Effect of Post Mold Cure Ramp-Down Temperature on Internal Package Stress for IC Plastic Packages.

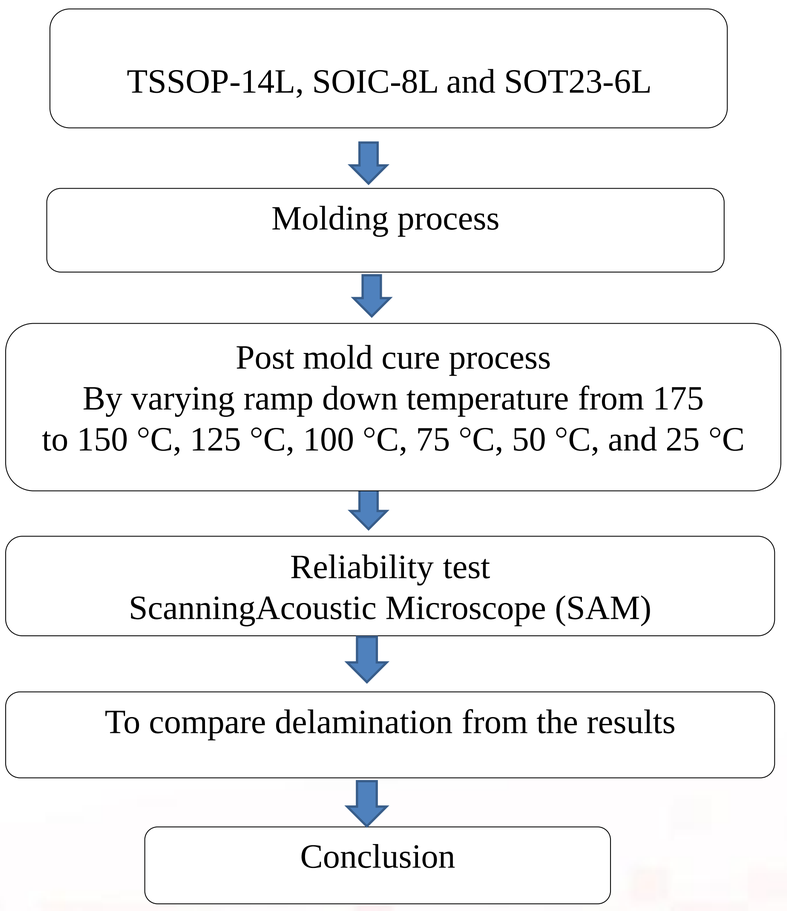
Anan Sukantharat[1*], Kessararat Ugsornrat[1], and Chalermsak Sumithpibul [2],
[1]Department of Industrial Physics and Medical Instrumentation, Faculty of Applied Science, King Mongkut's University of Technology North Bangkok, Bangkok, 10800.
[2]Department of Engineering, UTAC Thai Limited,Bangkok, 10260
**Corresponding author. E-mail: Anansu@utacgroup.com*

Abstract

This research studied an effect of ramp down temperature to integrated circuit (IC) packages after completed post mold curing in IC packaging process. Post mold cure process is so important to make a completed epoxy molding compound (EMC) due to cross linking to enhance microstructure of compound stiffness. Temperature is a factor effect to EMC base on the coefficient of thermal expansion. The ramp down temperature of post mold curing can change microstructure of compound in term of stress inside the package. In experiment, the ramp down temperatures were varied to check the effect of internal stress due to temperature. The ramp down temperature were varied from 175 °C until room temperature (25 °C) and analyzed the stress inside the packages by scanning acoustic microscope after take the test samples out from the oven cure. The results showed that the ramp down temperature at 175 °C, 150 °C, 125 °C, 100 °C, 75 °C, 50 °C, and 25 °C to observe delamination due to internal stress inside epoxy molding compound (EMC) and various materials inside the packages for the TSSOP-14L packages after completed post mold cure. The opposite way, the ramp down temperature of all these temperatures did not reveal delamination inside the SOIC-8L and SOT23-6L packages.

Methodology

This section, we describe the methodology of the studying an effect of the difference ramp down temperature in post mold cure process in three package kinds by reliability test with scanning acoustic microscope (SAM).



Results and Discussion

The results of delamination between EMC and various materials to observe by SAM for TSSOP-14L package as shown in Table 1 and Figure. 1.

Table 1: Shows the points of delamination for TSSOP-14L package.

Final ramp down temperature (°C)	Point of delamination				
	Die	Die attach paddle		Lead	
		top side	bottom side	top side	bottom side
175	0	0	128	0	77
150	0	0	71	0	102
125	0	0	17	0	55
100	0	0	29	0	71
75	0	0	59	0	129
50	0	0	12	0	86
25	0	0	15	0	88

From Table 1. shows the results of delamination of TSSOP-14L package to observe at die, top side on die attach paddle, and top side on lead. The results reveal that no delamination on these areas at all ramp down temperature which are 175, 150, 125, 100, 75, 50, 25 °C. The opposite way, the results show that delamination at bottom side on die attach paddle, and bottom side on lead at all ramp down temperature. Moreover, the results confirm about that at higher ramp down temperature can found the points of delamination more than lower ramp down temperature on the packages. From the results, the post mold cure process can not set to take shorter time by increasing the final temperature of ramp down temperature which be higher than 25 °C because the thermal stress can be generated by coefficient of thermal expansion (CTE) mismatch between over-molded EMC, silicon (Si) chips, substrates, and various materials in the packages due to unbalanced from a thermomechanical stress standpoint which leads to bowing upon cooling from the process temperature (around 175 °C) to higher room temperature (25 °C) effect to delamination inside the package.

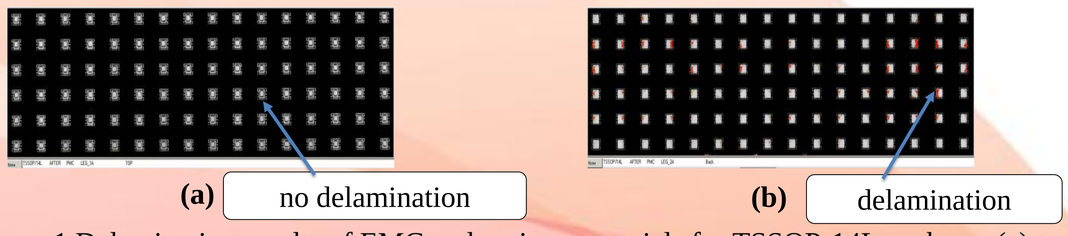


Figure. 1 Delamination results of EMC and various materials for TSSOP-14L package. (a) top side and (b) bottom side of the package.

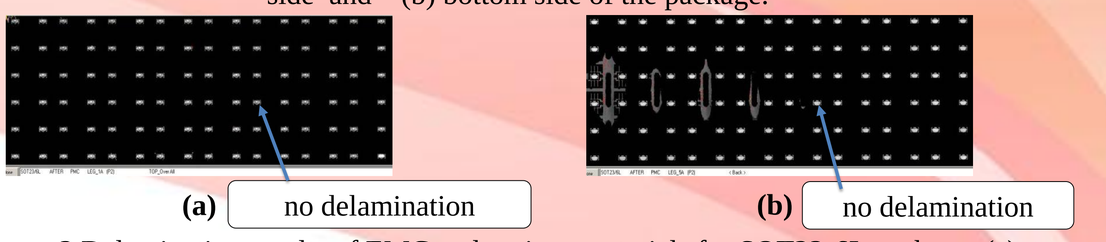


Figure. 2 Delamination results of EMC and various materials for SOT23-6L package. (a) top side and (b) bottom side of the package.

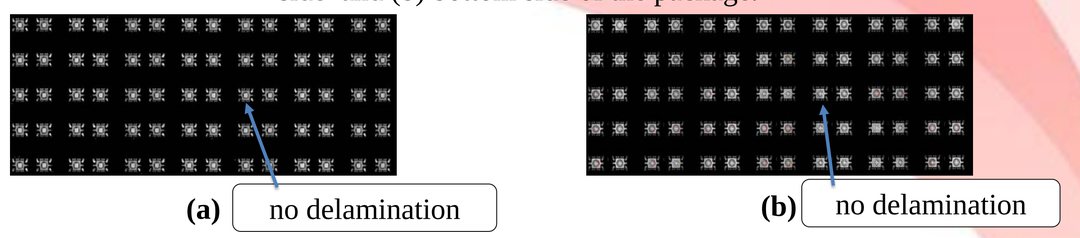


Figure. 3 Delamination results of EMC and various materials for SOIC-8L package. (a) top side and (b) is bottom side of the package.

Conclusion

An effect of ramp down temperature to integrated circuit (IC) packages after completed post mold curing in IC packaging process were studied for TSSOP-14L, SOIC-8L and SOT23-6L packages. The results showed about many delamination points on the packages due to internal stress at 175 °C, 150 °C, 125 °C, 100 °C, 75 °C, 50 °C ramp down temperatures for TSSOP-14L packages. The opposite way, the results show no delamination point on the SOIC-8L and SOT23-6L packages. Therefore, the results confirmed that the study about the effect of post mold cure ramp down temperature can be used for information in the IC packaging manufacturing.

References

1. Ming-Yi Tsai, C. T. Wang, and C. H. Hsu (2006), The Effect of Epoxy Molding Compound on Thermal/Residual Deformations
2. Chen-Hung Lee, Lu-Fu Lin, Tsung-Han Ho, Shi-Shiun Cheng, Study on paddle delamination for quad flat no leads package, Department of Chemical and Materials Engineering, National Kaohsiung University of Applied Sciences, Taiwan Chien Kung Campus 415 Chien Kung Road, Kaohsiung807, Taiwan, R.O.C.Hung-HsuTu,Chin-Cheng Chang,Advanced Semiconductor Engineering, Inc.,26 Chin 3rd Rd., Nantze Export Processing Zone, Nantze, Kaohsiung, Taiwan, R.O.C.
3. DANIEL J. BELTON (1987), The Effect of Post-Mold Curling Upon the Microstructure of Epoxy Molding Compounds. IEEE Transaction on components, Hybrids, and Manufacturing Jring Technology. Vol. Chmt-10, No 3, September
4. Peter Alpern and Kheng Chooi Lee (2008), Moisture-Induced Delamination in Plastic Encapsulated Microelectronic Devices: A Physics of Failure Approach, IEEE Trasactions on devices and materials reliability, Vol. 8 ,No.3, September 2008.

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