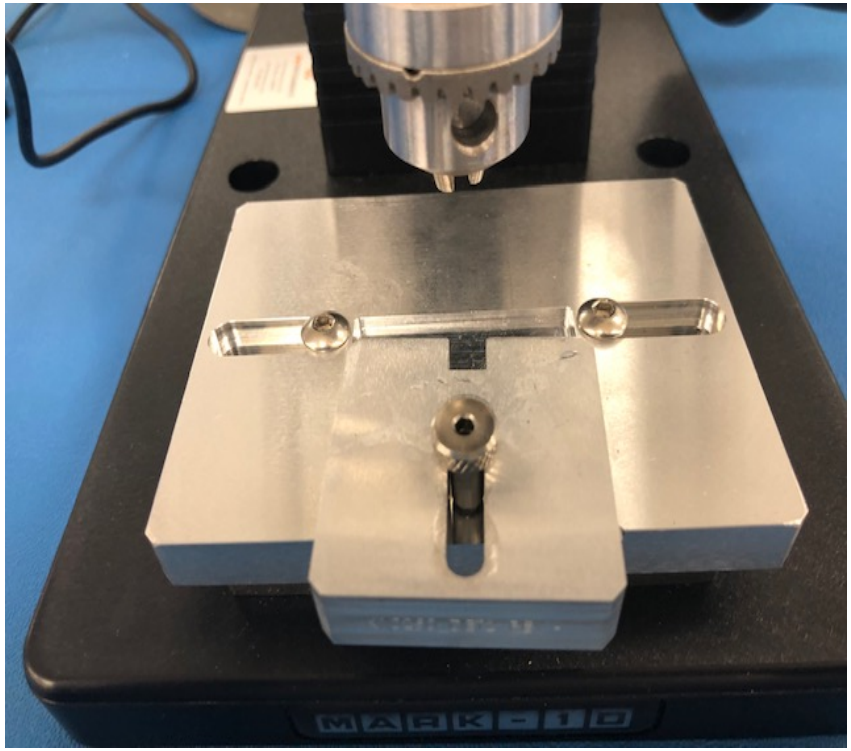
Figure 3 Test jig and test lids mounted to cans

Test Materials: Test Pin attached to Test jig with set screw



Test Materials: Final test fixturing with 3 jaw chuck

Test fixturing: mounting the sample

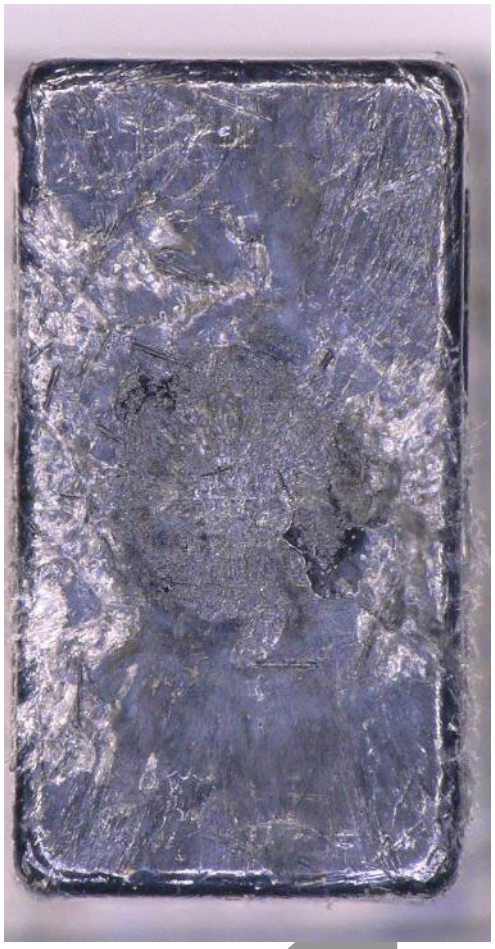


Test sample complete

Test sample prior to pull testing

Test sample post pull testing

Test sample post pull testing



Summary of Pull Test Data

Test Unit	Pull Strength (N)
1	10.5
2	17.7
3	5
4	10.4
5	7.7
6	11.2
7	8.2
8	11.9
9	12.6
10	9.1
Avg	10.4
Std Dev	3.40

Summary

- **Knowles Corp. produces SiSonic Surface Mount MEMS microphones**
- **The Knowles marketing group has requested improved RF performance**
- **Knowles decided to use a coating on the inside of the can**
- **We need to quantify the adhesion strength for this can configuration**
- **Tensile testing was selected**
- **Test stations were selected, tooling was designed and materials were developed for use in the new test**
- **The test achieved the desired fail mode and was able to quantify the material adhesion**
- **This test was then transferred to production and is ready to be implemented on new products**