



Faculty of Manufacturing Engineering

TO ELIMINATE ICING AND CONDENSATION IN TEMPERATURE CYCLING CHAMBERS

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Master in Manufacturing Engineering (Manufacturing System Engineering)

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**TO ELIMINATE ICING AND CONDENSATION IN TEMPERATURE CYCLING
CHAMBERS**

PREMNATHAN A/L RAMALINGAM

**A thesis submitted
In fulfilment of the requirements for the degree of Master of
Manufacturing System Engineering**

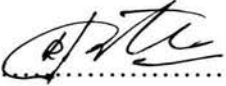
Faculty of Manufacturing Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2017

DECLARATION

I declare that this thesis entitled "To Eliminate Icing and Condensation in Temperature Cycling Chambers" is the result of my own research except as cited in the references. The Thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.


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APPROVAL

I hereby declare that I have read this thesis and in my opinion, this thesis is sufficient in terms of scope and quality as a partial fulfilment of Master of Manufacturing Engineering (Manufacturing System).

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DEDICATION

To my beloved parents Mr. Ramalingam Mahamoney and Mrs.Sushila Govindaraju.

ABSTRACT

In reliability testing, the temperature cycle chamber is one of the most common pieces of equipment needed to assess semiconductor devices reliability. Temperature cycling involves subjecting the semiconductor devices to an environment test to hot and cold temperature cyclic transition. In a temperature cycling stress which were needed to run for a longer period (higher number of cycles request), ice induced in the cold zone and this icing have been a long lasting unsettled issue. In Reliability Product Test lab (RPT) of Infineon Technologies Melaka there are total of 16 dual zone air-to-air temperature-cycling chambers. There are various values of temperatures requested to run, where cycles start from 80°C to 175°C (in the hot zone) and from -35°C to -65°C (in the cold zone). Icing in cold zone has been one of the main reasons for various problems occurred which not only effecting the chamber itself but also effects the whole temperature cycling stress test. Some of the problems are such as cradle basket jammed, spindle shaft bend, blower fan motor propeller damage, cradle motor damage, pneumatic cylinder jammed or spoil etc. Icing also cause the cooling to be slow which directly will cause the cycling process to be slow and this will affect the overall temperature cycling stress cycle time. There are multiple studies and physical trials have been conducted to solve this icing issue for quit sometime. The icing only can be eliminated if the wet molecules are removed from the chamber. As suggested by some chamber manufacturers, compressed dry air is the first choice but it is not effective for longer running processes. In this research, the trials using dry air also conducted. Finally after gone through some trials, go through online articles and discussion with the chamber manufacturers, a better solution was justified. That is by purging N₂ gas into temperature cycling chambers. Like compressed dry air, N₂ also will remove the wet molecules but it will be faster and will be suitable for longer running processes. The N₂ gas will be purged into both hot and cold zone in an optimum volume. In this research, the optimum volume was identified. Result from the research will be shared to the management of Infineon Technologies RPT Lab for improvement actions implementation.

ABSTRAK

Dalam penilaian kebolehppercayaan, mesin pengitar suhu adalah antara mesin-mesin utama yang diperlukan untuk menguji kebolehppercayaan peranti-peranti semikonduktor. Pengitaran suhu merupakan sebuah process menundukkan peranti semikonduktor untuk ujian persekitaran untuk suhu peralihan kitaran panas dan sejuk. Dalam penilaian kitaran suhu yang memerlukan jangka masa yang panjang (kekerapan kitaran yang tinggi berdasarkan permintaan), ais wujud di dalam zon sejuk dan ais ini telah menjadi sebuah isu yang belum ada penyelesaian sejak lama lagi. Di makmal penilaian kebolehppercayaan Infineon Melaka (RPT Lab) terdapat sebanyak 16 buah mesin pengitar suhu yang mengandungi dua zon. Terdapat pelbagai kadar suhu sentiasa diminta untuk dijalankan, daripada 80°C hingga 175°C (zon panas) dan daripada -35°C hingga -65°C (zon sejuk). Ais yang wujud di dalam zon sejuk merupakan factor utama kepada pelbagai masalah yang berlaku dalam proses pengujian pengitaran suhu. Ais ini bukan sahaja merosakkan mesin, ia juga mengganggu seluruh proses pengujian pengitaran suhu. Antara kerosakkan yang selalunya berlaku akibat ais adalah, bakul buaian tersekat, gelondong aci bengkok, kipas motor rosak, motor buaian rosak, silinder pneumatik tersekat atau rosak dan sebagainya. Ais pada bahagian yang tertentu di dalam zon sejuk boleh melambatkan proses penyejukan di mana ia akan secara langsung perlahankan keseluruhan proses penilaian pengitaran suhu. Ini akan meningkatkan jangka masa lebih daripada yang ditentukan. Pelbagai kajian dan ujian fizikal telah dijalankan untuk menyelesaikan masalah ais ini sejak dahulu lagi. Ais di dalam zon sejuk hanya boleh dihapuskan jika molekul basah dapat dikeluarkan daripada zon tersebut. Seperti yang dicadangkan oleh beberapa pengeluar mesin, udara kering yang dimampatkan dipilih sebagai jalan penyelesaian pertama tetapi ia tidak berkesan untuk proses pengitaran suhu yang lebih lama. Dalam kajian ini, ujian menggunakan udara kering yang dimampatkan juga disertakan. Akhirnya selepas melalui beberapa perbincangan, melalui artikel dalam internet dan perbincangan dengan pengeluar mesin, penyelesaian yang lebih baik telah ditentukan. Ia itu dengan salurkan gas N₂ kedalam mesin pengitar suhu. Seperti angin kering yang dimampatkan, gas N₂ juga mempunyai kebolehan untuk mengeluarkan wap air tetapi dengan cara yang lebih cepat dan sangat sesuai untuk penggunaan proses berterusan yang lebih lama. Gas N₂ akan ditiup kedalam kedua-dua zon, iaitu kedalam zon panas dan zon sejuk dengan satu kuantiti yang paling sesuai. Keputusan daripada penyelidikan ini akan ditunjukkan kepada pihak pengurusan makmal penilaian kebolehppercayaan Infineon Melaka (RPT Lab) untuk penambahbaikan berterusan dan perlaksanaan.

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CHAPTER 1

INTRODUCTION

This chapter comprises the background of the study, problem statement, aim and objectives, scope of the study, and background of Company, Infineon Technologies Sdn. Bhd. The importance and the expected outcomes of this study are also presented at the end of this chapter.

1.1 Factory Background

Infineon Technologies AG is a German semiconductor manufacturer founded on 1 April 1999, when the semiconductor operations of the parent company Siemens AG were spun off to form a separate legal entity. As of 30 September 2015, Infineon had 35,424 employees worldwide with a net of 6 billion Euro. Infineon Technologies Melaka (Malaysia) Sdn.Bhd. is one of the largest semiconductor manufacturing industry in Malaysia with more than 8000 employees. In Malaysia, Siemens starts its business in 1973. Through time and with the dedication towards success, Infineon Melaka becomes the largest sites for Discrete Semiconductors, Power Semiconductors, Logic and Sensor Products as can be seen in Figure 1.0. It had been converted to one of the largest economy growths for the state of Melaka. Infineon Melaka is the only semiconductor company in Malaysia which have a large laboratory for reliability stress test.

Infineon headquarters is situated in Villach, Germany and it is the world leader in semiconductor products offering products to industries such as Automotive, Multi market

and Industrial products. The Research and Development (R&D) aggressively inventing new products to compete in these challenging global economies.

Infineon has a number of facilities in Europe, one in Dresden, Germany, Europe's microelectronic, and emerging technologies center. Infineon's high power segment is in Warstein, Germany; Villach and Graz in Austria; Cegléd in Hungary; and Italy. It also runs R&D centers in France, Singapore, Romania, Taiwan, UK and India, as well as fabrication units in Singapore, Malaysia, Indonesia, and China. There's also a Shared Service Center in Maia, Portugal. Main customers are Bosch, Continental, Omron, Delphi and other automotive customers.



Figure 1.0: Infineon Melaka (Malaysia) Sdn.Bhd.

1.2 Core Business

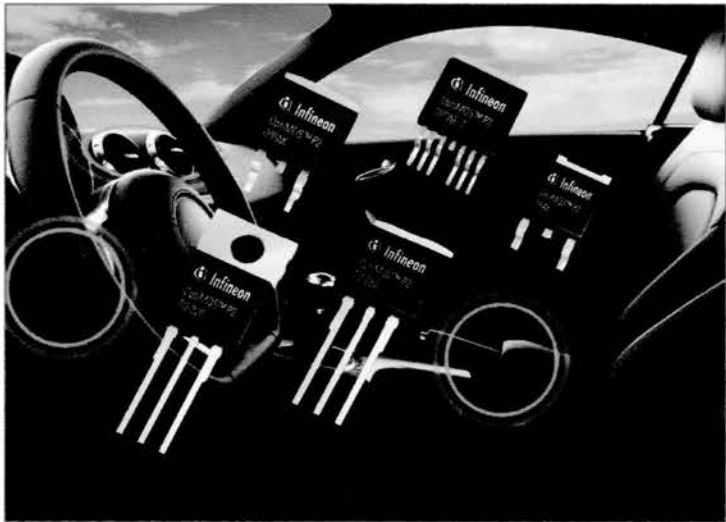


Figure 1.1: High Power semiconductor devices for automotive industries. (Product Catalogue for distribution 2014)

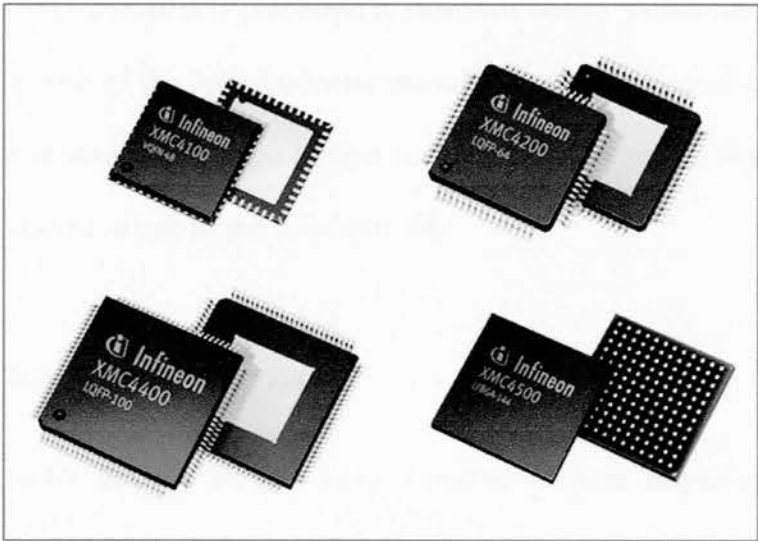


Figure 1.2: Memory products (XMC4500) (Product Catalogue for distribution 2014)

Figure 1.1, Figure 1.2 and Figure 1.3 shows the varieties of semiconductor components/products manufactured in Infineon Technologies Melaka Plant. Manufacturing processes differs according to segments.

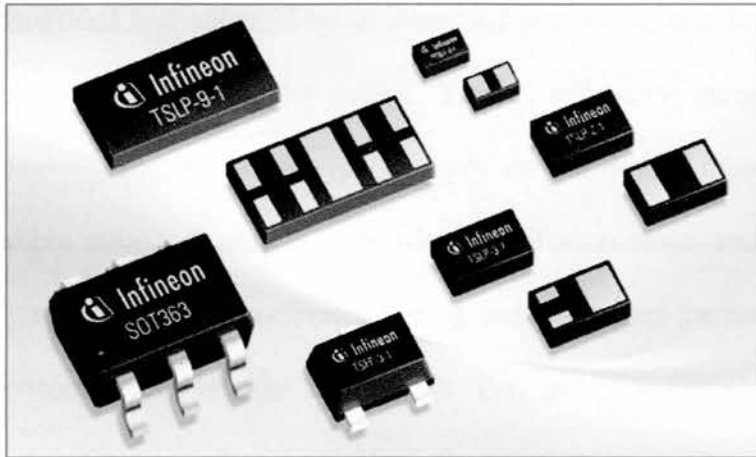


Figure 1.3: Transistor/Diodes (Product Catalogue for Distribution 2014)

Infineon Melaka is divided into four segments which is Power Product, Sensor, Logic and Discrete products. Power product provides the highest volume of product compare to other segment. Main packages from Power Segment are LPL, Dpak, Fullpack and SS08. Each of the products is processed at different blocks within the Power Segment. Infineon Melaka is one of the semiconductor manufacturer with product reliability test lab and the company is investing a huge budget for the reliability stress test processes. This research was conducted in one of the reliability lab.

1.3 Product Reliability Stress Test

Semiconductor devices are the most sensitive towards impurities and particles. Therefore, to develop these devices it is necessary to manage many processes while accurately controlling the level of impurities and particles. The finished product quality depends upon the relationship of each interacting substance in the semiconductor, including metallization, chip material and package. The ultimate purpose of the “reliability test” is to ensure that semiconductor devices manufactured by a semiconductor

manufacturer, assembled and adjusted by an assembly contractor, and finally delivered to customers can perform for the intended period. Various reliability stresses are applied to semiconductor devices, and the stress type depends on the device manufacturing stage, such as the assembly stage, adjustment stage, field installation stage, and operation stage. Among the many environmental accelerated testing methodologies for assessing reliability of electronic systems, temperature cycling is the most commonly used for the characterization of devices as well as interconnections.

1.4 Reliability Laboratory in Infineon Melaka

Globally, Infineon Technologies have product reliability test labs in six places such as German (Villach, Munich & Regensburg), China (Wuxi), Singapore and Malaysia (Melaka). The lab in Melaka is the largest among the other labs. All six labs were connected clustery.



Figure 1.4: Infineon Reliability Product Testing Cluster
Overview - RPT MAL Lab Presentation 2015