

**Effect of Epoxy Molding Compound Floor Life to Reliability Performance for
Integrated Circuit (IC) Package
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**Udom Peanpunga^{1*}, Kessarat Ugsornrat¹, Panakamol Thorlor¹, and Chalernsak Sumithpibul², and
Apichart Phoawongsa²**

¹Department of Industrial Physics and Medical Instrumentation, Faculty of Applied Science,
King Mongkut's University of Technology North Bangkok, Bangkok, 10800

²Department of Engineering, UTAC Thai Limited, Bangkok, 10260

*Corresponding author. E-mail: Udompe@utacgroup.com

Abstract

This research studied about an epoxy molding compound (EMC) floor life to reliability performance of integrated circuit (IC) package. Molding is the process for protecting the die of IC package form mechanical and chemical reaction from external environment by shaping EMC. From normal manufacturing process, the EMC is stored in the frozen at 5^oC and left at around room temperature for aging time or floor life before molding process. The EMC floor life effect to its properties and reliability performance of IC package. Therefore, this work interested in varied the floor life of EMC before molding process to analyze properties of EMC such as spiral flow length, gelation time, and viscosity. In experiment, the floor life of EMC were varied to check the effect of its property to reliability performance. The EMC floor life were varied from 0 hours to 60 hours with a step of 12 hours and observed wire sweep, incomplete EMC, and delamination inside the packages for 5x5 mm² of QFN packages. The evaluation showed about clearly effect of EMC floor life to IC packaging reliability. EMC floor life is not any concern for EMC property, moldability, and reliability from 0 hours to 48 hours for molding process of 5x5 mm² QFN packaging manufacturing.

Keywords: Integrated circuit (IC) packaging, epoxy molding compound (EMC), molding compound floor life, gelation time

Introduction

Today, encapsulation of molding process using a transfer epoxy molding compound (EMC) is a popular method for integrated circuit (IC) packaging manufacturing. Molding is the process to protect the die in IC package form external environment for mechanical and chemical protection by shaping EMC continuing with the formation of a gelatin with complete cross linked network and leading finally to the fully cured thermoset.

EMC is thermosetting polymer which this materials with cross-linked polymer chains that has no melting temperature after they are cured. EMC is

a mixture of an epoxy resin, a filler (silica, SiO₂), a hardener and other additives. The important part of EMC which is epoxy resin functions as an adhesive and binder. For silica filler part, this part is the largest portion of EMC provides excellent mechanical strength and a thermal dispersion. From normal manufacturing process, the EMC is stored in the frozen at 5^oC and left at around room temperature for aging time or floor life before molding process. The EMC floor life effect to its properties and reliability performance of IC package.

Therefore, this research interested in study to vary floor life of EMC before molding process from

0 hours to 60 hours with a step of 12 hours and analyze properties of EMC such as spiral flow length, gelation time, and viscosity. Moreover, this research also studied about molding process quality and reliability performance. The next section describes methodology of inspection effect of epoxy molding compound floor life to reliability performance for Integrated circuit package. Section 3 presents results and discussion. Finally, we conclude this paper.

Materials and Methods

This section describes about the methodology for inspection EMC property with different floor life after aging time before molding process, moldability and reliability performance were observed by using EMC on each floor life time on QFN 5x5 mm² package. In experiment, EMC floor life was from 0 hours to 60 hours with a step of 12 hours for analysis as shown in Table 1 and Figure 1.

Table 1 Interval of EMC floor life after aging time.

Floor life (Hrs)	0	12	24	36	48	36
Compound A	1	2	3	4	5	6

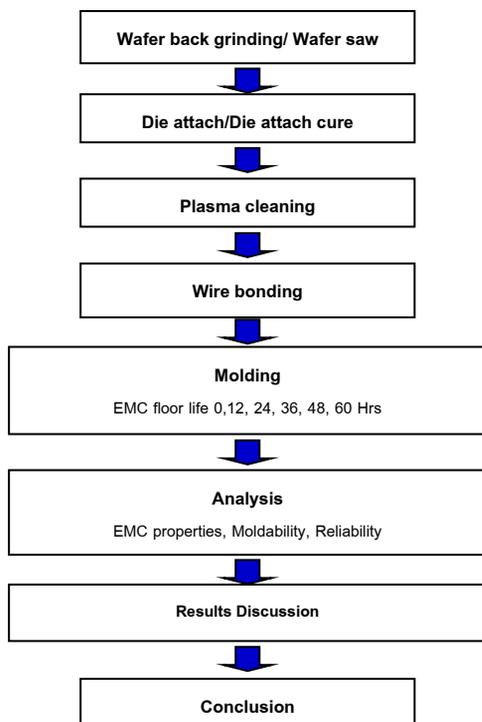


Figure 1 The experiment flow.

For analysis, the sample were divided into three groups for inspection EMC properties consists of viscosity, gel time and spiral flow length. The second group was observed moldability with x-ray which are wire sweep and incomplete mold. The last group used for reliability testing.

For the reliability, this experiment was performed moisture sensitivity test by refer standard J-DEC-020D as shown in Figure 2, Table 2, and Table 3 (moisture/reflow sensitivity classification for nonhermetic solid state surface mount devices : MSL).

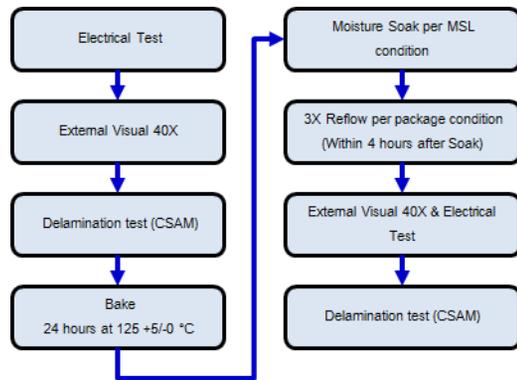


Figure 2 The procedure for moisture sensitivity level test (MSL).

Table 2 Standard of moisture sensitivity level

MSL Level	Floor life	
	Time	Condition
1	Unlimited	≤ 30 °C/ 85% RH
2	1 year	≤ 30 °C/ 60% RH
3	168 hours	≤ 30 °C/ 60% RH
4	72 hours	≤ 30 °C/ 60% RH
5	48 hours	≤ 30 °C/ 60% RH

Table 3 Standard of moisture sensitivity level for soaking requirement.

MSL Level	Soaking Requirement				
	Standard		Accelerated Equivalent		Condition
	Time (hour)	Condition	eV	eV	
			0.40-0.48	0.30-0.39	
Time (hour)	Condition	Time (hour)	Time (hour)	Condition	
1	168 +5/-0	85 °C/ 85% RH	N/A	N/A	N/A
2	168 +5/-0	85 °C/ 60% RH	N/A	N/A	N/A
3	192 +5/-0	30 °C/ 60% RH	40 +1/-0	52 +1/-0	60 °C/ 60% RH
4	96 +2/-0	30 °C/ 60% RH	20 +0.5/-0	24 +0.5/-0	60 °C/ 60% RH
5	72 +2/-0	30 °C/ 60% RH	15 +0.5/-0	20 +0.5/-0	60 °C/ 60% RH

Results and Discussion

The EMC property

For EMC properties results, spiral flow, gelation time, viscosity were determined for inspection IC package performance for 5x5 mm² QFN packages.

Spiral flow length

The relationship between spiral flow length test and EMC floor life is shown in Figure 3. Spiral flow is the length that EMC flow with helix shape under 1000 psi and 175 °C. The results showed that spiral flow length was deteriorated around 20 % at EMC flow life more than 48 hours floor life. Therefore, spiral flow less than 48 hours can be acceptable for standard value of IC packaging manufacturing process.

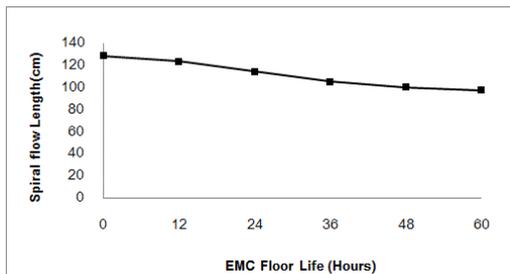


Figure 3 The relationship between spiral flow length test and EMC floor life.

Gelation time

The gelation time results are shown in Figure 4. The result show that gelation time of EMC slightly reduce around 2% from 0 hours to 60 hours floor life time. The gelation time results are acceptable for IC packaging manufacturing process.

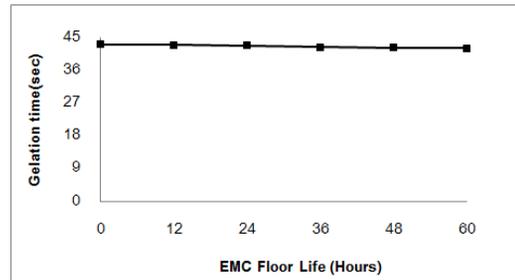


Figure 4 The gelation time for EMC floor life.

Viscosity

The viscosity results with varied EMC floor life are shown in Figure 5. The results show that gelation time of EMC slightly increase from 0 hours to 60 hours floor life time. The gelation time values are acceptable for IC packaging manufacturing process.

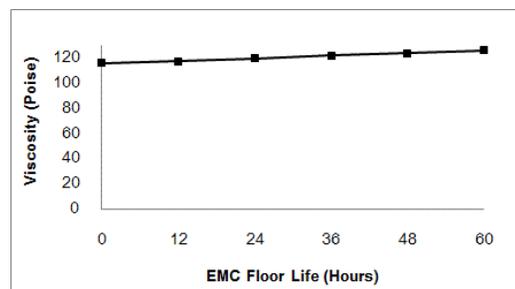


Figure 5 The viscosity results with varied EMC floor life.

Moldability.

The results of wire sweep and incomplete mold used for observing moldability of 5x5 mm² QFN on each EMC floor life.

Wire Sweep

The wire sweep results with varied EMC floor life are shown in Table 3 and Figure 6. The wire sweep results were observed about displacement and deformation of wire loop inside the packages. The results show that wire sweep values clearly increase

from 0 hours to 60 hours EMC floor life. For standard IC packaging manufacturing. The maximum wire sweep was controlled with 15% from standard values. However, the EMC floor life at 60 hours is closed to 15% which is maximum stand specification of wire sweep. The EMC floor life at 60 hours is acceptable or wire IC packaging manufacturing process.

Table 3. The wire sweep results for EMC floor life.

Wire sweep (%)	EMC floor life (hours)					
	0	12	24	36	48	60
Max	6.88	8.97	10.95	11.93	12.59	14.81
Min	2.04	3.39	3.18	4.66	4.28	5.32
Average	4.28	6.12	7.09	7.74	8.17	10.70

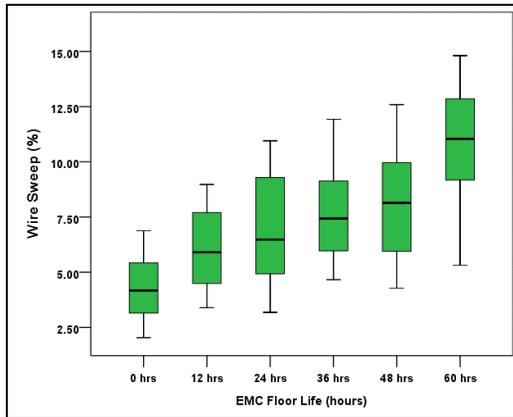


Figure 6. The wire sweep results with varied EMC floor life.

Incomplete mold

After molding process, the IC package also were observed with visual inspection to inspection incomplete molding. The inspection results show that not found incomplete mold for all EMC floor life. The result is shown in Table 4.

Table 4 The inspection results for incomplete mold of each EMC floor life

Incomplete mold	EMC Floor life (hours)					
	0	12	24	36	48	60
Result	0/760	0/760	0/760	0/760	0/760	0/760

Delamination

All IC packages were observed delamination inside the package on each EMC floor life. The results show that no any delamination, separation, and internal void for every EMC floor life as shown in Table 5.

Table 5 Delamination results for each EMC floor life.

Delamination result	EMC Floor Life (hours)					
	0	12	24	36	48	60
Result	0/760	0/760	0/760	0/760	0/760	0/760
CSAM						
TSAM						

Reliability

The IC package was tested for MSL testing with 22 units per each EMC floor life. The results show about delamination before and after testing as shown in Table 6. The results of reliability testing are acceptable for all EMC floor life due to no delamination both on die surface paddle and lead surface.

Table 6 Delamination test result before and after MSL test for EMC floor life.

Delamination result	EMC Floor Life (hours)					
	0	12	24	36	48	60
Result	0/22	0/22	0/22	0/22	0/22	0/22
Before						
After						

Conclusion

This research studied about effect of epoxy molding compound floor life to EMC property, moldability, and reliability performance QFN packages. The properties of EMC are acceptable such as gelation time and viscosity for all the floor life time spiral flow less than 48 hours can be acceptable for

standard value of IC packaging manufacturing process. The mold ability also acceptable in term of wire sweep, incomplete mold, and delamination. For all EMC floor life. However, for wire sweep, the EMC floor life at 60 hours is closed to 15% which is maximum stand specification of wire sweep. For reliability test, the results show that, no delamination was observed for all packages. Therefore, EMC floor life is not any concern for EMC property, moldability, and reliability from 0 hour to 48 hours for molding process of IC packaging manufacturing.

Acknowledgments

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