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Improved etching recipe for exposing Cu wire allowing reliable stitch pull

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ABSTRACT

The AECQ-006 (Automotive Electronics Council Qualification Requirements for components using Cu wire) requires stitch pull tests on decapsulated Cu wire devices after TMCL and HAST/THB testing. The challenge is to perform decapsulation that exposes the complete interconnect without damaging the wires, leads or bondpads. A new method was developed in NXP to achieve this goal. An existing Cu wire decapsulation recipe was improved to protect the leads by adding Benzotriazole or $AgNO_3$ to the nitric/sulphuric acid mixture.

1. Background

The AECQ-006 (Automotive Electronics Council Qualification Requirements for components using Cu wire) requires stitch pull tests on decapsulated Cu wire devices after TMCL and HAST/THB testing. Current etch methods do not allow for preservation of Ag spots on leads. No specification is available for location of stitch pull and no historic data available. In this paper a method will be presented to allow reliable decapsulation of the entire bondwire.

2. New improved method

2.1. Hook placement

First of all the location of the pull hook needed to be defined. In order to have the best reproducible location, it was suggested to pull at the end of the lead, which also gives sufficient space to place the hook.

2.2. Laser ablation

First step in decapsulation is laser ablation. A Rofin Baasel with 384 nm wavelength is used. A stepwise laser program is used for large packages (see Fig. 1).

The option exists to laser all the way down to the die surface as the functionality of the die is not relevant for this test (see Fig. 2). For smaller packages it becomes more difficult to use the step function.

2.3. Experiment setup

For each experiment 3 samples were decapped with different methods. After that they were submitted to stitch pull tests. The average pull result and standard deviation determine what would be the best method for the device under test. The higher the average and the smaller the standard deviation, the better the method. A lower standard deviation shows as a steeper line in a probability chart.

2.4. Additives

Previous investigations by Chambard [1,2] identified chemicals that can be used for Ag protection during decapsulation. From this investigation $AgNO_3$ and BTA were selected as additives to be added to the etching mixture. The Cu decap chemistry remains the same, a mixture of HNO_3 and H_2SO_4. For the rest the existing Cu wire decapsulation settings were kept the same. Samples decapsulated using the $AgNO_3$ additive were visually less successful than the samples decapsulated with BTA. After decapsulation with the use of $AgNO_3$ still some damage to the Ag spot was visible. When BTA was added visually a much better result was obtained (see Figs. 3–5). After decapsulation wirepull was performed on several samples to check the effect of the additives.

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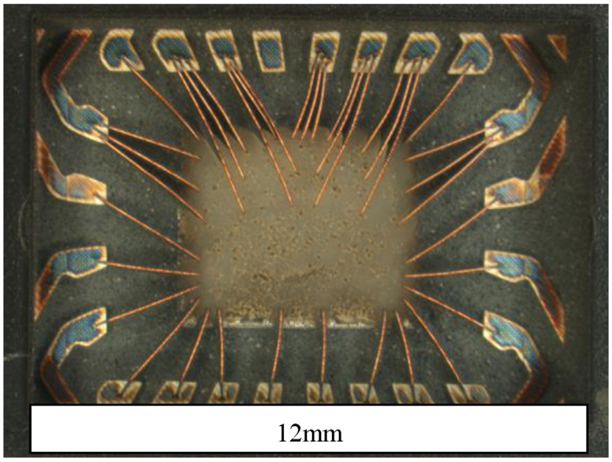

Fig. 1. Overview of lasered HSOP packaged product.

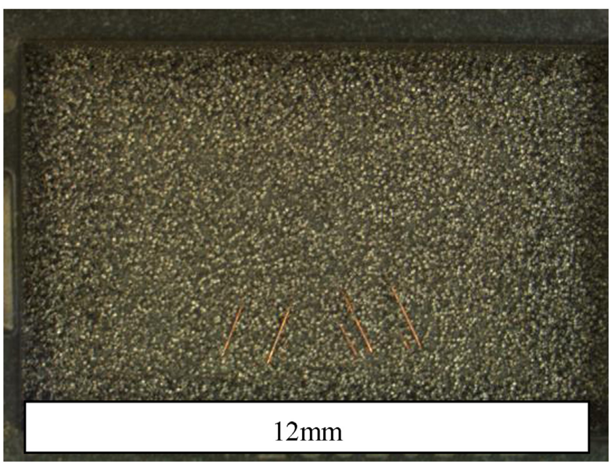

Fig. 2. Fully lasered HSOP package with chipcoat.

2.5. Wirepull results

Wirepull has revealed some interesting results. First of all premold results are significantly lower than post mold results. To understand this difference an experiment was done to encapsulate a

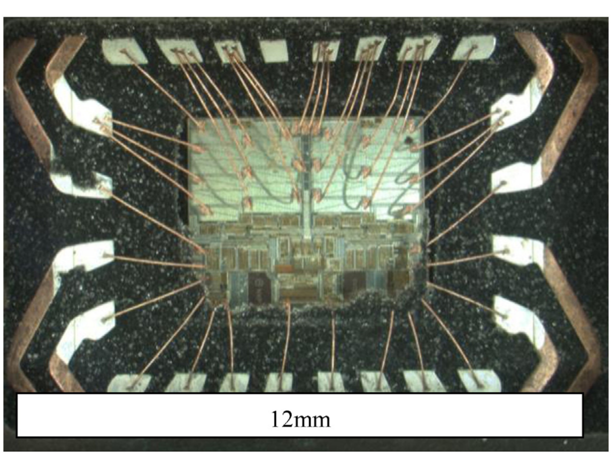

Fig. 3. Overview of HSOP packaged product etched according to the developed recipe.

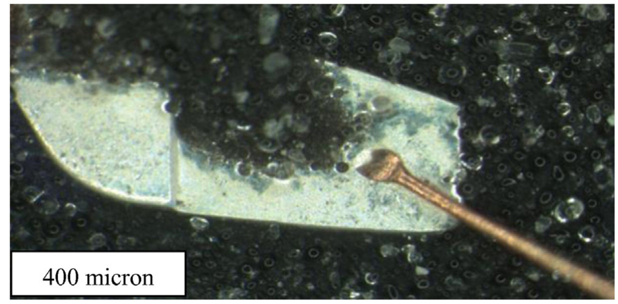

Fig. 4. Lead with stitch and Ag spot in perfect condition.

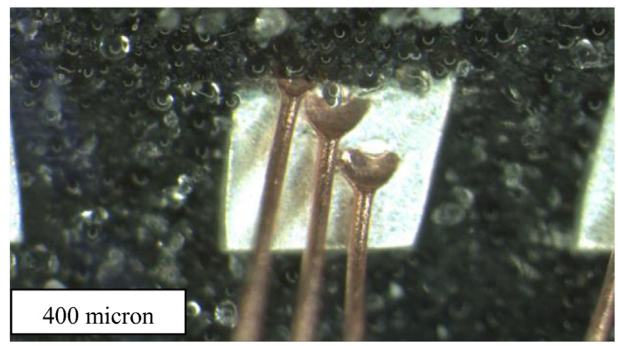

Fig. 5. Triple stitch, wires are very well preserved.

leadframe with epoxy without covering the wires. This was done with an underfill material. Using this method slightly higher values were obtained, but still a gap remains. This means that several factors influence the stitch pull values (see Table 1). The difference also become very clear when the normal probability plots are drawn (see Fig. 6).

Follow up experiments that included a 4 h 175 °C bake of leadframes showed stitch pull values that were similar to those obtained after decapsulation. This indicates that at least for 50 μm wires the PMC step increases the strength of the stitch. Further investigations are needed to understand the mechanism behind this. Probably relaxation of Cu wires during Post Mold Cure (PMC) plays a role. This theory is supported by the fact that there is a clear correlation between the location of the stitch break and the pull strength (see Fig. 7).

More experiments were performed on other types of devices. So far it seems that there is not one method fits all solution available. Mold compound material, package thickness and wire thickness all play a role.

High Tg compound with 20 μm Cu wire for example needs a higher decapsulation temperature to minimize the time wires are exposed to

Table 1
Average values and standard deviation for stitch pull on HSOP package.

Sample	Average (g)	Standard deviation(g)
Decap BTA @40C	43.2	6.3
Decap BTA @90C	39.9	7.2
Decap with AgNO3	46.7	3.5
LF with underfill	29.6	2.9
Bare LF	27.1	3.7
No additives	44.8	2.9

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