

Understanding Die Attach Epoxy Open Time

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I. OVERVIEW

An epoxy bond is formed by attaching the die to the leadframe with the use of epoxy glue. A drop of epoxy is dispensed on the package and the die placed on top of it. The package needs to be heated at an elevated temperature to cure the epoxy properly. This process uses adhesives such as polyimide, epoxy and silver-filled glass as die attach material to mount the die on the die pad. The mass of epoxy on the die peripheral of the die is known as the Epoxy Coverage area after die bonded, this provide mechanical strength along die edge as shown in Figure 1. Common criteria or requirement for epoxy coverage is 100%. The problems in achieving and controlling the Epoxy Coverage and Inadequate corner coverage can lead to delamination at the corners.

This paper aims to share and discuss the study of actual experimental for Die Attach Epoxy Open time as part of control to achieve good epoxy coverage.

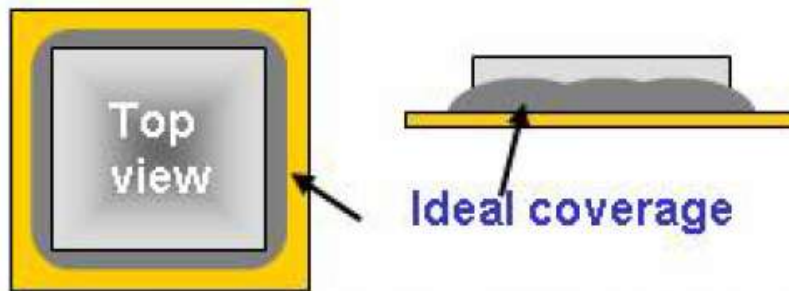


Fig. 1. Ideal Epoxy Coverage

Mixing epoxy resin and hardener begins a chemical reaction that transforms the combined liquid ingredients to a solid. Understanding epoxy chemistry is important to using epoxy safely and effectively. The time it takes for this chemical transformation from liquid to solid is called cure time. As it cures, the epoxy passes from the liquid state, through a gel state, before it reaches a solid state. As it cures, mixed epoxy passes from a liquid state, through a gel state, to a solid state as illustrated in Figure 2.

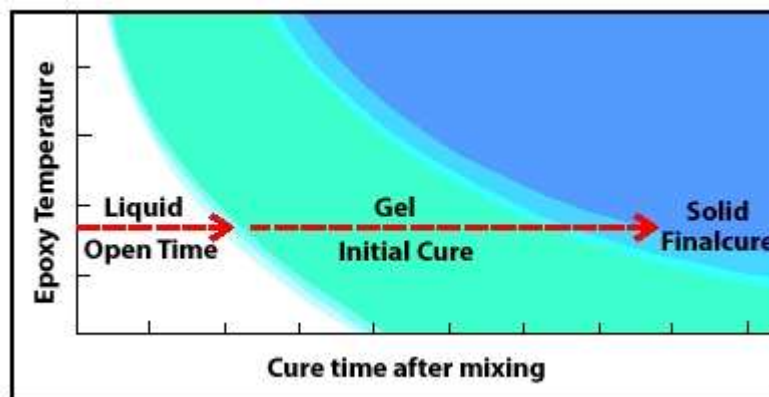


Fig. 2. Epoxy Curing State

Open time (also working time or wet lay-up time) is the portion of the cure time, after mixing the resin and hardener to incite an epoxy chemistry reaction, that the mixture remains a liquid and is workable and suitable to apply. Open time start upon epoxy dispense, up to Die placement or bonding as illustrated in Figure 3. All assembly and clamping should take place during the open time to assure a dependable bond.

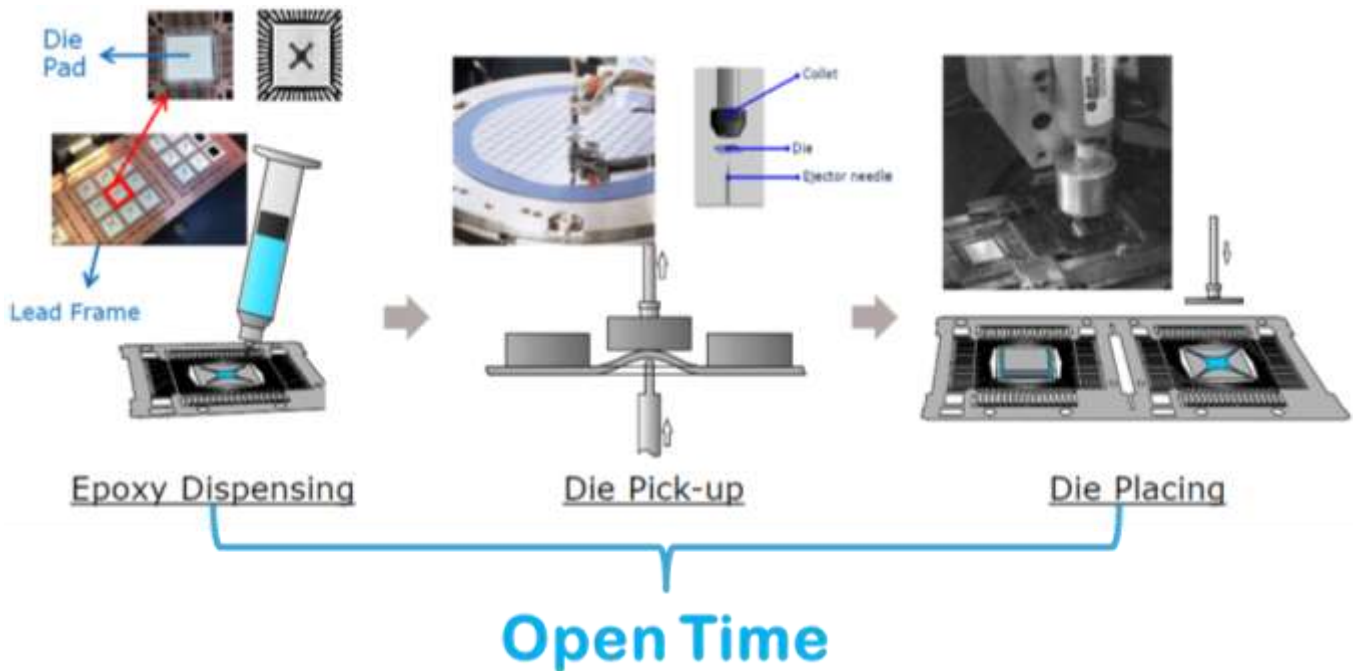


Fig. 3. Open Time

II. PROBLEM IDENTIFICATION

Open time is the time it takes for a mixed resin system to gel or become so highly viscous that it can no longer be considered workable or able to be spread during die bonding which cause Insufficient Epoxy Coverage. A thermoset resin system converts from a liquid mixture of chemicals to a dry type material that has a highly cross-linked polymer as the major structural material. The Open time is the time when the polymer formation is in its early stages of cross-linking to the point that if the polymer gel state is disturbed then the final polymer will have properties that are not well established.

Staging of epoxy especially when there is a major machine down that may lead to insufficient epoxy coverage. Insufficient Epoxy Coverage after Die bond can lead into separation or gap at the chip edge during curing due to mismatch between die and leadframe. Leadframe is going to be expanded while Die attach curing, but the adhesive is being shrunken because of its polymerization. And during Molding process the mold compound or EMC can be penetrated through gap that cause reliability failure of Delamination as illustrated in Figure 4, the Failure mechanism for Insufficient Epoxy Coverage.

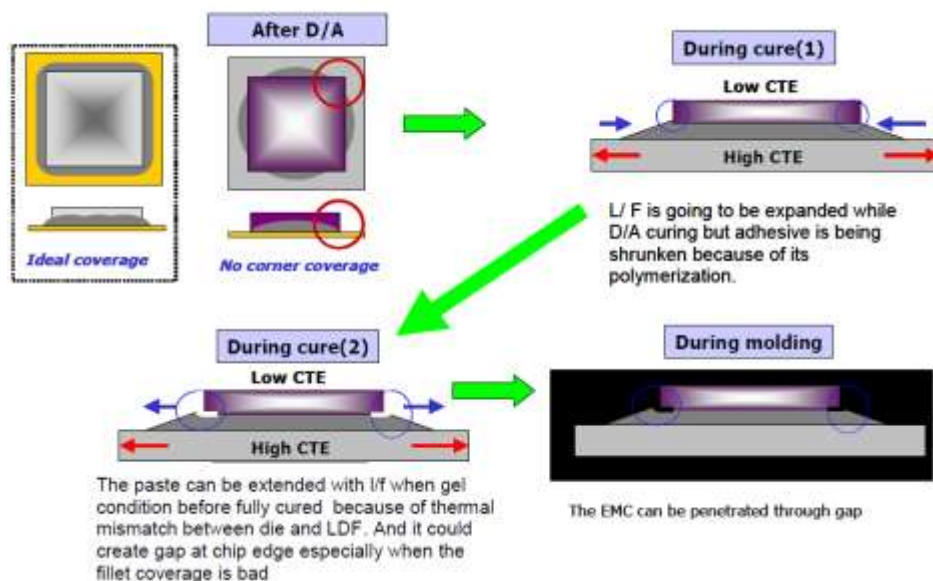


Fig. 4. Failure mechanism for Insufficient Epoxy Coverage

III. ASSEMBLY PROCESS IMPROVEMENT

One of the solution is to study the suitable Open Time control to prevent epoxy drying prior die bonding. Below is the Evaluation flow to define suitable Open Time control shown in Figure 5.



Fig. 5. Evaluation Flow

As a result, Epoxy Coverage verification show there is good epoxy coverage and fillet formation with all open times up to 60 minutes after die attach process as shown in Figure 6.

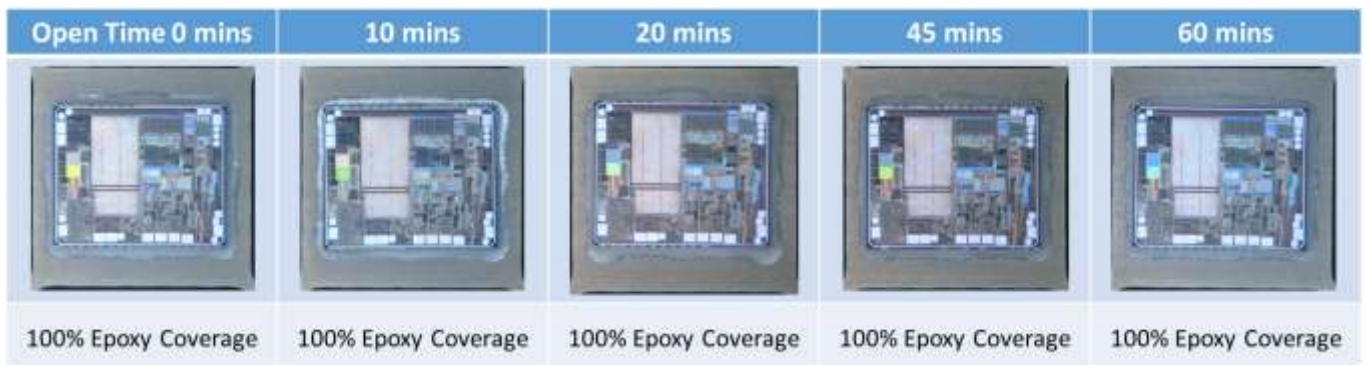


Fig. 6. Epoxy Coverage Verification Result

No Epoxy Voids show in X-Ray result with all open times up to 60 minutes after die attach process after Oven Cure process as shown in Figure 7.



Fig. 7. Epoxy Voids Verification

Using the Statistically ANOVA test, for Bond line thickness (BLT) there is no significant difference with all open times (0/10/20/45/60 minutes) before cure with P value of 0.430 as shown in Figure 7.

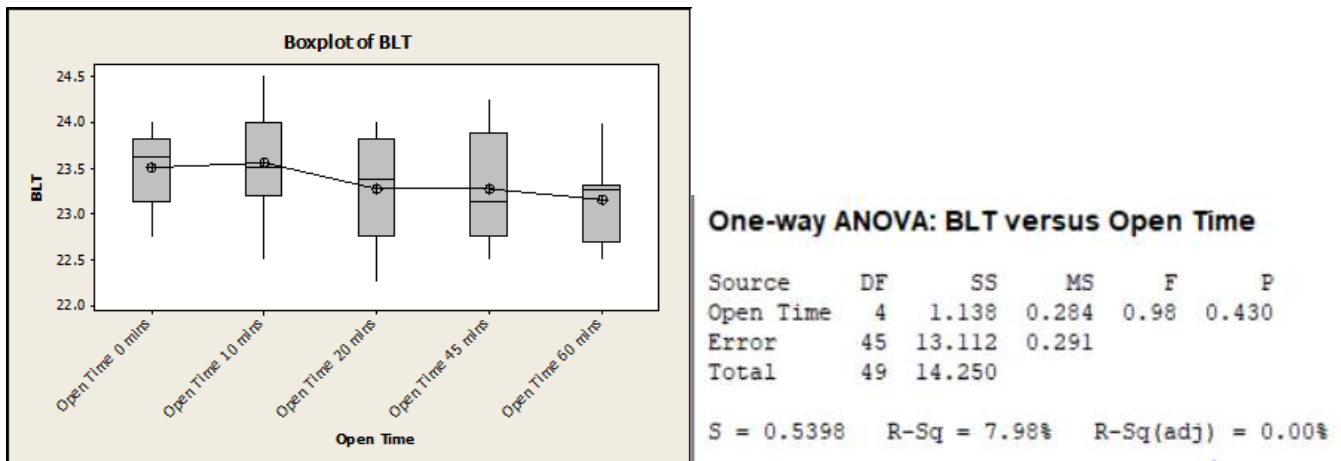


Fig. 7. Bond Line Thickness (BLT) Verification result

For Die Shear Test (DST) response, since P value of statistical ANOVA is 0.223, lessmore than the set alpha 0.05. We there for conclude, all Die Shear Test result means are equal, under 0 to 60 minutes Open Time as shown in Figure 8.

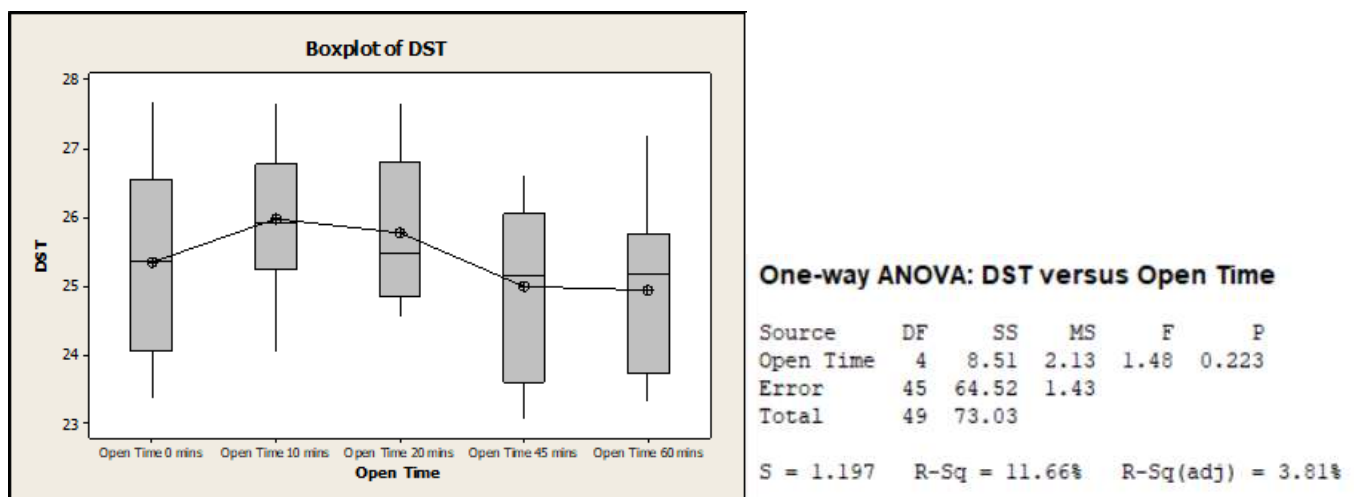


Fig. 8. Die Shear Test (DST) Verification result

Overall result shows, consistence epoxy coverage at open time until 60 minutes. No epoxy void was found during 0 to 60 minutes' interval time before die attach. Bond line thickness (BLT) and Die Shear Test (DST) test response are not significant difference under 0 to 60 minutes Open Time.